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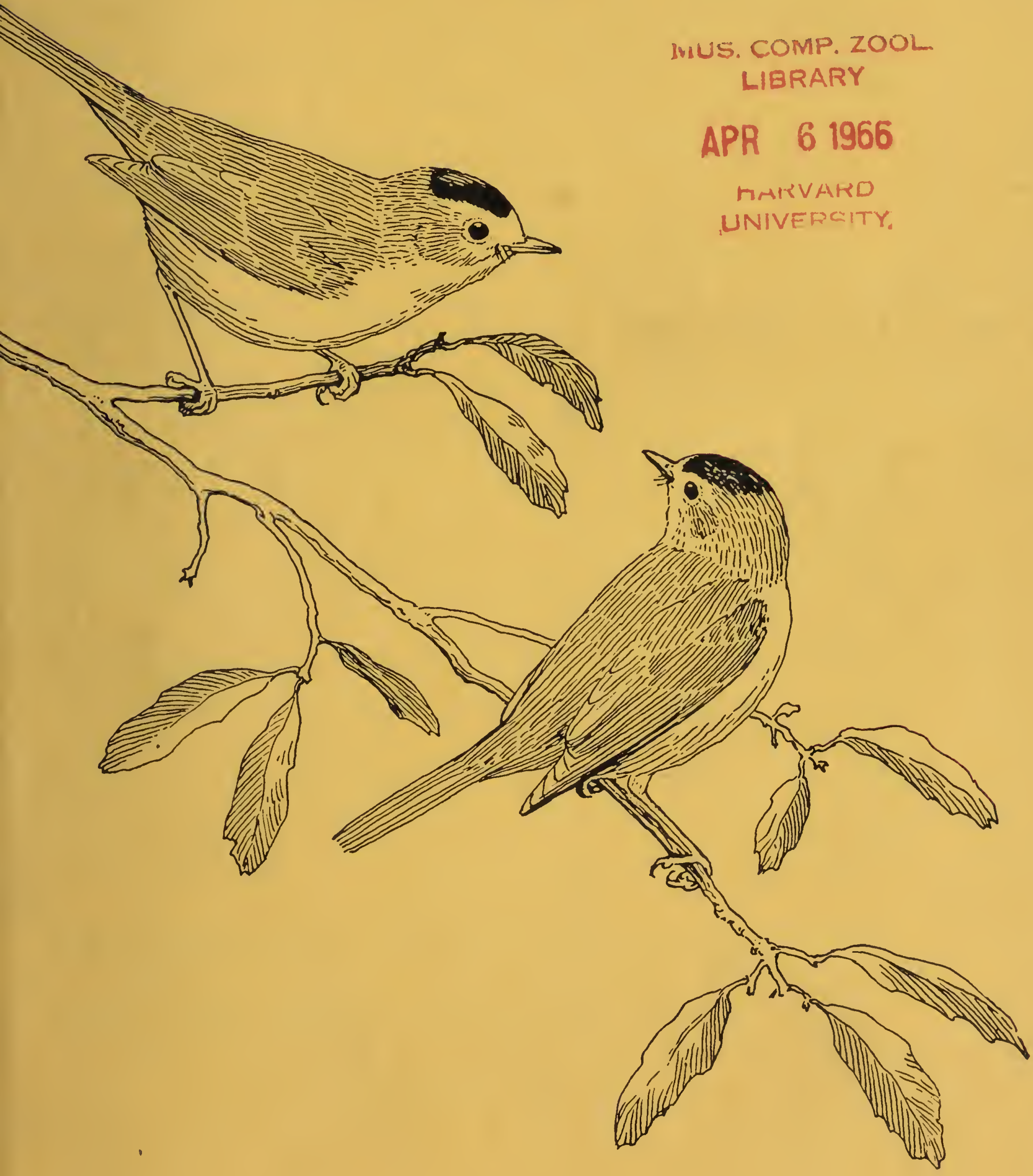

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MOTTLED WOOD-OWL *(Ciccaba virgata)*

From a tempera painting by Don R. Eckelberry

(See page 8)

RECENT RECORDS OF BIRDS IN TRINIDAD AND TOBAGO

RICHARD P. FFRENCH AND MARGARET FFRENCH

In a tropical country where amateur ornithologists are few and professional work is usually limited to short periods with little time for general observation, it is to be expected that much is still to be learned about the occurrence and status of uncommon birds. The island of Trinidad, so close to the South American mainland and sharing much of its fauna, is also on one of the fall migration routes for water birds from the North down the chain of the Lesser Antilles. Thus its unique position makes it a likely place for unusual visitors from both North and South.

This paper is designed to supplement "The Birds of Trinidad and Tobago" (Herklots, 1961), clarifying the status of several species on the basis of recent fieldwork and recording recent additions to the avifauna of these islands. A few recently published records have also been included for completeness. In addition to our own observations, those of several other observers, particularly David W. and Barbara K. Snow and Charles T. Collins, have been incorporated in the text. We are grateful to them for permission to include these records.

Although the majority of the records are sight records, only unquestionable identifications from reputable observers have been included. Full field notes made on the spot have been required, and any doubtful records have been rejected. Nevertheless, the sight records of species new to the islands must be considered provisional, pending the collection of specimens.

Seventeen new records for Trinidad, three for Tobago, and six new breeding records for Trinidad are reported here. Other records are for birds which have rarely been seen in the past, while some show that certain birds are not as rare as was thought. The text reflects the fact that we were working intensively on banding shorebirds at Pointe-a-Pierre during 1959–62, in the course of which several interesting observations were made. It is more than likely that a similar concentration in swamps or forests would bring to light many other unusual occurrences, especially among migrant ducks and warblers from the North, and among raptors from the continent of South America.

Audubon's Shearwater (*Puffinus lherminieri*).—A bird was found dead at Manzanilla Beach on 4 April 1957. The skin is in the American Museum of Natural History. One bird was seen on 20 April 1963 at sea off Soldado Rock, southwest of Trinidad. Rare off Trinidad, where it is not known to breed, though it breeds on Tobago.

Mediterranean Shearwater (*Puffinus kuhli*).—Dead or exhausted birds have been found on Mayaro Beach on 21 June 1955, 19 February 1956, and 29 April 1961. The skins have been identified at the American Museum of Natural History, and one of them is in the collection of the Trinidad Regional Virus Laboratory, Port of Spain. Only one bird had been recorded previously.

Greater Shearwater (*Puffinus gravis*).—A bird found dead at Manzanilla in July 1960 (D. Snow) was identified at the American Museum of Natural History as this species. This is the first record for Trinidad.

Manx Shearwater (*Puffinus puffinus*).—Two dead birds were found on the Manzanilla Beach on 6 December 1958 (D. Snow), supplementing the one previous record for Trinidad.

Bulwer's Petrel (*Bulweria bulwerii*).—One dead bird was found on 23 January 1961 on Soldado Rock by J. B. Saunders. This is the only record for Trinidad and the Caribbean area (ffrench, 1963).

White Pelican (*Pelecanus erythrorhynchus*).—A bird seen in December 1963 at Blanchisseuse by three observers (Eckelberry, 1964) is the first record of the species in the southern Caribbean.

Gray Heron (*Ardea cinerea*).—A bird banded as a nestling in France was shot by a Fyzabad hunter in early August 1959. The exact locality was not recorded. This is the first record of this species for the Caribbean area, although another banded bird was taken in Montseratt at about the same time (Baudouin-Bodin, 1960). In the New World the bird has only occurred before in Greenland.

White Ibis (*Eudocimus albus*).—A bird was seen going to roost along with several thousand Scarlet Ibis (*Eudocimus ruber*) in the Caroni Swamp on 19 July 1964. It was seen again on 17 August 1964 by the author, C. T. Collins, N. Niosi, and I. Black. This is the first record for Trinidad, although in Venezuela the two *Eudocimus* species commonly live side by side (Zahl, 1950).

Swallow-tailed Kite (*Elanoides forficatus*).—Two adult birds were seen on 10 April 1963 at Pigeon Peak, Tobago. This is the first record for Tobago, although the bird is a common visitor to Trinidad.

Short-tailed Hawk (*Buteo brachyurus*).—Birds of dark and light phases, but chiefly the latter, have been seen by numerous observers on numerous occasions during the last six or seven years, nearly always over hill forest, but also occasionally over fairly open country in central Trinidad. The species appears to be widespread in Trinidad; the fact that Herklots (op. cit.) quotes but one record is due to the difficulty which observers have hitherto experienced in its identification.

Black-collared Hawk (*Busarellus nigricollis*).—Two adult birds were seen on 30 December 1963 in Bush-Bush Forest, Nariva Swamp, by D. R. Eckelberry, C. Brooke Worth, and other observers. The first-named observer is very familiar with this species on the mainland. This is the first record for Trinidad, though its presence has been suspected before (Eckelberry, 1964).

Yellow-headed Caracara (*Milvago chimachima*).—A bird was seen in the Nariva Swamp on 5 October 1960 (D. Snow), and another by R. P. ffrench in the Caroni Swamp on 31 May 1964. These supplement the two previous records for Trinidad.

Pearl Kite (*Gampsonyx swainsoni*).—Previously known from only two or three records, birds of this species, usually singly, have been seen on various occasions recently: 26 July 1960 at Alandale Beach near Toco, 11 September 1960 at the mouth of the Nariva River, 3 December 1961 in the Moruga forest, and in July 1963, March, September, October, and November 1964 on the edge of the Nariva Swamp, at Chaguanas, and at Waller Field. It seems to be uncommonly seen, rather than rare.

Aplomado Falcon (*Falco femoralis*).—A bird was seen on 21 and 26 January 1962 by several observers on the edge of the Oropouche Lagoon. It was frequenting the area where thousands of Dickcissels (*Spiza americana*) came to roost. The species is very rare, but possibly breeds, in Trinidad.

Sora Rail (*Porzana carolina*).—One was seen on 21 November 1963 on the edge of the Oropouche Lagoon. This bird is commonly observed in winter on the nearby island of Barbados, but is rather rarely seen in Trinidad, where there is much more extensive cover.

Yellow-breasted Crake (*Porzana flaviventer*).—Two birds have been seen on three occasions, 3 May 1959, 2 May 1960, and 28 May 1961, in the same patch of decaying water hyacinth (*Eichhornea speciosa*) on the southeastern edge of the Caroni Swamp. Originally thought to be *Laterallus exilis*, they were seen by up to four observers at distances ranging down to less than 30 feet in perfect light conditions with 8 × 30 binoculars. Detailed descriptions checked at the American Museum of Natural History subsequently indicated their identity. These are the first records for Trinidad, but the species is known to inhabit several islands of the Greater Antilles, as well as Central and South America, including the Guianas.

Temminck's Crake (*Laterallus exilis*).—Individual birds have been seen on 21 December 1960, 4 February 1964, and on other unnoted occasions on the edge of the Oropouche Lagoon. Also birds were seen on 5 July 1961 and 28 August 1962 at Waller Field (Collins). It is resident in Trinidad, and is probably less rare than it seems.

Cayenne Lapwing (*Belonopterus cayennensis*).—A bird was seen under excellent conditions on the bank of a reservoir at Pointe-a-Pierre on 22 and 23 May 1961 by three observers at distances down to 75 feet. On 26 May 1963 three birds were seen by Wilbur G. Downs on the University College savannah at St. Augustine. These are the first records for Trinidad, although the species is abundant on the nearby mainland.

Ringed Plover (*Charadrius hiaticula*).—A bird was caught in a mist net at Pointe-a-Pierre on 31 October 1962, which had its inner toes almost entirely unwebbed and very small webs to the outer ones. The observers, R. P. and M. ffrench and J. B. Saunders, are quite familiar with all the species of *Charadrius* which have occurred in Trinidad, including *C. semipalmatus* (of which more than 40 have been banded), *C. collaris*, and *C. wilsonia*. The bird was banded and released. This appears to be the first record for Trinidad, but a specimen was taken in Barbados about 1888.

Killdeer (*Charadrius vociferus*).—Five birds were seen feeding on a flooded pasture at Pointe-a-Pierre on 19 November 1961, and a single bird also at Pointe-a-Pierre on 25 December 1962. Though the species has been recorded from neighbouring islands, including Tobago, these are the first records for Trinidad.

Wilson's Plover (*Charadrius wilsonia*).— A nest was found on bare earth among mangroves on the seashore at Pointe-a-Pierre on 26 May 1960. It contained one hatching egg and one very small chick. Another nest was found 8 yards away on 19 June 1960, containing three eggs. The eggs were still there on 11 July but had disappeared on 14 July. These are the first definite breeding records for Trinidad. It was impossible to establish whether the birds were of the nominate race, which breeds as far south as Antigua, or of the form *cinnamominus* which breeds on the South American continent and neighbouring islands.

Upland Plover (*Bartramia longicauda*).—This bird does not seem to be as rare as is stated by Herklots (op. cit.). Up to four birds have been seen on grassland at Pointe-a-Pierre on 17 September 1960, 16 October 1960, from 19 September to 22 October 1961, from 4 to 7 October 1962, and from 18 to 25 September 1964. One was trapped and banded on 17 September 1960. Also about 20 birds were seen on 4 October 1960 at Arima (D. Snow). It seems to be a regular passage-migrant in small numbers.

Knot (*Calidris canutus*).—Although sparsely recorded previously, this bird appears to be regular on migration in small numbers through Trinidad. Recent records include birds seen at Pointe-a-Pierre on 26 August and 7 September 1960, and trapped and banded on 19 September 1960, 19 September 1962, and 22 September 1964. A single bird was seen at the Nariva River mouth on 15 September 1962.

Stilt Sandpiper (*Micropalama himantopus*).—Though Herklots (op. cit.) gives the impression that this bird is an irregular visitor, it appears in fact to be regular on migration through Trinidad, although in small numbers. Birds have been seen at Pointe-a-Pierre as early as 5 August and as late as 24 October. Six birds were trapped and banded in 1960 and three in 1962.

Buff-breasted Sandpiper (*Tryngites subruficollis*).—Despite recent fieldwork on shorebirds, this species still appears to be rare on migration through Trinidad. Individuals have been seen on but three occasions recently, 11 September 1960 at Nariva River mouth, and on grassland at Pointe-a-Pierre on 16 October 1960 and 4 October 1962.

Hudsonian Godwit (*Limosa haemastica*).—Two birds were seen at close quarters on the seashore at Pointe-a-Pierre on 19 September 1960. This seems to be a very rare species in Trinidad, having apparently not been recorded before during this century.

Parasitic Jaeger (*Stercorarius parasiticus*).—A light phase adult was seen from a distance of 30 feet by three observers on a boat at anchor in Port of Spain harbour on 22 January 1961. Jaegers, possibly of this species, have also been seen at sea near Soldado Rock on 18 June 1961, 27 May 1962, and 8 July 1962, and another off the north coast on 18 May 1963. These are the first records for Trinidad.

Ring-billed Gull (*Larus delawarensis*).—An immature bird was seen by several observers at Pointe-a-Pierre from 17 November to 18 December 1960. It was always with a flock of *Larus atricilla.* This is the first record for Trinidad.

Royal Tern (*Thalasseus maximus*).—Small numbers were found breeding on Soldado Rock in 1962 and 1963 among a large breeding colony of *Sterna fuscata* and *Anous stolidus* (ffrench and Collins, 1965). These are the first breeding records for Trinidad.

Cayenne Tern (*Thalasseus eurygnathus*).—Indications of breeding were found on Soldado Rock in 1962 and 1963 (ffrench and Collins, 1965). These are the first breeding records for Trinidad.

Band-tailed Pigeon (*Columba fasciata*).—Previously considered to be an extremely rare resident, this species appears to be not only rare but very local, perhaps confined to the higher parts of the Northern Range around El Tucuche. Two birds were seen by four observers at the summit of this mountain (elevation 3,075 feet [936 meters]) on 13 January 1963, and five birds were also seen there on 26 June 1963 (Collins and F. Gary Styles).

Mottled Wood-Owl (*Ciccaba virgata*) (see frontispiece).—This uncommon owl has been seen and heard on several occasions recently in the Bush-Bush Forest, Nariva Swamp, by T. H. G. Aitken and C. Brooke Worth.

Rufous Nightjar (*Caprimulgus rufus*).—The well-known call of this species was heard at Chaguaramas on 21 May 1963 (Collins). At Monos Island on 16 and 17 May 1964 the calls of many individuals were heard and recorded on tape by members of the Trinidad Field Naturalists' Club (ffrench, 1965), and later compared with authenticated recordings of the species. The presence of the species in Trinidad remains, however, unsubstantiated by a specimen.

Chapman's Swift (*Chaetura chapmani*).—Previously considered to be a rare resident, it has been observed in mixed flocks of *Chaetura* swifts near Rio Claro on 13 June 1964. It has also been seen flying in the company of Short-tailed Swifts (*C. brachyura*) on numerous occasions from May to November 1964 near Valencia and in the Arima Valley, and roosting with *C. brachyura* near Valencia (Collins). The first nest of this species was found near Valencia on 3 June 1963 (Collins in prep.).

Picine Woodhewer (*Xiphorhynchus picus*).—Although previously considered to be extremely rare, this species was seen and heard on numerous occasions in the centre of the Caroni Swamp from May to October 1964. On 28 July a nest containing two well-grown young was found in the hollow trunk of a dead mangrove tree. This is the first breeding record for Trinidad.

Souleyet's Woodhewer (*Lepidocolaptes souleyeti*).—This bird, rare in Trinidad, has been seen on 31 July 1962 and several other occasions in Bush-Bush Forest, Nariva Swamp. A single bird was trapped by C. Brooke Worth and T. H. G. Aitken near Vega de Oropouche in July 1964.

White-winged Swallow (*Tachycineta albiventer*).—Although rarely seen in northern Trinidad, this species is common at Pointe-a-Pierre, where nests have been found in scaffolding pipes near water. Eggs were found abandoned on 28 July 1962, but a second brood hatched on 16 September.

Gray-cheeked Thrush (*Hylocichla minima*).—An adult male (which had killed itself by flying against a glass door) was found in Port of Spain by T. H. G. Aitken on 1 November 1963. The skin was referred to the nominate race at the American Museum of Natural History, and is now in the collection of the Trinidad Regional Virus Laboratory (No. 7154). This is the first record for Trinidad, although the species is a common visitor to Venezuela (Worth and Aitken, 1965).

Yellow-throated Vireo (*Vireo flavifrons*).—A bird of this species was caught in October 1960 by the lighthouse keeper on Chacachacare Island and seen on the following day (D. and B. K. Snow). This is the first record for Trinidad, although there is a single record for Tobago (ffrench, *in* Herklots, op. cit).

Black-whiskered Vireo (*Vireo altiloquus*).—One was seen at Pointe-a-Pierre on 10 September 1961 by the writer, who knew the species well in Barbados. Birds were seen in the Arima Valley on 14 March and 9 April 1961 (D. Snow). Although seen "frequently" in the years 1921–26 (Belcher and Smooker, 1937) it now seems to be a very occasional visitor.

Black and White Warbler (*Mniotilta varia*).—One was seen among other migrant warblers on 20 October 1960 at the head of the Arima Valley (D. Snow). Other birds have been seen by various American visitors at the same place (Christmas 1961, 10 January and 20 January 1965). It appears to be a regular visitor in small numbers. These are the first records for Trinidad.

Chestnut-sided Warbler (*Dendroica pensylvanica*).—A male of this species, not quite in full spring plumage, was seen in the Arima Valley in March 1959 (D. Snow). This is the first record for Trinidad.

Rice Grackle (*Scaphidura oryzivora*).—A flock of about a dozen birds was seen on 8 September 1964 in the Louis d'Or Valley, Tobago. Until recently the species was unknown in Tobago, although common in Trinidad.

Baltimore Oriole (*Icterus galbula*).—An adult male of this species was seen by several observers during December 1963 at Pointe-a-Pierre. It fed mainly at a golden apple tree (*Spondias cytherea*). This is the first record for Trinidad, although the species has been recorded from Tobago.

Troupial (*Icterus icterus*).—An adult bird was seen at Pointe-a-Pierre from September 1964 through February 1965. It was in richly coloured plumage, but since the species is occasionally imported in captivity from Venezuela, it is possible that this and previous records are of escaped birds.

Cravat (*Tanagra trinitatis*).—This species has recently been reported on Tobago (Pilling and Trowern, 1964). It is perhaps pertinent to point out that this species is a common cage bird in Trinidad, and that traffic in caged birds is frequent between Trinidad and Tobago. The present writer recently found a pair of Blue-winged Parakeets (*Forpus passerinus*) breeding in Tobago, undoubtedly introduced by this method.

Hepatic Tanager (*Piranga flava*).—Birds of this species have been seen frequently in the higher parts of the Northern Range, especially near the Arima–Blanchisseuse road. Breeding has been recorded and individuals of both sexes have been trapped and photographed. A recent skin is now in the Florida State Museum, and at least 12 others collected many years ago are in other American museums.

There has evidently been confusion in the past over the identification in Trinidad of this species and *P. rubra*. Herklots (op cit.) states that *flava* has a black bill, but individuals caught have shown in life the mandible to be pale horn, while the maxilla is blackish only at the base, ridge, and tip, otherwise horn-coloured. *Flava*, moreover, has quite a distinct call from *rubra*, and the majority of birds found in the Northern Range (and all those found from April to August) have given the call attributed to *flava* by Peterson (1941). Birds have been collected only in the Northern Range, usually above 1,000 feet, and have been seen there in every month of the year.

Birds of this genus seen in the lowlands at Pointe-a-Pierre have given only the typical *rubra* call. These birds, moreover, have been observed only during the winter months. Specimens have been taken on 6 November 1903 and 28 October 1964, the latter in the Northern Range.

Saffron Finch (*Sicalis flaveola*).—Recorded in every month of the year at Pointe-a-Pierre, where the species is not uncommon. Breeding behaviour has often been observed, and a nest was found on 4 October 1962 which contained young birds until 11 October. It had been built inside an old nest of the Yellow Oriole (*Icterus nigrogularis*), at about 35 feet from the ground in a mango tree (*Mangifera indica*). The species has been thought a migrant, but it seems more likely to be a localized resident, gradually spreading over savannah country throughout Trinidad.

SUMMARY

Recent records for 48 species in Trinidad and Tobago are presented, including 17 species not previously recorded in Trinidad, three new for Tobago, and six new breeding records for Trinidad.

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TEXACO TRINIDAD INC., POINTE-A-PIERRE, TRINIDAD, 11 MARCH 1965

ISLAND NESTING OF THE GADWALL IN NORTH DAKOTA

Harold F. Duebbert

Female ducks of most species usually select nest sites widely dispersed in the available preferred habitat. However, some individual hens often nest close together forming aggregations of unusual density. Usually these aggregations are found on islands. Among diving ducks, eiders (*Somateria* spp.) and scoters (*Melanitta* spp.) are traditionally social nesters and colonies containing hundreds or thousands of nests are often formed (Gudmundson, 1932; Gross, 1944; Scott, 1951; Koskimies and Routamo, 1953; Pettingill, 1959). Scott (1952) reported high density nesting of Greater Scaup (*Aythya marila*) and Oldsquaws (*Clangula hyemalis*) on a peninsula (nearly an island) in Myvatn, a shallow lake in Iceland. Descriptions of island nesting by various species of ducks in North America, principally Gadwalls (*Anas strepera*), American Widgeon (*Mareca americana*), and Lesser Scaup (*Aythya affinis*), have been presented by Job (1898), Bent (1907, 1923), Henry (1948), Hammond and Mann (1956), and others. Clarke (1895) wrote of ducks nesting on islands in the Camargue marshes on the delta of the Rhone River in southern France. Witherby et al. (1939) noted the tendency of many species of waterfowl to select islands as nest sites.

This paper describes a study of the breeding behavior and nesting ecology of the Gadwall on an island having an extremely high nest density. Observations were made on a 7-acre natural island in Pool 320 of the Lower Souris National Wildlife Refuge in north central North Dakota, from May through August in 1956 and 1957.

In the preferred cover types on the nesting island many nests were only inches apart. At each step several hens flushed from their nests. It seemed apparent that study of Gadwall breeding behavior and nesting ecology under these crowded conditions might yield interesting results.

STUDY AREA

The Lower Souris National Wildlife Refuge consists of 58,780 acres: 21,350 acres are river bottom marsh having a freshwater ecology; uplands consist of 37,430 acres of grassland, cropland, and small tree groves. Pool 320 covers 3,600 acres; 2,700 acres (75 per cent) was in open water and 900 acres (25 per cent) in emergent aquatic vegetation, predominantly broad-leaved cattail (*Typha latifolia*) and soft-stem bulrush (*Scirpus validus*), during the years of my study. The open-water zones of the impoundment contained excellent beds of pondweeds (*Potamogeton perfoliatus, P. pectinatus,* and *P. pusillus*). Water depth in Pool 320 during the waterfowl reproductive periods of 1956 and 1957 varied from 12 to 18 inches and was relatively stable.

The natural island upon which this study was conducted (hereafter referred to as Ding Island) has gentle surface contours and was elevated 10 to 15 feet above the surrounding water levels in 1956 and 1957. It was separated from the nearest mainland by 2,000 feet of open water. A narrow fringe of emergent aquatic vegetation, predominantly soft-stem bulrush and broad-leaved cattail, surrounded most of the island. The only woody cover on the island was three small patches of low willow (*Salix* sp.) and three small box elder trees (*Acer negundo*). Figures 1 and 2 illustrate vegetative relationships and Gadwall nest locations on Ding Island in 1957.

Associations of coarse weeds, predominantly tall nettle (*Urtica procera*), and Canada thistle (*Cirsium arvense*), and giant ragweed (*Ambrosia trifida*) covered approximately 25 per cent of the island surface. The remainder was covered with a grass–forb association which included smooth brome (*Bromus inermis*), western wheatgrass (*Agropyron smithii*), quackgrass (*Agropyron repens*), bluegrass (*Poa* spp.), blue wild lettuce (*Lactuca pulchella*), flixweed (*Descurainia sophia*), goosefoot (*Chenopodium berlandieri*), sweet clover (*Melilotus* spp.), Canada anemone (*Anemone canadensis*), and prairie wild rose (*Rosa arkansana*).

Precipitation at Lower Souris during 1956 and 1957 totaled 14.94 inches and 12.09 inches, respectively. Although these amounts were less than the long-term average of 16 inches, soil moisture was adequate for full development of the vegetation on Ding Island.

The Gadwall was second in abundance among breeding ducks at Lower Souris during this study (17 per cent and 24 per cent of total breeding pairs, 1956 and 1957, respectively). In 1956 we estimated that there were approximately 1,260 breeding pairs of Gadwalls on the refuge and 450 pairs were in Pool 320. In 1957, our estimates were approximately 1,640 breeding pairs of Gadwalls on the refuge and 300 pairs were in Pool 320 (Table 1).

METHODS

An elevated blind was constructed near the island center from which Gadwall behavior could be observed. The lower portion of this blind was designed to permit temporary habitation, so that 2 or 3 days could be spent there without undue disturbance of nesting activities. A 7 × 35 binocular and 20-power spotting scope with tripod mount were used as aids to close observation.

When nesting was well advanced, the island was systematically searched with a rope drag to locate nests. They were also located by watching hens and by random walking. Tall, slender, numbered willow wands were used for

FIG. 1. Aerial view of Ding Island, Pool 320, Lower Souris National Wildlife Refuge, North Dakota, July 1957.

marking them. The stage of development of each egg was determined by use of the field candling technique of Weller (1956). Nests were visited periodically to determine their status, usually two or three times between discovery and hatching.

Plumage aberrations and other distinctive criteria made it possible to identify certain individual drakes and hens. Nest trapping of females was attempted in 1956, but it seemed to create too much disturbance and was discontinued.

Portions of vegetation surrounding three nests within 25 feet of the blind were removed in 1957, enabling me to closely observe behavior of these hens. The nearest nest was 12 feet from my blind. The height and density of vegetation supporting the highest concentration of nests prevented me from observing incubation behavior of many hens.

RESULTS

Prenesting behavior.—Gadwalls are among the last ducks to arrive on the breeding areas of the north central United States. The average spring arrival date for northern North Dakota is in the second or third week of April. Incoming migrants usually arrive in flocks of about 100 or fewer, and this

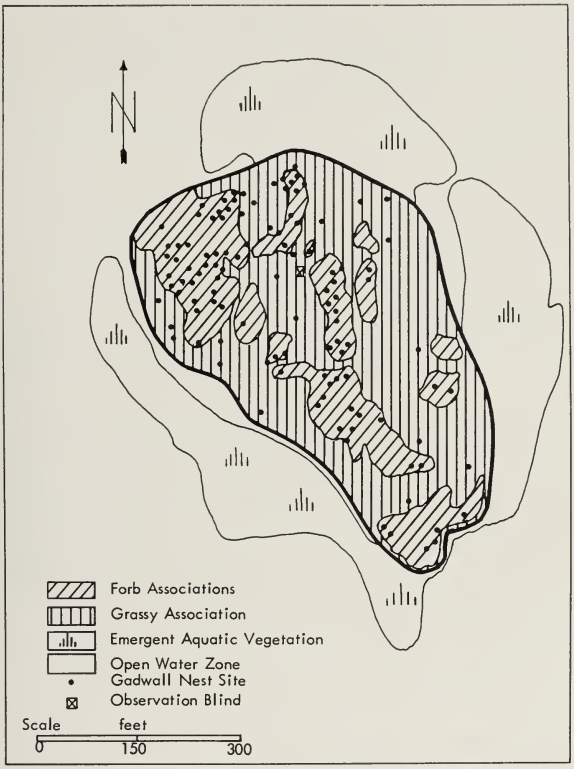

FIG. 2. Vegetative associations and Gadwall nest locations on Ding Island, 1957.

flocking pattern is maintained for 2 or 3 weeks. Upon arrival, the birds are mostly paired, and the flocks exhibit almost equal sex ratios (approximately 110 males to 100 females).

Prior to the beginning of egg laying there was little Gadwall activity near Ding Island. Gadwall pairs were assembled into flocks of five to 50 birds elsewhere in the marsh and spent their time feeding, loafing, and displaying. Water-display postures identical to those described by Lorenz (1953) were common. Most frequently observed were the "grunt–whistle," "chin-lifting," introductory shaking, displacement preening, and drinking activities.

Flocks of 30 to 100 Gadwalls frequented small open-water bays in the marsh during the prenesting period. One preferred bay was 3 miles north–northwest of Ding Island and another was 1½ miles north. On the basis of plumage variations, I was able to confirm that at least some of these pairs later moved to Ding Island to nest.

Pursuit flights composed of three to 15 birds were often initiated from

TABLE 1
GADWALL POPULATIONS AND PRODUCTION, 1956 AND 1957

	1956	1957
Pairs on refuge	1,260	1,640
Broods on refuge	380	980
Productivity rate (per cent)	30	60
Pairs in Pool 320	450	300
Broods in Pool 320	135	180
Productivity rate (per cent)	30	60
Nests found on Ding Island	78	121
Broods hatched on Ding Island	60	101

these flocks on the water. Flights were often released when one pair swam too close to another pair, and I interpreted these pursuits as originating from spatial intolerance between pairs. During this period, individual distance (Conder, 1949) or moving territory (Dzubin, 1955) seemed more applicable to Gadwall behavior than territory based on topographic reference. Wüst (1960) has discussed Gadwall display flights in Bavaria; many aspects were similar to behavior observed during my study.

As the season progressed the flocks gradually dispersed. In late April and early May pairs frequented open shorelines of the impoundment 320 and adjacent broken marsh and small water areas, but many pairs occupied open-water loafing sites. Although many pairs spent long periods of time (up to 3 to 4 hours) on open water, I was not able to determine that they did not also frequent loafing sites on shorelines.

When only a few pairs were using Ding Island in early May, they spaced themselves along the shore and on the grassy zones as if maintaining discrete territories. Later, when many pairs moved to the island in late May and early June, intense aerial pursuits developed, and territoriality based on defense of a female or a section of habitat broke down. For example, on 6 June 1957, 40 pairs of Gadwalls were observed at Ding Island during the first hour after sunrise. Ten three-bird chases were seen and an additional nine flights evolved into group chases. This was typical of Gadwall breeding behavior at Ding Island during the early laying period. These flights continued to be frequent during the laying and incubation period from late May to early July. In the early morning in June and early July it was common to observe as many as 50 pursuit flights an hour from my blind.

Early in the laying period the pursuit flights seemed to originate from individual intolerance among pairs, but during incubation they appeared to be of increasing sexual significance. In nearly all pursuit flights the male of one pair chased the female of another pair; occasionally aggression was directed toward the other male. Midair fights between males were common. Pursuit flights were especially intense during the second and third weeks of July, when the majority of hens spent most of the day on the nests and males were still sexually active. During this period male Gadwalls chased any female Gadwall in sight, even leaving the company of their own females to do so.

The combined expression of reproductive behavior by approximately 100 pairs of Gadwalls in a 7-acre area caused an intensity of pursuits not observed on the mainland. Although pursuit flights do occur among Gadwalls breeding under more dispersed conditions, they occur less frequently than under high-density nesting. Interpretation and analysis of the pursuits was difficult, because as many as 10 pursuits involving from three to 15 birds each were in progress over the island at one time during early morning in mid-June. In my opinion, the individual Gadwall pairs attempted to complete the same behavioral rhythms found in widely dispersed nesting populations. When nearly 250 Gadwalls are in approximately the same physiological condition for breeding, the resulting confusion and great variation in behavioral expression are difficult to unravel.

Although there was much aggression between the pairs, it did not prevent them from nesting successfully. This indicates that the Gadwall has evolved behavior patterns enabling many pairs to nest in a very restricted area without impairment of reproductive efficiency, a condition unusual among other ducks.

During the last week of May and the first week of June, Gadwall pairs flew into the island from its perimeter, from surrounding open water and shorelines and from marsh and pothole habitat as far as 3 miles away. Home ranges were apparently very large, consisting of several hundred acres. Pairs were very mobile and many did not favor specific sites for loafing. For example, a lone male Gadwall with a white neck ring was observed in a small bay in the marsh three miles north–northwest of Ding Island on 24 May 1957 (8:30 PM). This male was observed in the company of a female on Ding Island on 29 May (5:40 AM), while the pair was searching for a nest site. The male participated in pursuit flights at both locations.

With the high nesting density existing on this area, Gadwall home ranges were certainly much larger than the average of 67 acres described by Gates (1962). During incubation, when male harassment of lone females was very common, hens leaving their nests for the relief period flew more than a mile to feed and rest unmolested.

Nesting.—Pairs arriving on the island to scout for nest sites usually landed in the grassy zones, and after a few minutes the female walked into the weed zones while the male waited. Occasionally the male accompanied the female during this exploration. This exploration phase preceded laying of the first egg by about 5 to 7 days.

The highest density of nests occurred in patches of nearly pure nettle; approximately 80 per cent of the nests were in this cover in 1957. Most nests were initiated when the plants were 6 to 10 inches high. By the time the majority of nests were in the late incubation stage this nettle was 5 to 6 feet high.

In 1957 six clutches of eggs were found in the bowls of Gadwall nests remaining from the preceding year. Two of these bowls appeared to have been in use for more than 2 years. Pettingill (1959) found most nests of the Common Eider (*Somateria mollissima*) in an Iceland colony were in old nest depressions.

On 6 June I dug several bowls in areas of cover near the blind where Gadwall hens had been exploring. Five eggs were found in one of these bowls on 13 June, indicating the female had laid the first egg on 9 June, just 3 days after I had made the bowl. The clutch of nine eggs was completed on 17 June and hatched on 13 July, after 26 days of incubation. This experiment suggests that the presence of a nest bowl may provide a stimulus for a hen to begin laying.

Most hens came to the island to lay between 5:00 and 7:00 AM. Ordinarily drakes accompanied the hens until the clutch was complete. The observed length of pair-bond attachment varied widely, at one extreme ending about the seventh day of laying (a hen coming in alone to lay the last three eggs of a 10-egg clutch) and at the other, lasting until the end of incubation (a drake which accompanied his female to within one day of hatching). The last date I observed a male and female together in 1957 was 12 July. Male Gadwalls had nearly all gathered into molting flocks by 1 July, and after 15 July very few males were seen.

Individual hens were well oriented to their nests–laying and incubating females flew directly to them without search or uncertainty, despite their close spacing. Hens having nests in short cover or near the edge of the dense nettle–thistle zone usually landed from three to 25 feet away and walked the remainder of the way. Hens returning to nests in the dense nettle, which was over 5 feet tall by late July, flew to a point directly over the nest and dropped within a few inches of it.

After the males had gathered into molting flocks, the nesting hens were able to carry on their daily activities unmolested. It was striking that as soon as there were no males near the island, hens flew only a short distance for their relief period, in contrast to the long flights during early incubation. On several occasions in mid-July, nesting hens gathered in groups of three to

TABLE 2

GADWALL NEST AND EGG DATA, DING ISLAND, 1956 AND 1957

	1956		1957	
	Number	Per cent	Number	Per cent
Nests found	78	——	121	——
Nests with complete history	70		109	
Hatched successfully	60	85.7	101	92.7
Predator-destroyed	7	10.0	3	2.5
Deserted by hen	3	4.3	3	2.5
Other	0	0.0	2	2.3
Totals	70	100.0	109	100.0

	1956		1957	
	Number	Per cent	Number	Per cent
Eggs studied	710	——	1,045	——
Hatched successfully	570	80.3	898	85.9
Left in nest (See Table 4)	48	6.8	66	6.2
Predator-destroyed	56	7.9	32	3.1
Deserted by hen	28	3.9	26	2.5
Unknown loss	8	1.1	6	0.7
Other	0	0.0	17	1.6
Totals	710	100.0	1,045	100.0

five just at the edge of the island to feed, bathe, and rest. This seemed to be another expression of innate sociality during the nesting season.

In 1956, 78 Gadwall nests were found on Ding Island, and a complete history was obtained for 70. I did not attempt to locate every nest but estimated that about 90 nests were present. In 1957, I attempted to locate every one and found 121 Gadwall nests; a complete history was obtained for 109. A summary of Gadwall nest and egg data obtained on Ding Island in 1956 and 1957 is presented in Table 2.

Gadwall nests situated in this nearly ideal environment had a rate of success seldom experienced by ducks nesting elsewhere. The 92.7 per cent nest success observed in 1957 may be a record for a wild nesting population of Gadwalls. Miller and Collins (1954) reported a nesting success of 90.3 per cent of 381 Gadwall nests in northern California, while Rienecker and Anderson (1960) found that 87.4 per cent of 277 nests in the same area hatched.

Average size of 51 clutches was 9.5 in 1956 and that of 79 clutches was 9.7 in 1957. In the determination of clutch size only those clutches which were being incubated when found were used. The frequency distribution of clutch sizes is shown in Table 3.

TABLE 3

CLUTCH SIZES OF 130 GADWALL NESTS UNDER INCUBATION WHEN FOUND

	Number of eggs															
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1956	1	1	5	6	8	12	9	3	3	0	0	1	0	1	0	1
1957	0	2	12	12	23	19	9	10	0	0	0	1	0	0	0	1

The only apparent hazard experienced by Gadwalls nesting in high density is a slight irregularity of daily laying and incubation rhythms. Hens attempting to lay were often chased temporarily from the island by pursuing drakes, and incubating hens returning to their nests from the daily rest period were similarly kept from their nests. A female was chased from her nest for approximately 2 hours each day for 2 days by the harassment of unattached males. Five different group pursuit flights developed around this hen as she attempted to enter her nest at the beginning of incubation. The nest hatched successfully after an incubation period of 29 days. This interruption of incubation rhythm was common among the island nesters but did not depress productivity significantly.

A few nests contained eggs of different shapes and colors, suggesting they were laid by more than one hen, although this was uncommon. For the two years, only 5 of 130 (4 per cent) known-age nests contained more than 13 eggs. In one nest of 20 eggs, 16 hatched successfully. Eggs of the Redhead (*Aythya americana*) were laid parasitically in 11 of 70 Gadwall nests (15.7 per cent) in 1956 and seven of 109 nests in 1957 (6.4 per cent). In each year Pool 320 had a breeding population of about 150 pairs of Redheads. This may account for the high rate of parasitic egg laying by the Redheads.

The condition of unhatched eggs remaining in successful nests is shown in Table 4. The group showing "no embryo developed" probably were not infertile eggs, but eggs in which embryonic death had occurred at such an early stage that an embryo was not detectable under field conditions (Munro and Kosin, 1945). It is possible that harassment of nesting females by males during early incubation caused the high early embryonic mortality observed in both years.

In 1957 one complete clutch was apparently infertile, and the female incubated this nest for at least 7 days past the normal incubation period of 26 days.

Perhaps the most remarkable aspect of the Gadwall's proclivity toward social nesting is the close spacing of nests. Many nests were found within a few feet of each other, and some were less than 12 inches apart. In the area of highest density in 1957, 28 nests were located in a 75-foot radius. This

TABLE 4

CONDITION OF UNHATCHED EGGS REMAINING IN HATCHED NESTS

Condition	1956 Number	1957 Number
No embryo visible	41	47
1–5-day embryo	0	0
6–10-day embryo	0	2
11–15-day embryo	3	1
16–20-day embryo	0	8
21–25-day embryo	4	7
	—	—
Totals	48	66

nest density is certainly unique among surface-feeding ducks, and even among the strongly social Common Eider in Iceland, Pettingill (1959) reported that the closest nests were 2 feet apart.

The nesting period on Ding Island was relatively short, spanning a period of 7 to 9 weeks from first laying to hatching in the last nests. There was only one hatching peak in both years, indicating that renesting was not significant. In both years most eggs hatched during the period 8–14 July. First hatching occurred during the second and third weeks of June and most nests were terminated in 8 weeks. Hatching dates of mainland nests spanned more than 9 weeks in 1956 and 1957, as determined from backdated broods. In 1956 *all* eggs hatched in 41.4 per cent of the successful nests, and in 1957 *all* eggs hatched in 59.4 per cent of such nests.

Ding Island was not attractive to Gadwalls after the young had hatched. A few hens remained to brood around the perimeter of the island, but most moved their broods to other portions of Unit 320. One such favored brooding area was 300 yards northeast of the island in an open-water bay having an abundance of plant and animal foods. Some hens led their broods across about 500 yards of open water on the day they left the nest.

POST-1957 CONDITIONS

That Gadwall nesting concentrations are not formed each year on a particular island irrespective of environmental conditions is shown by the following account.

On 18 June 1958, the first year after my study, the island was visited by refuge personnel and only eight active Gadwall nests were found, while 10 destroyed ones were seen. From the sign present, it was concluded that several raccoons (*Procyon lotor*) had gained access to the island because of low water levels in the unit. On 18 July, only one active Gadwall nest was found.

It was concluded that nesting Gadwall hens deserted the island either during early laying or just before laying began.

Although few observations were made in 1959, refuge personnel believed that the Gadwall nesting effort that year was low.

On 15 June 1960, 16 active Gadwall nests were found by refuge personnel on Ding Island in a 30 per cent sample of the island.

In 1961, I visited the island on 7 June and found only two active nests and destroyed nests of the Gadwall on 25 per cent of the island. It was obvious that Gadwall nesting effort was very low in 1961.

DISCUSSION

The tendency toward social nesting among Gadwall hens is most likely a traditional response to preferred environmental factors. Female Gadwalls apparently have an innate tendency to congregate for nesting, but expression of this instinct may be influenced by environmental factors. The most important factors are: (1) a small upland-type island, isolated by large expanses of open water; (2) patches of dense, coarse upland vegetation as nesting cover; and (3) absence of actual or potential predation.

Many nesting studies have revealed that Gadwalls prefer dense, coarse vegetation for nesting (Hammond and Mann, 1956; Miller and Collins, 1954; Williams and Marshall, 1938). The nettle and thistle patches on Ding Island provided an abundance of this cover type, and these weeds with the interspersed shorter vegetation provided a highly attractive nesting environment for Gadwalls.

Nest predators were very insignificant on Ding Island during this study. One family of mink (*Mustela vison*) and a few short-tailed weasels (*Mustela erminea*) were the only mammals present. Occasionally a Ring-billed Gull (*Larus delawarensis*) visited the island and some eggs were eaten by these birds, mostly from nests containing fewer than three eggs. It was obvious that predation pressure was virtually nonexistent.

Social facilitation was possibly another factor contributing to the high-density nesting. During late May and early June when most Gadwall hens in the nesting population were physiologically ready to lay eggs, aerial display behavior was at a high level of intensity over the island. It is possible that the vocal and visual stimuli provided by these displays were very stimulating to females ready to initiate nests. Such synchronization of breeding as a phenomenon among birds was first pointed out by Darling (1938) based on his study of Herring Gulls (*Larus argentatus*). In my study, small groups of nests located close to each other were often in the same stage. Also, when one hen departed from her nest for a daily rest period, nearby hens frequently left within a few minutes. These two examples suggest that the behavioral expression of one hen may have stimulated similar behavior among other hens nearby.

Concentration of nesting Gadwalls would also be favored by a relatively high rate of homing by adult hens and return of first-year nesters to their natal area. Sowls (1955) found a high rate of homing among Gadwall hens nesting in Manitoba and Gates (1962) recorded a 60 per cent homing rate in Utah.

The interaction of the above factors during my study led to the formation of dense nesting concentrations of Gadwall hens on Ding Island. Evidence recorded in this study shows that the species does not suffer any loss of reproductive efficiency under the extreme nest density observed.

SUMMARY

An island nesting Gadwall population was studied during 1956 and 1957 at the Lower Souris National Wildlife Refuge in North Dakota. This 7-acre natural island supported extremely high nest densities in both 1956 (78 nests) and 1957 (121 nests). Vegetation supporting the highest density of nests (80 per cent of all nests) was nettle (*Urtica procera*) and Canada thistle (*Cirsium arvense*). The island was separated from the nearest mainland by 2,000 feet of open water.

In late May, pairs began moving to the nesting island and at this time much intolerance began among the pairs. The first pairs to arrive were able to maintain home ranges on the island and its shorelines. As the number of pairs increased to approximately 100, island home ranges appeared to break down and most of the pairs had at least part of their daily range up to 3 miles from the island. The intolerance between pairs seemed to have both sexual and topographic significance.

Although there was much aggression between pairs, this did not prevent normal and highly successful completion of their individual reproductive cycles.

Nesting success for the 70 nests studied in 1956 was 85.7 per cent and for the 109 nests studied in 1957, 92.7 per cent, possibly the highest success ever recorded. Causes of nest failure follow for 1956 and 1957, respectively: predation—10 per cent and 2.5 per cent; desertion—4.3 per cent and 2.5 per cent; and other causes—none and 2.3 per cent.

The average clutch size of incubated clutches was 9.5 in 1956 and 9.7 in 1957.

The nesting period was relatively short, spanning 7 to 9 weeks from first laying to last hatching. The peak hatch occurred during 8–14 July and renesting was not significant. By contrast, the mainland nesting period for Gadwalls spanned more than 9 weeks in both years.

After hatching of nests, females led their broods to other portions of the marsh for rearing.

In the 3 years following completion of this study, an interaction of low water levels and mammalian predation prevented the formation of high nesting densities on this island.

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MALHEUR NATIONAL WILDLIFE REFUGE, BURNS, OREGON, 12 FEBRUARY 1965

A COMPARISON OF THE SPECIES COMPOSITION OF TWO TV TOWER KILLED SAMPLES FROM THE SAME NIGHT OF MIGRATION

Charles A. Kemper, Dennis G. Raveling, and Dwain W. Warner

Large kills of passerine birds are occurring at TV towers and ceilometer beams in many locations each autumn. The potential for learning about migrations and the species involved has been well pointed out by many, especially Tordoff and Mengel (1956). Unfortunately lack of time and personnel have greatly limited the values to be obtained from such samples, and most reports have necessarily been confined to a listing of the species involved. Such species listings, however, over a period of years from different locations and from different times of the migration periods will yield a great amount of information on the timing, composition, and routes of these migratory "flocks" and of individual species. Howell (1955) compared the species composition of kills from two ceilometer beam locations in Tennessee, and Brewer and Ellis (1958) compared kills from an Illinois TV tower to other reported kills. This paper compares two TV tower kills that occurred on the same night of migration.

THE TOWERS

The two samples to be compared were killed on the night of 9–10 September 1962 at the WEAU TV tower, Eau Claire, Wisconsin, and at the KCMT TV tower, 2 miles west of Westport, Minnesota, in Stearns County.

WEAU is within the city limits. The environment at the base of the tower is mostly blacktop and mowed grass, and with the exception of rooftops, junkyard rubbish, and a busy highway, collection of fallen birds is not difficult. Collections made at WEAU are considered to represent accurately the composition of the bird kill. Birds were gathered here on the morning of 10 September 1962.

KMCT, however, rises from a dense alfalfa field. Thus there is a possibility that the brightly colored and larger birds may have been more conspicuous, giving some bias to the sample collected. Birds were collected here on the afternoon of 10 September.

Westport, Minnesota, is approximately 190 miles northwest of Eau Claire. The Westport TV tower rises 1,100 feet above a low hill on the edge of the prairie. The Eau Claire tower is 1,000 feet high within the city, which is in a deciduous woodland area about 50 miles east of the Mississippi River.

RANDOMNESS OF THE SAMPLES

Tordoff and Mengel (1956) pointed out that interspecific comparisons from TV tower samples should be approached with extreme caution as virtually nothing is known about the relative vulnerability of different species with regard to striking towers. Furthermore, nothing is known as to relative tendencies of species to strike towers under different conditions at different times and places, and also to the possibility of different species migrating at different altitudes. The species composition can change considerably at any one location through the course of the migration season and before a truly sound appraisal of the progress of these migrants can be made, many samples taken at different times from each locality and from many different localities are going to be needed. In addition, the sex and age composition of any one species on any one night can be radically different from samples on other nights (unpublished data, Minnesota Museum of Natural History), and these sex and age data are necessary to the drawing of conclusions about the timing, progress, composition, and routes of migrations.

RESULTS

The number and percentage of the total for each species from each tower is presented in Table 1. The quite different species composition of the two samples is obvious; the Red-eyed Vireo, Tennessee, Bay-breasted, and Chestnut-sided Warblers make up nearly 60 per cent of the total from WEAU, while the Swainson's Thrush, Yellow Warbler, Sora, and Red-eyed Vireo make up nearly 60 per cent of the total KCMT sample.

The WEAU sample is quite representative of the species composition of many other Eau Claire kills (Kemper, 1958, 1959, 1964, and unpublished data). The typical species composition of kills at Eau Claire, Wisconsin, is usually quite similar to reported kills from many other localities east of the Mississippi River: Illinois (Brewer and Ellis, 1958; Parmalee and Parmalee, 1959); Tennessee (Laskey, 1960); and Georgia (Johnston, 1955; Johnston and Haines, 1957). The KCMT sample, on the other hand, is unusual in many respects as compared to other reported kills. However, with the exception of the large numbers of thrushes, Soras, and Yellow Warblers, the kill at KCMT is most similar to kills in Kansas (Tordoff and Mengel, 1956). The KCMT kill of Yellow Warblers and Soras is apparently the highest total reported for each species. It is difficult to generalize about the Swainson's Thrush as this species has been variously important at certain times at many locations, however, never associated with the same species as at KCMT. The same can be said of the Red-eyed Vireo, a species which through the wooded portion of the United States east of the Mississippi River seems to be associated in migration with many of the woodland warblers, but across the prairie with a different species association as shown by this KCMT kill and kills in Kansas. The Catbird has been variously important at different places

TABLE 1

SPECIES COMPOSITION OF TWO TV TOWER KILLED SAMPLES FROM THE SAME NIGHT (9–10 SEPTEMBER 1962)

WEAU TV Eau Claire, Wisconsin			KCMT TV Westport, Minnesota	
Number	Per cent of total	Species	Number	Per cent of total
279	32.2	Red-eyed Vireo—*Vireo olivaceus*	54	10.2
98	11.3	Tennessee Warbler—*Vermivora peregrina*	2	0.4
73	8.4	Bay-breasted Warbler—*Dendroica castanea*	0	0.0
63	7.3	Chestnut-sided Warbler—*Dendroica pensylvanica*	0	0.0
50	5.8	Flycatchers*—(Tyrannidae)	20	3.9
31	3.6	Connecticut Warbler—*Oporornis agilis*	0	0.0
28	3.2	Blackpoll Warbler—*Dendroica striata*	1	0.2
25	2.9	Swainson's Thrush—*Hylocichla ustulata*	128	24.2
25	2.9	Veery—*Hylocichla fuscescens*	23	4.4
24	2.8	Ovenbird—*Seiurus aurocapillus*	12	2.3
22	2.5	Blackburnian Warbler—*Dendroica fusca*	0	0.0
19	2.2	American Redstart—*Setophaga ruticilla*	0	0.0
16	1.8	Canada Warbler—*Wilsonia canadensis*	0	0.0
14	1.6	Yellow Warbler—*Dendroica petechia*	74	14.0
11	1.3	Black-and-White Warbler—*Mniotilta varia*	1	0.2
11	1.3	Rose-breasted Grosbeak—*Pheucticus ludovicianus*	6	1.1
11	1.3	Scarlet Tanager—*Piranga olivacea*	0	0.0
10	1.2	Magnolia Warbler—*Dendroica magnolia*	0	0.0
10	1.2	Cape May Warbler—*Dendroica tigrina*	0	0.0
7	0.8	Wilson's Warbler—*Wilsonia pusilla*	7	1.3
7	0.8	Yellowthroat—*Geothlypis trichas*	6	1.1
5	0.6	Goldenwing Warbler—*Vermivora chrysoptera*	0	0.0
5	0.6	Philadelphia Vireo—*Vireo philadelphicus*	0	0.0
4	0.5	Nashville Warbler—*Vermivora ruficapilla*	6	1.1
4	0.5	Gray-cheeked Thrush—*Hylocichla minima*	12	2.3
3	0.3	Northern Waterthrush—*Seiurus noveboracensis*	19	3.6
2	0.2	Bobolink—*Dolichonyx oryzivorous*	11	2.1
2	0.2	Parula Warbler—*Parula americana*	0	0.0
2	0.2	Black-throated Blue Warbler—*Dendroica caerulescens*	0	0.0
1	0.1	Black-throated Green Warbler—*Dendroica virens*	0	0.0
1	0.1	Yellow-throated Vireo—*Vireo flavifrons*	0	0.0
1	0.1	Indigo Bunting—*Passerina cyanea*	0	0.0
1	0.1	Eastern Kingbird—*Tyrannus tyrannus*	0	0.0
0	0.0	Solitary Vireo—*Vireo solitarius*	1	0.2
0	0.0	Warbling Vireo—*Vireo gilvus*	1	0.2
0	0.0	Yellow-headed Blackbird—*Xanthocephalus xanthocephalus*	1	0.2
0	0.0	Wood Thrush—*Hylocichla mustelina*	2	0.4
0	0.0	Baltimore Oriole—*Icterus galbula*	19	3.6
0	0.0	Mourning Warbler—*Oporornis philadelphia*	31	5.9
0	0.0	Catbird—*Dumatella carolinensis*	34	6.4
0	0.0	Sora—*Porzana carolina*	57	10.8
865		Total	528	

* Flycatchers are being saved for further analyses and identification.

and times. We believe the occurrence of such high numbers of Mourning Warblers at KCMT and in Kansas, and their extreme rarity at other localities, is strongly suggestive of their migration route and species association.

The kill of Nashville Warblers at KCMT is significantly higher (Chi-square, 0.05 level) than at WEAU and, along with the numbers killed in Kansas and their relative scarcity at other locations, is indicative of their more western migration route. The Nashville Warbler also seems to be more common at Eau Claire than at other localities (except Kansas). The kill of Wilson's Warblers at KCMT is one of the highest reported as a percentage of the total, although it is not significantly different from the total at Eau Claire (Chi-square, 0.05 level) on the same night.

The presence of a fair number of Ovenbirds and Northern Waterthrushes at KCMT would seem to indicate an extremely broad front of migration for these species as they have been present in so many other reported kills. The kill of Baltimore Orioles is apparently the largest reported for this species.

It is hoped that this brief summary and the peculiarities and consistencies noted for certain species will stimulate continued interest in these mortalities. Such study will eventually help to piece together a much more complete account of these nocturnal migrations. More sex and age data along with the numbers and percentages of species are needed. Continued compilation of such material will yield information on many aspects of migration that is impossible to gather in any other way.

SUMMARY

The numbers and percentages of species killed on the same night of migration (9–10 September 1962) at Eau Claire, Wisconsin in a deciduous woodland area, and 190 miles to the northwest at Westport, Minnesota at the edge of the prairie, are compared. The species composition of the Eau Claire kill is typical for that area and similar to many other reported kills east of the Mississippi River. The Westport, Minnesota sample is a very unusual one as compared to other samples as the Yellow Warbler, Sora, Mourning Warbler, and Baltimore Oriole were killed in unusually high numbers. Just as obvious at this prairie-edge tower was the lack of woodland warblers so common to nearly all other reported TV tower mortalities.

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SUMMER BIOLOGY OF TRAILL'S FLYCATCHER

LAWRENCE H. WALKINSHAW

THE Traill's or Alder Flycatcher (*Empidonax traillii*) is found over the entire state of Michigan. Aldrich (1951, 1953) has described the subspecies occurring there as *E. t. campestris,* but this race was not recognized by the 1957 A.O.U. Checklist which considers the Michigan birds as belonging to the widespread race, *traillii.* Stein (1958) differentiated the New York and Michigan populations by voice, behavior, and ecology, into two groups. The northern Michigan birds, at least south to Charlevoix (probably farther south) were of the *fee-bee-o* song type while those in the southern part of the state were of the *fitz-bew* song type.

MIGRATION

Arrival.—In southern Michigan all of the Traill's Flycatchers that remain to breed are of the *fitz-bew* song type. At Battle Creek, Calhoun County, for 35 seasons between 1919 and 1964, the average spring arrival date for first-observed males was 17 (10–27) May. All males do not arrive at once, but over about a 10-day or 2-week period most males, and also females, have returned from the south. After arrival, both males and females remain usually on their territories for the duration of the breeding season.

Departure.—Traill's Flycatcher usually departs from southern Michigan in early August, though a nesting pair with young still in the nest stays later. I find few birds after 10 August. My latest Calhoun County records have been: 22 August 1934, 22 August 1937, 4 September 1938, 1 September 1939, 17 August 1941, 16 August 1951, 1 August 1952, 11 August 1953, 7 August 1954, 10 August 1956, 10 August 1958, 13 September 1959 (1 caught), 5 August 1960, 2 August 1961, 9 August 1962, 20 August 1963, and 4 August 1964.

Each summer at Ackley Lake, Convis Township, Calhoun County, I have caught these birds in mist nets, but only one has been caught after 10 August.

Near the shores of Lake Michigan, in Muskegon County, there are no summer resident Traill's Flycatchers on the unplowed, brushy, grass-grown fields. Yet I have caught them there in May and August: 15 May 1960, 5 August 1960 (2), 8 August, 9 August, 11 August, 13 August (2), 20 August, and 24 August 1961.

TERRITORY

On a dry marsh adjacent to the building at the Baker Sanctuary, Calhoun County, the size of 27 *fitz-bew* territories averaged 2.06 (1.3–2.9) acres (83.3 ares). A similar habitat farther out in the Baker Sanctuary was flooded

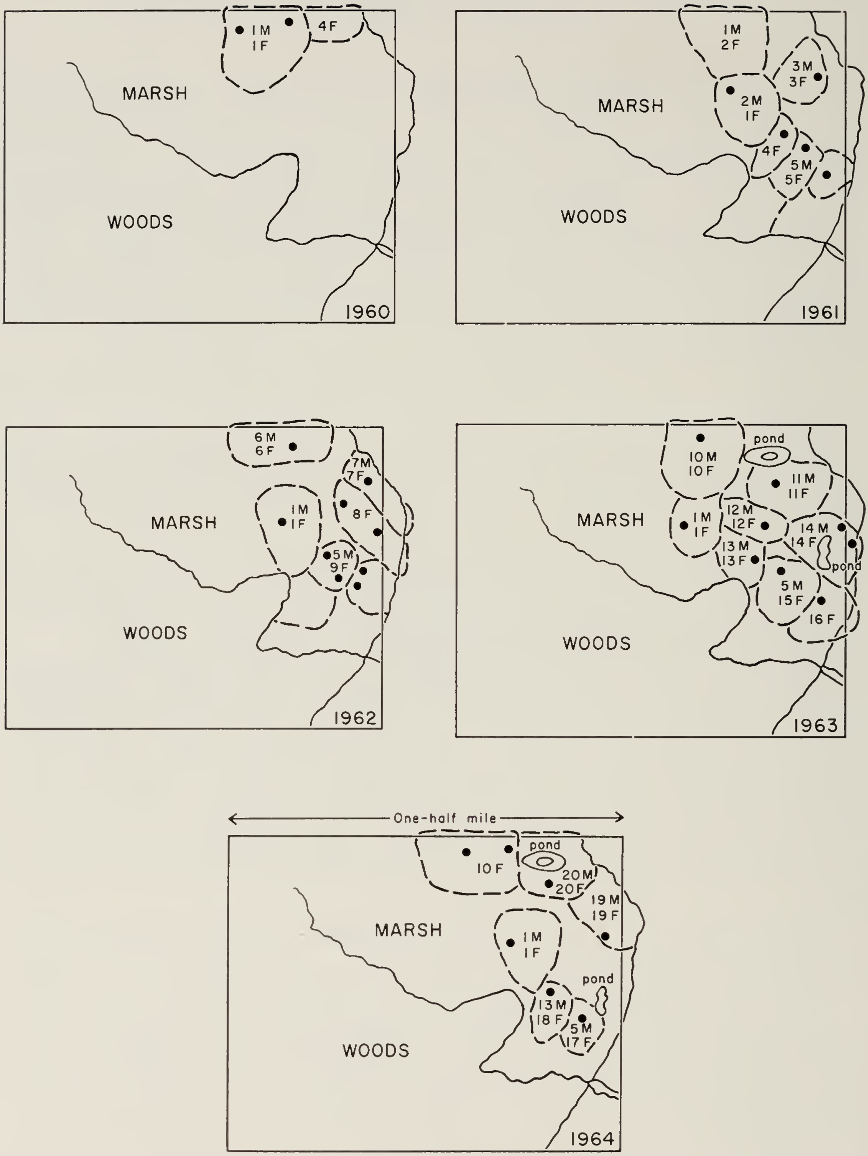

Fig. 1. Territories of Traill's Flycatcher at Baker Sanctuary, Convis Township, Calhoun County, Michigan, 1960–64. Black circles are nest sites. F—refers to a banded female bird. M—refers to a banded male bird.

in the fall of 1961, after the nesting season. This area, now under up to 10 feet of water, was still used by Traill's Flycatchers in 1962, and some were still there in the summer of 1964. Territories (15) averaged 1.86 acres (75.3 ares), slightly smaller than those near the building. At Ackley Lake, 15 territories averaged 1.52 acres (61.5 ares). At Montague, Muskegon County, 16 territories averaged 1.3 acres and some were as small as 0.8 acre (32.4 ares). Thus 73 territories in southern Michigan, 1957–64, averaged 1.74 (0.8–2.9) acres (70.4 ares). Figure 1 shows the territories at the Baker Sanctuary for the years 1960–64.

The limiting factors to territorial boundaries near the building at Baker Sanctuary were dry land, woodland, other Traill's Flycatcher territories, and probably necessary foods. At Ackley Lake territories were compressed between the lake and dry land, along a narrow brushy border. At the Big Marsh Lake, Baker Sanctuary, the birds maintained their territories where bush concentrations occurred. At Montague, the territories were long and narrow, compressed into two brushy ditch banks between cultivated celery fields.

All territories required shrubs and small trees, and some clearings. If water, whether lake, stream, or ditch, was not present it was essential very close to the territory. The foods utilized probably had much to do with the habitats used.

HABITAT

The Baker Sanctuary building habitat consisted of an open marsh, usually dry in summer, covered with rank sedges and rushes (*Carex* and *Scirpus*) and grasses through which grew *Lilium superbum, Cypripedium candidum, Salix* (at least three species including *S. discolor*), *Corylus americana, Betula pumila*, a few small *Quercus macrocarpa* on drier portions, some *Ulmus americana, Spiraea salicifolia*, and *S. tomentosa, Crataegus* sp., *Rosa carolina*, one or two patches of *Zanthoxylum americanum, Rhus vernix, Asclepias incarnata, Sambucus canadensis, Eupatorium purpureum*, and *E. perfoliatum*, and species of *Solidago*.

The shrubs were in clumps or scattered, sometimes parklike, among the tall sedges and grasses. A few lower spots contained some water during the spring and in wet years. Most of the study here was made during a dry-weather period.

The study area at the Big Marsh Lake was originally similar; but, with the increase in water depth, it consisted only of shrubs and small trees protruding above the water. The area at Ackley Lake was also similar, but the immediate lake-border was much more grown in shrubs. Here many taller trees, *Ulmus americana, Populus tremuloides*, and one large hickory (*Carya ovata*) bordered the flycatcher habitat. The Branch County habitat was also similar,

TABLE 1A

FREQUENCY OF OCCURRENCE OF SHRUBS IN 5-METER QUADRATS AROUND 35 NEST SITES. BAKER SANCTUARY, SECTION 14, CONVIS TOWNSHIP, CALHOUN COUNTY, MICHIGAN

Shrubs in quadrat	Number of times used as nest site	Number of quadrats in which found	Percentage of times found as nest site	Approximate number of stalks in quadrats (all)
Betula pumila	1	5	2.8	127
Cephalanthus occidentalis	0	1	0	15
Cornus amomum	17	19	48.5	1,785
Cornus stolonifera	2	2	5.6	136
Corylus americana	2	2	5.6	500
Crataegus sp.	5	6	14.3	77
Populus tremuloides	0	1	0	21
Prunus serotina	0	1	0	1
Rosa carolina	1	1	2.8	25
Salix all sp.	3	15	8.4	581
Sambucus canadensis	2	2	5.6	15
Ulmus americana	1	6	2.8	19
Zanthoxylum americanum	1	1	2.8	67
Totals	35		100	3,369

TABLE 1B

FREQUENCY OF OCCURRENCE OF SHRUBS IN 5-METER QUADRATS AROUND 14 NEST SITES. ACKLEY LAKE, SECTION 3, CONVIS TOWNSHIP, CALHOUN COUNTY, MICHIGAN

Shrubs in quadrat	Number of times used as nest site	Number of quadrats in which found	Percentage of times found as nest site	Approximate number of plants in quadrats (all)
Cornus amomum	3	3	21.4	225
Cornus stolonifera	1	7	7.1	176
Crataegus sp.	0	2	0	2
Rosa carolina	2	6	14.2	80
Salix all sp.	5	13	35.7	859
Spiraea tomentosa	2	3	14.2	48
Ulmus americana	1	3	7.1	5
Totals	14		100	1,395

but the birds extended their ranges somewhat onto the dry neighboring land covered with *Crataegus*. The original Muskegon County study area, prior to drainage, was very similar to that at the Baker Sanctuary.

Campbell (1936) and Berger and Parmelee (1952) found two types of habitat used by the species, and while most of the nests I have observed have been in marshy habitats, a few have been in *Crataegus* trees growing parklike on dry fields near the border of a marsh.

FIG. 2. Typical nest of Traill's Flycatcher, 18 June 1954, Baker Sanctuary, Calhoun County, Michigan.

Table 1 lists the relative abundance of the shrub species found in quadrats, five meters square, centered on the nest site, and also gives the relative frequency with which each was selected as a nest site.

NEST SITES

Ninety-four of the Traill's Flycatcher (*fitz-bew type*) nests that I have found were in upright crotches in small trees or bushes and 14 were on horizontal branches of similar trees (Fig. 2). If placed on a horizontal branch they were fastened to another branch extending upight from it.

Sometimes the nest bush was a lone one separated from others of its kind in the marsh, but again it was in a large clump. At the Baker Sanctuary these clumps were often pure stands of one species. Of 35 nests found on the drier habitat there, 14 were in pure stands (nine in *Cornus amomum*, three in *Crataegus* sp., one each in *Salix* sp. and *Sambucus canadensis*); four others were in almost pure stands (one each in *Cornus amomum, Corylus americana, Rosa carolina,* and *Zanthoxylum americanum*). Five were located in a lone bush: three in *Crataegus* sp., one in *Sambucus canadensis,* and one in *Salix* sp.

A summary of 93 Traill's Flycatcher nests is given in Table 2. Of the 93, 33 (35.5 per cent) were in *Cornus amomum*, 12 (12.9 per cent) in *Cornus stolonifera*, 14 (15 per cent) in *Salix* sp., 8 (8.6 per cent) in *Crataegus* sp., and 11 (11.8 per cent) in *Sambucus canadensis.* In lesser numbers, four were found in *Rosa carolina,* three in *Ulmus americana,* two each in *Corylus americana, Spiraea tomentosa,* and *Zanthoxylum americanum,* and one each in *Betula pumila* and *Cephalanthus occidentalis.*

A single *fee-bee-o* type nest in Schoolcraft County, northern Michigan, was built in *Viburnum cassinoides.*

Table 2 shows average heights of 93 nests on the different southern Michigan study areas in Calhoun, Muskegon, and Branch counties. These were measured from the ground to the rim of the nest. The average height of these 93 *fitz-bew* nests was 133.2 (61.2–281.6) cm. The nests at the Baker Sanctuary lake were measured over the water; the remaining 85 nests over land averaged 145.9 cm above the ground. Berger and Hofslund (1950) found the average height of 17 nests at Ann Arbor, Washtenaw County, Michigan was 125.7 (104.5–160) cm. The single *fee-bee-o* nest in Schoolcraft County was only 63.6 cm above the ground. Stein (1958) found *fee-bee-o* nests were much lower than *fitz-bew* nests in New York.

Most nests were well concealed by the leaves of the shrub, but at the new Baker Sanctuary lake one was built in an almost dead bush. During 1960, several nests were built and ready for eggs when a severe hailstorm crossed the Baker Sanctuary area and stripped most of the leaves from the bushes. These nests were deserted and new ones begun.

THE NEST

Fitz-bew nests are well constructed of cottony materials (Fig. 3) from old thistles (*Cirsium*) and the stems of swamp milkweed (*Asclepias incarnata*), fur, feathers, and deer hair, lined with similar materials and fine grasses. The average inside measurements of 24 nests were: diameter, 52.3 (46.5–57) mm; depth, 38.5 (31–46) mm. Outside measurements were: diameter, 82.2 (71–99) mm; depth, 67.3 (54–105) mm. The average weight of 18 nests after use was 6.94 (3.3–12.1) grams.

The Yellow Warbler (*Dendroica petechia*) builds similar nests in the same areas used by Traill's Flycatchers, but they are usually closer to the ground and smaller. The eggs of the Yellow Warbler are smaller and more heavily spotted. Later, during late July, August, and early September, the Goldfinch (*Spinus tristis*) also builds similar nests in the same area. Goldfinches often used the materials from unused Traill's Flycatcher and Yellow Warbler nests. On two occasions I have watched a Traill's Flycatcher female use material from a previously destroyed nest when building her new nest.

FIG. 3. Traill's Flycatcher at the nest, 15 July 1961, Montague, Muskegon County, Michigan.

NESTING DATES

From studies of 23 females, nesting on the two Calhoun County and the Muskegon County areas, the first egg in a nest was laid, on an average, 17 June (6–28) and nests were terminated, on an average, 19 July (9 July–14 August).

TABLE 2

SITUATION AND HEIGHT (CM) OF TRAILL'S FLYCATCHER NESTS

	Calhoun County												
Plant in which nest was built	Baker Sanctuary (by building)		Baker Sanctuary (over lake)		Ackley Lake		Pennfield Township		Muskegon County, Montague		Branch County Union Township		Average height
	No.	Height	No.	Height	No.	Height	No.	Height	No.	Height	No.	Height	
Cornus amomum	16	131.5	3	110.5	3	137	1	158	10	139	0		133.1
Cornus stolonifera	2	129.5	0		1	132	0		9	118	0		121.0
Salix sp.	4	157	5	107	5	151	0		0		0		136.7
Crataegus sp.	7	174	0		0		0		0		1	137	170.0
Sambucus canadensis	7	133	0		0		0		1	107	3	121	127.5
Rosa carolina	2	85	0		2	107	0		0		0		96.0
Ulmus americana	1	274	0		1	124	0		0		1	122	173.3
Zanthoxylum americanum	1	107	0		0		0		0		1	81	94.0
Spiraea tomentosa	0		0		2	99	0		0		0		99.0
Corylus americana	2	119.5	0		0		0		0		0		119.5
Betula pumila	1	198	0		0		0		0		0		198.0
Cephalanthus occidentalis	0		0		0		1	137	0		0		137.0
Total	43		8		14		2		20		6		
Average height		142.7		108		130.9		147.5		127.8		117	133.2

Average height of all 93–133.2 cm.

Although I found a female building a nest 25 May 1930, usually nests are built in early June and eggs laid during mid-June, in Calhoun County. Early egg dates there were as follows: 20 June 1920 (4 eggs); 17 June 1928 (2nd egg); 15 and 17 June 1930 (2 nests each with 4 eggs); 16 June 1954 (1st egg); 14 June 1958 (1st egg); 20 June 1960 (1st egg in 2 nests); 21 June 1961 (4 eggs); 22 June 1961 (4 eggs); 11 June 1962 (1st egg); 12 June 1962 (4 eggs); 13 June 1962 (1st egg). One early date for Muskegon County for the first egg laid in a nest was 10 June 1962.

Late Calhoun County nesting dates were: 1 August 1920 (3 young left nest); 3 August 1924 (3 eggs); 1 August 1929 (3 young left); 13 August 1936 (2 young left); 1 August 1952 (4 young); 14 August 1955 (1 young left); 3 August 1956 (4 young ready to leave); 9 August 1956 (3 young left); and 8 August 1962 (3 young just out of the nest). In Muskegon County, late dates were 11 August 1956 (3 young left), and 8 August 1959 (1 young still in nest).

THE EGGS AND INCUBATION

Fee-bee-o eggs in northern Michigan were whitish, covered with very fine spots. In Schoolcraft County one complete set had four eggs, laid 26–29 June 1957. Apparently the first, second, and third were laid prior to 8:00 AM, the fourth between 9:00 AM and noon. They measured, respectively: 18.2 × 13.8; 18.2 × 13.2; 18.4 × 14; and 18.3 × 13.8 mm. On 30 June they averaged 1.7 grams in weight.

Fitz-bew eggs are almost white, with or without a creamy or buffy tinge, with spots of varying size, mostly at the larger end. On some eggs the spots were very fine, blackish or brownish in color. Others resemble Acadian Flycatcher (*Empidonax virescens*) eggs, with large irregular spots in a wreath around the larger portion. On the same egg some spots may be very dark brown and some almost black. The eggs are ovate or elliptical–ovate in shape, with little gloss. In southern Michigan one set was of five, 52 sets were of four, and 26 sets of three, averaging 3.68 eggs per set. The average set in Muskegon County was 3.81 (1 × 5, 7 × 4, 3 × 3); in Calhoun County, 3.70 (45 × 4; 19 × 3); in Branch County, 3.00 (4 × 3).

The average measurements of 155 *fitz-bew* eggs (Muskegon, Calhoun, and Branch Counties) were 17.70 (15.2–19.3) × 13.29 (12.5–14.3) mm. The average weight of 83 eggs was 1.67 grams. Three eggs in a Baker Sanctuary nest in 1958 measured, as laid, 17.2 × 12.5, 17 × 12.8, and 18 × 13.2 mm. Another set, in 1961, measured, as laid, 18 × 13.8, 17.8 × 13.6, 17.8 × 14, and 17.8 × 13.9 mm.

Eggs are usually laid during the early morning, the last egg in the late morning or even later. One nest at Baker Sanctuary had one egg on 18 June

1958 at 7:00 AM. The second egg was laid 19 June, the third egg prior to 7:00 AM 20 June. Another nest had no eggs at 7:00 AM 18 June 1958, but two at 7:00 PM 19 June, and still two at 7:00 AM 20 June. At another nest a female was on one egg at 5:40 AM 12 June 1962. At 6:30 AM she had returned and there were two eggs. On 13 June at 7:30 AM there were three and at 7:00 PM 14 June four.

Incubation periods were obtained as follows: (1) Branch County, 15 July 1955, 3rd egg laid; 29–30 July, all hatched: (2) Baker Sanctuary, 23 June 1961, 4th egg laid; 8 July, 4th egg hatched: (3) Baker Sanctuary, 23 June 1961, 4th egg laid; 8 July, all hatched: (4) Muskegon County, 13 June 1962, 4th egg laid; 27 June, all hatched: (5) Baker Sanctuary, 14 June 1962, 4th egg laid; 28 June, 4th egg hatched: (6) Baker Sanctuary, 16 June 1962, 4th egg laid; 30 June, 4th egg hatched: (7) Calhoun County, 13 July 1963, 3rd egg laid; 26 July, 3rd egg hatched. The incubation periods (between the laying and the hatching of the last egg) were thus: 15 days (3), 14 days (3), and 13 days (1).

NESTING SUCCESS

I have previously published (1961:267–268) records of the survival of nests and eggs of the four *Empidonax* flycatchers found in Michigan. Since then four more year's records have been added. For *fitz-bew* Traill's Flycatchers the data on nesting success are given in Table 3. Of 92 nests for which the success or failure was known, young hatched in 64 (69.6 per cent) and young left from 60 (65.2 per cent). Of 302 known eggs, 223 (73.8 per cent) hatched while 198 (65.6 per cent) fledged.

Only two of the 23 females had more than one nest during the summer. The average number of eggs laid by these 23 females during a single summer was 4.0 (2–8). An average of 3.2 (0–5) young was reared. Of the two females which laid more than one set of eggs, one laid seven, the other eight.

One female, during 6 years, had one nest each year. She laid at least 20 eggs, of which 17 (85 per cent) hatched and from which 13 young (65 per cent) fledged. During the 6 years she raised, per year: none, none, four, two, four, and three young.

COWBIRD PARASITISM

The Brown-headed Cowbird (*Molothrus ater*) seldom parasitizes the nests of Traill's Flycatcher. I have previously published (1961) records of four parasitized nests, and I have found one since. Consequently, out of 94 Traill's Flycatcher nests, only 5 (5.3 per cent) have been parasitized. In each of two nests one cowbird was fledged. This was at the expense of seven Traill's Flycatcher eggs which did not hatch. In another nest both cowbird and

TABLE 3

NESTING SUCCESS OF TRAILL'S FLYCATCHER

Year	Nests	Nests in which flycatcher eggs hatched	Nests in which flycatcher eggs fledged	Per cent nest success	Flycatcher eggs laid	Flycatcher eggs hatched	Flycatcher young fledged	Flycatcher per cent success
before 1960	43	23	23	53.5	139	80	76	53.9
1961	10	10	8	80.0	39	37	30	76.9
1962	18	15	14	77.8	58	54	44	75.9
1963	13	10	9	69.2	40	28	24	60.0
1964	8	6	6	75.0	26	24	24	92.2
	92	64	60	65.2	302	223	198	65.6

flycatcher eggs were taken by a predator. In the other two nests, the flycatcher built the cowbird eggs into the nest bottom. Neither of these eggs hatched; the one nest met with failure, but the second may have succeeded.

From the flycatcher's standpoint the success in these nests was possibly two fledged from at least 12 eggs laid. From the cowbird's standpoint, five eggs laid in five nests produced two young (40 per cent success). If a cowbird lays an egg in a Traill's Flycatcher nest the nest is doomed to failure in at least 80 per cent of cases.

THE YOUNG

The young are born naked except for tufts of gray down, 4.5–6 mm long on the crown, and a little shorter on the spinal, alar, humeral, femoral, and crural tracts. Young *E. t. brewsteri* described by King (1955:161–163) were very similar to those of *E. t. traillii.*

The down on newly hatched *E. t. traillii* and *E. flaviventris* is a little darker than that on newly hatched *E. minimus,* which in turn is a little darker than that on *E. virescens,* which is white. The flesh-colored skin is similar in all. Young *traillii* are much less mottled in appearance as they approach fledgling age than are the young of *virescens.*

Day 0: Seven young, weighed in the early morning, averaged 1.28 (1.2–1.4) grams in weight. Day 1: Seven young averaged 2.57 (1.6–3.3) grams. Day 3: Seven young averaged 4.2 (3.0–5.7) grams. Day 7: Six young averaged 8.1 (8.0–8.4) grams. Day 10: One young weighed 11.5 grams. Day 11: Three young averaged 11.7 (10.1–13.4) grams.

One 3-hour-old *E. t. traillii* raised its head, opened its mouth, and called, a low *queep,* when the parents called *whit* at the nest.

Of five family groups which were undisturbed the young left the nest at the following known ages: 16 days; 13, 13, 12 days; 15, 15, 15, 14 days;

Fig. 4. Young Traill's Flycatcher, about 14 days old, 31 July 1955, Montague, Muskegon County, Michigan.

13, 13, 13 days; and 14, 14 days. The average for these 13 young was 13.8 days.

At 12 days of age the young were unable to fly, but at 14 days they could fly as far as 100 feet (Fig. 4). The young remained on the parent's territory until they departed southward in August. On 1 August 1961 at Ackley Lake two young flycatchers were caught: one less than 100 feet from the nest it had left on 13 July, the other 175 feet from the nest it had left on 17 July. The first bird was 29 days old and weighed 13.3 grams. Its wing measured 65 mm, and its tail, 54 mm. The second bird weighed 12.3 grams. Its wing measured 67 mm and its tail, 54 mm.

After leaving the nest, the young remain for about 3 or 4 days in the bushes near the nest, then follow the parents through the territory begging for food until they are 24 or 25 days old. Gradually they become adept at catching moths and other insects. Two captive young ate spiders, moths, grasshoppers, flies, mosquitos, and even crickets.

SECOND NESTING ATTEMPTS

On no occasion have I found evidence of Traill's Flycatcher renesting after a brood has been reared. *E. virescens* renests regularly nearly every year in Michigan; *E. minimus* does so less often; *E. t. traillii*, like *E. flaviventris*, does not renest at all. If the eggs or young are destroyed, all four species will renest, *E. t. traillii* if the eggs or young have been taken prior to 20 July. If a female has lost several nests, usually up to three, and has laid as many as 8–11 eggs, she will not renest, even prior to 20 July.

NESTLING RETURNS

Two banded nestling Traill's Flycatchers, out of a possible 147, have returned in later years to nest near where they were born. Both were males. In Muskegon County one made his territory along the same ditch bank where he was born but about 1,600 feet (485 m) from his birthplace. Neither of his parents returned the 2 years he was there. The second male was found 5,230 feet (1,612 m) from his birthplace at the Big Marsh Lake, Baker Sanctuary. When he was one year old he took up a territory at Ackley Lake and raised a family there.

RETURNS OF BANDED ADULTS

Males.—Twenty-two adult male Traill's Flycatchers have been banded on their nesting territories. They were at least one year old when banded. Of these, nine (40.9 per cent) returned the year following; five (22.7 per cent) the third year; three (13.6 per cent) the fourth year; and one (4.5 per cent) the fifth year. All returned to their former territory or to a part of it. (See Table 4 and territory maps in Fig.1.)

Females.—Thirty-one females were banded on the three areas. Only seven (22.6 per cent) returned the first year. During the next 4 years only one (3.2 per cent) female returned.

TABLE 4
RETURNS OF BANDED TRAILL'S FLYCATCHERS BANDED WHEN ADULTS

	Year banded				
	First year	Second year	Third year	Fourth year	Fifth year
Males					
Muskegon County, Montague	3	3	2	0	0
Calhoun County, Convis Township, Ackley Lake	6	2	1	1	0
Calhoun County, Convis Township, Baker Sanctuary	13	4	2	2	1
Total	22	9	5	3	1
Per cent		40.9	22.7	13.6	4.5
Females					
Muskegon County, Montague	5	2	0	0	0
Calhoun County, Convis Township, Ackley Lake	8	2	0	0	0
Calhoun County, Convis Township, Baker Sanctuary	18	3	1	1	1
Total	31	7	1	1	1
Per cent		22.6	3.2	3.2	3.2
Total of both sexes	53	16	6	4	2
Per cent		30.1	11.3	7.5	3.7

Pairs.—A mated pair, designated 1M and 1F, were the first pair banded at Baker Sanctuary in 1960. They returned in 1961 and each had a different mate, 2M and 2F. In 1962 neither 2M nor 2F returned, but both 1M and 1F were back and mated again; they did so in both 1963 and in 1964. 1M used the same territory during 1960 and 1961. 2M had the territory immediately south of this in 1961. In 1962, 1M moved into 2M's 1961 territory and maintained this during that year, and during 1963 and 1964. In 1965 1M did not return but 1F was back on her 1964 territory with a new mate. All other males have returned to their past season's territory. Except for 1F in her second year, this was also the case with female returns. One female, 32-33140, returned her second year to Ackley Lake, but her first year's mate did not return. She occupied the same territory with a new mate. In all other cases, when both male and female returned, they mated together again.

ADULT WEIGHTS AND MEASUREMENTS

The average weight of 16 breeding males was 12.9 (11.4–14.7) grams. The average wing length of 28 males was 70.9 (65–75) mm and the average length of tail was 58.4 (53–60.5) mm.

The average weight of 22 breeding females was 12.3 (10.2–14.2) grams. The average wing length of 33 females was 66.6 (65–72) mm and the average tail length, 55.2 (52–61) mm.

SUMMARY

Traill's Flycatchers of the *fitz-bew* song type arrived at Battle Creek in Southern Michigan on dates averaging 17 May (10–27) during a 35-year period and departed on 15 August (2 August–13 September). The average size of 27 territories was 2.06 (1.3–2.9) acres (83.8 ares).

Habitats in southern Michigan are chiefly in dry shrubby marshes or along lake borders. On the Baker Sanctuary, Convis Township, Calhoun County, 48.5 per cent of nests were found in *Cornus amomum* bushes, and 14.3 per cent in *Crataegus.* At Ackley Lake, in the same township, 35.7 per cent of the nests were in *Salix*, 21.4 per cent in *Cornus amomum*, and 14.2 per cent each in *Rosa carolina* and *Spiraea tomentosa.* The average height of 93 nests was 133.2 cm.

Eggs are laid during the early morning, as a rule; often the last egg is laid just prior to noon. The average egg set was 3.68 and the average measurements, 17.70 × 13.29 mm. The average egg weight was 1.67 grams. Incubation required between 13 and 15 days, averaging 14.

Of 92 nests observed, eggs hatched in 64 and young left 60 (65.2 per cent). In these 92 nests, 302 eggs were laid, of which 223 hatched; 198 young fledged (65.6 per cent).

Thirteen young left nests at 13.8 (12–16) days of age. They remained on their parent's territories until about a month old.

Cowbird parasitism was found in five of 94 nests. Two cowbird young were fledged, at the expense of seven Traill's Flycatcher eggs. The laying of a cowbird egg in a nest causes the nest to fail in over 80 per cent of cases.

Of 22 banded males, nine returned the next year, five the third, three the fourth, and one the fifth. Of 31 banded females, seven returned the next year and only one the next 4 years. Through 1964 two banded nestlings out of 147 returned to nest within 1,600 feet and 5,230 feet of where they were born.

Both male and female return to their past year's territory if possible. One pair was paired for 4 of 5 years.

From records of 23 banded females, the first egg was laid 17 (6–28) June, and nests were terminated 19 July (9 July–10 August). Only two of these females attempted second nests. The average number of eggs laid by the 23 females during the summer was four.

Adult weights and measurements are given.

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1703 WOLVERINE-FEDERAL TOWER, BATTLE CREEK, MICHIGAN, 25 NOVEMBER 1964

NEW LIFE MEMBER

Miss Marie E. Thompson of Ft. Lauderdale, Florida, has recently become a Life Member of the Wilson Ornithological Society. Having spent most of her life in Michigan, where she graduated from Western Michigan University, she has recently retired to Florida. A former officer of the Michigan Audubon Society and the Audubon Society of Kalamazoo, Miss Thompson is also a member of the AOU, and numerous state and local ornithological organizations. Her interests in birds are mostly observational, and she sandwiches these in with church activities, gardening, and photography.

BEHAVIOR OF YOUNG CACTUS WRENS AND CURVE-BILLED THRASHERS

Robert E. Ricklefs

While studying the growth of nestling Cactus Wrens (*Campylorhynchus brunneicapillus*) and Curve-billed Thrashers (*Toxostoma curvirostre*) near Tucson, Arizona, during the late spring and summer of 1964, I made incidental observations on their behavior. A nestling of each species was removed to be raised in an artificial environment. The wren was 12 days old, the thrasher, 9. Both birds, but especially the wren, were somewhat retarded in physical growth (weight) prior to their removal from the nests. A retardation of their behavioral development may have been associated with this, but no behavioral abnormalities were observed.

The birds were kept together in my room in a small cardboard carton with "nests" made of cloth-lined pint-sized containers. Other than keeping them indoors, I made no attempt to restrain them, even after they could fly. Both birds were handled regularly and became extremely tame. Most of my observations were made when the birds were placed on a large flat table for feeding. Horsemeat proved to be quite satisfactory. Other observations were made on nestlings which were being weighed daily in the field.

In the Sonora Desert of the Tucson region, this wren and thrasher are two of the most conspicuous passerines and are usually associated with each other. In my study area, both use cholla cacti (*Opuntia* spp.) for nesting. Certainly the greatest difference between the environments of the nestlings of the two species, disregarding parental behavior, is the construction of the nest, the wren's being an enclosed structure with a side entrance, the thrasher's, open (Fig. 1).

NESTLING BEHAVIOR

The nature of behavior and the amount of activity are limited by physical capabilities. The weakness of the newly hatched bird is reflected in its assumption of a nonalert attitude (the "embryonic position") in the nest, and little activity. Early nestling behavior, and its change with increase in size and strength, has been described for the Cactus Wren by Anderson and Anderson (1961) and for the Curve-billed Thrasher by Rand (1941), and will not be stressed in this paper.

Feather preening and picking at disintegrating feather sheaths, as well as wing-stretching and exercising during the last few days of nestling life, are certainly related to the physical development of the nestling. The time of fledging must also reflect the attainment of a critical level of physical capabilities of the young bird.

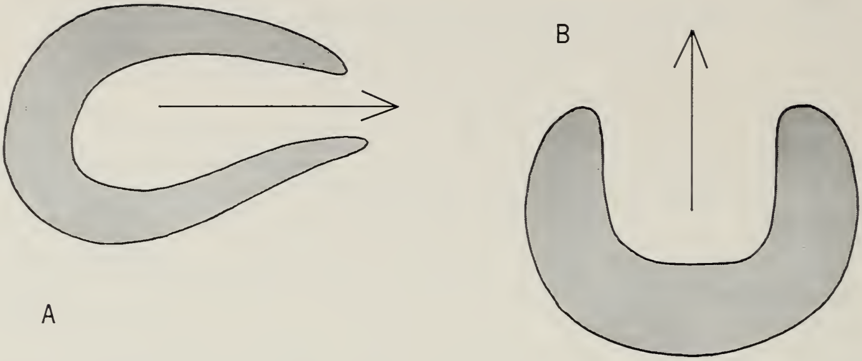

Fig. 1. Idealized cross sections of the nests of (a) the Cactus Wren and (b) the Curve-billed Thrasher. The arrows indicate the direction of parent–nestling interaction.

Many features of nestling behavior demonstrate adaptation to nest form.

Begging.—In Figure 1, the direction of the interaction between the nestling and the parent is indicated by an arrow. As would be expected, the nestling thrasher begs vertically with full extension of the legs, body, and neck. The wren assumes a horizontal, almost crouched, position, stretching the neck forward. The difference in direction, when both were placed on a flat table, was striking. Loud, high-pitched cries accompany the begging of both.

If food is presented to the wren from above, the bird will maintain the horizontal body position and direct only its head upwards. Conversely, if food is presented to the thrasher from the side, the nestling will still stretch upwards with its legs and body, directing only its head, with some difficulty, towards the food.

Lateral movement.—While in the nest, thrashers have very little freedom of lateral movement, whereas nestling wrens, when large enough, crawl out to the opening of the nest to meet the parent with the food, and then crawl back into the safety of the nest cavity after being fed. This is possibly the basis of the wren's much greater "exploratory" activity and movement when placed on a tabletop, and also the "backup" behavior (described by Anderson and Anderson (1961) as a fright response). After being fed, the wren would often back up, with as much agility as in forward movement. If it backed into any object within a few inches, such as my hand placed on the table, the wren would not hesitate to snuggle up against it. In this case, the behavior could not be attributed to fright, and may be directly related to the wren's manner of crawling back into the nest cavity. Satisfaction of hunger, or fright, would serve to initiate the response. During the backup, the wren often backed off the tabletop and so apparently did not rely on vision to determine its course. In one instance when I did not catch it, one leg was injured enough so that the other was favored for a couple of days. Such manner of movement could be of value only if there is always something to back into, the nest cavity.

Defecation.—The manner of defecation of the thrasher and wren was strikingly different. In both cases, the parents remove the feces when present, after they have fed the young. Thus, it is essential that the parents be aware of the presence of fecal sacs in the nest. The nestling Cactus Wren defecates only immediately after being fed. Its position when defecating is not markedly different from that when begging, but it is accompanied by an unmistakable shaking of the body. Whether this is a necessary accompaniment to the physical act of defecation, or is a secondarily adapted "signal," could not be determined, but it did serve as adequate warning to me. I did not determine, in the field, whether nestling wrens face the nest opening or the nest cavity while defecating. It would seem at first thought that the latter position would make the task of finding and removing the feces easier for the parent. However, the presence of several well-grown nestlings in the neck of the nest at the same time leaves no room for turning around, and the young bird must face the opening to be fed. It is likely that the wrens are always facing the nest opening when in the neck of the nest and so the "signaling" behavior may have developed for the purpose of advertising the defecation which the parent could not otherwise observe.

The thrasher's cup-shaped nest is deep, and when defecating, the nestling raises its posterior as high as possible, making the fecal sac readily visible from above. This action was invariably displayed on the flat tabletop in the absence of a nest rim. When the nestling is large enough, it can defecate onto the nest rim, making the fecal sac conspicuous without the parent's having to observe the defecation. Towards the end of its "nestling" period, the hand-raised thrasher frequently defecated between feedings. Body-shaking did not accompany defecation in the thrasher as it did in the wren.

Exercises.—The form of the nest also affects the manner of wing- and leg-stretching which commences several days prior to normal fledging. The nestling thrasher is not confined in a vertical direction and the hand-reared bird exhibited three general exercises: (a) stretching the leg and wing on one side far back, (b) standing up, stretching both legs, and (c) the previous exercise combined with wing-flapping.

The young wren's stretching behavior seems to have adapted to the extreme confinement of the nest. The only exercise observed was a peculiar wing-stretching which involved lowering and moving posteriorly the wrist of the wing and spreading the primary feathers over the back. Thus, the exercise was accomplished without using additional space.

BEHAVIORAL CHANGES

Begging.—As early as the 15th day, the thrasher would beg towards a food source, rather than in a primarily vertical direction. Beginning on the 20th day, it would wait until I had presented food before begging, now without strong vocalization and stretching, and occasionally accompanied by a quivering of the wings.

By the 18th day, the wren begged with its head drawn back instead of extended, and also quivered its wings. Begging was still accompanied by strong vocalizations. After the 23rd day, the wren would beg only when presented with food.

The wren from the 17th day, and the thrasher from the 15th day, occasionally begged towards the other bird. After the 21st day, attempts to place food in the begging wren's mouth often elicited a *refusal behavior.* The wren drew its head back and turned it rapidly to the side, usually ejecting the food from its mouth. The bird then had to be force-fed. Rand reported similar behavior in young thrashers after the 30th day. After the 20th day, when food was presented on the palm of my hand, the thrasher would often gape or beg at the food.

Defecation.—Noticeable changes in defecation took place in the thrasher and the wren at 18 and 21 days, respectively. As "nestlings," their feces were large and enclosed in a fecal sac; defecation occurred after feeding (except as mentioned for the thrasher during the latter part of the nestling period) and in the wren was accompanied by a conspicuous behavioral "signal." After the time when fledging would have occurred in the wild, feces were smaller and not enclosed in a sac. The wren's "signal" behavior also disappeared and the thrasher no longer raised its posterior.

Roosting.—Adult and fledged Cactus Wrens use roosting nests for passing the night, but the fledged thrasher roosts perched in the cholla cactus. On the 18th and subsequent nights, the thrasher slept perched on the rim of its artificial nest.

New behavior.—On the 17th day the wren began head-scratching, on the 21st day was cocking its tail in an adult manner, on the 23rd day began exploratory pecking, and on the 24th, bathing (without water) and bill-wiping motions. For the thrasher, bill-wiping was first noticed on the 16th day, tail-cocking on the 18th, pecking on the 20th, and head-scratching on the 22nd.

Pecking activities were seemingly acquired simultaneously in the two birds. They began pecking on the same date and would peck objects together. When one would start pecking, the other would also become interested in this activity. Other than this and the mutual begging described above, the only other interaction witnessed between the two birds was that the wren often

TABLE 1

THE ONSET OF BEHAVIORAL FEATURES AND CHANGES

	Days after hatching													
	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Cactus Wren														
Begging:														
Towards thrasher						x								
Flexibility							x							
Only with food												x		
Defecation change										x				
Chatter syllable							x							
Adult chatter										x				
Refusal behavior										x				
Pecking												x		
Preening				x										
Stretching						x								
Tail-cocking										x				
Head-scratching						x								
Bill-wiping													x	
Bathing													x	
Weak flight											x			
Curve-billed Thrasher														
Begging:														
Towards wren				x										
Flexibility				x										
Only with food									x					
Defecation change							x							
Chirp note					x									
Adult song phrase							x							
Roosting							x							
Pecking									x					
Preening		x												
Stretching				x										
Tail-cocking							x							
Head-scratching											x			
Bill-wiping					x									
Weak flight							x							

Behavioral features and changes are listed in the left column and an (x) is placed under the day by which these changes were first observed. First weak flight is given as a reference to physical development. The normal time of fledging is indicated by the vertical line. See text for details.

snuggled up beside the thrasher while in the box; the thrasher paid little attention to this.

Vocalizations.—On the early morning of the 22nd day, the wren gave a typical adult chatter for the first time. For several days it had constantly been using single syllables of this phrase. On the morning of the 18th day, and at subsequent times, the thrasher uttered a short warbled and liquid phrase similar to that which adults often gave when I was weighing their young in the field. By this time, the thrasher also occasionally used a "chirp" note.

The onset of the behavioral changes observed in the wren and the thrasher are compared in Table 1.

DISCUSSION

One must be careful in drawing conclusions from behavioral studies on hand-raised birds. The environment of the hand-raised bird is artificial and may elicit responses at incorrect times and in false context, thus leading to misinterpretation. A comparison of my observations with those of Rand (1941) on artificially raised thrashers shows that while the behavior patterns correspond closely, they were often initiated at different ages. Some of the discrepancy may be due to observational errors, but the environments were undoubtedly dissimilar in any number of ways as Rand raised his thrashers with a "minimum" of human contact in large outdoor cages, each containing several birds. The variation may partly be due to the absence of parent birds, whose behavior must act to stabilize the environment of the young and give direction to their behavioral development.

In spite of drawbacks, this method has important advantages. The ease of observation, and familiarity obtainable with hand-raised birds, is not possible in the field. Further, because subtle behavior patterns and changes are out of natural context, the artificial environment tends to emphasize some of them.

There are several factors which appear to limit and direct the behavioral development of the young bird: (1) physical development, (2) environment, (3) energy requirements, and (4) the goal: mature adult behavior.

Physical development.—Whereas growth is essentially continuous, the passing of certain critical points marks off phases of behavior. Feather-preening and exercising have already been mentioned. The opening of the eyes might be correlated with the restriction of indiscriminate begging of the nestling.

The termination of the nestling period is ultimately determined by survival probabilities in and out of the nest, and should be regarded as a behavioral change, or complex of such changes, occuring with the attainment of a level of development dependent on the nest type and the physical capabilities of the nestling.

Environment.—The nest form determines the direction of begging and the manner of defecation, restricts the amount and nature of exercising in the Cactus Wren, and may also affect the motility of the nestling.

The abandonment of the nest environment is reflected in the abrupt change in defecation behavior and the adoption of a new roosting behavior in the thrasher. New behavior, such as pecking and tail-cocking, not useful to the bird until out of the nest, develops at this time.

The nest serves as the focal point for the breeding activities of the parent bird and, with its abandonment, the parents and young associate as a family. Whereas nestlings are physically confined by the nest, the family must be held together by behavioral means. Vocalizations are used by the young to indicate their presence and position. Both the wren and the thrasher had developed "location notes" (the chirp note of the thrasher and the single chatter syllable of the wren) by the time either would have been ready to fledge.

Energy requirements.—The growth curves of the thrasher and the wren are sigmoid in shape and thus the rate of growth, and hence the required input of energy, is highest during the middle of the growing period and tails off toward both ends. It is possible that while the growth rate is increasing and the parents are becoming increasingly taxed, the energy resources of the young are directed primarily to growth, and behavior is limited to begging and defecation. During this period (the *competitive phase*) nestlings compete with each other for food by begging with extreme extension towards the feeding parent (Ricklefs, 1965). With the passing of the maximum growth rate, a *noncompetitive phase* ensues and continues until the bird becomes independent. Begging becomes flexible in direction and pronounced stretching is absent.

Mature behavior.—After the onset of the noncompetitive phase more time and energy are diverted towards such mature behavior as awareness, behavioral flexibility, and learning. The young bird begins to acquire a greater consciousness of its surroundings as indicated by head movements, and its repertory of behavioral responses broadens (cf. mutual begging). Fear reactions, such as crouching in the nest and escape attempts when being handled, appear fairly late in the nestling period.

Some of Rand's observations suggest that species recognition may take place after the onset of the noncompetitive phase. Rand mentioned that thrashers taken from the nest when 14–15 days old learned to beg, whereas birds taken on the 18th day never begged and had to be force-fed. This suggests that birds taken on the 18th day had identified themselves with thrashers and would not accept food from other sources. Begging during earlier stages of nestling development appears to be a generalized response to many types of stimuli. Either the young nestling is not capable of distinguishing, for example, man from its own parents, or the distinction carries no significance.

Ability to recognize species would enable the fledgling to distinguish its parents from possible predatory animals. Recognition would also be expected to play an invaluable role in family association and the development or learning of specific mature behavior.

The relationship of the parent to young during the early nestling stage is so simple (i.e., the transfer of food and protection from weather) that even the crudest, or most restricted, level of recognition will suffice. After fledging, the nature of the parent–fledgling relationship becomes spatially more varied and behaviorally more complex. At this time the young bird must have a better defined conception of the characteristics of its species.

One might easily imagine that a fledged bird which had not learned recognition might be prone to confusion. Possibly the "juvenile defense behavior" described by Rand in which the young thrashers drew back their heads, opened their bills wide, and spread their wings slightly is an example of such confusion. This behavior lasted for a period of 2 weeks or so and was given towards a ring-tailed cat, a juvenile Gila Woodpecker, and occasionally to an extended hand and to small objects placed quickly in front of a bird. That the "juvenile defense" is solely a defense behavior seems unlikely since prior to its onset, and later when the fledgling is beginning to attain independence, the normal response to unfamiliar or menacing objects is to flee. During the period of the "juvenile defense" there must be another factor acting to produce the observed response. The desire to obtain food is a likely possibility. The attraction of an object as a potential food source could produce a behavior which is neither solely a begging or solely a fleeing response, but a combination of the two. When the young bird becomes self-feeding, the urge to beg gives way to the fleeing response and the "juvenile defense" disappears. Such behavior would not be expected from a bird which had learned species recognition, but Rand does not mention whether the behavior was observed in birds removed at 18 days.

In other species, nestlings may exhibit a similar behavior towards their parents, involving a withdrawal of the head, gaping, and spreading or quivering of the wings. This suggests two other possibilities for the "juvenile defense." First, it may be a modification of the begging response as a mechanism of, or due to interaction with, species recognition learning. One could postulate that the behavior stimulates complementary behavior on the part of the parent which facilitates species recognition. More likely, the juvenile defense may be a submissive behavior. Gaping and forward movements are major components of both aggressive action of adults and begging behavior of nestlings. It is possible that these components must be abandoned or modified when the young leave the nest and take on an adult appearance so that the parent may readily distinguish begging from aggressive behavior.

TABLE 2

NESTLING DEVELOPMENT SCHEME

Physical development	Environment	Energy requirement	Mature behavior
Hatching			
Weak, blind Indiscriminate begging Eyes open	Nest phase: Behavior modified by nest form	Competitive phase: Energy devoted to growth, behavioral responses few and simple	
		Peak energy requirement	
Feather preening Exercising		Noncompetitive phase: More energy diverted to behavior	Awareness Signs of fear Species recognition
Weak flight, fledging behavioral complex			
Bird becoming adult in appearance and physical capabilities	Family association: Adult environment modified by parents		Development of feeding behavior and specific adult behavior
	Independence		
	Adult environment		

Table 2 summarizes the progress of development as outlined in the discussion.

SUMMARY

A Curve-billed Thrasher and a Cactus Wren were taken from their nests at 9 and 12 days, respectively, and raised in an artificial environment. They retained behavioral features obviously adapted to the nest types of their own species.

Most of the behavioral features of the nestlings underwent one or more changes which were tentatively related to (1) changes in environment associated with fledging, or (2) to a possible shift from increasing to decreasing energy requirements of the nestlings. It

was proposed that while energy requirements for growth are increasing (the *competitive phase*), little energy is allocated towards elaborate behavior. The beginning of the *non-competitive phase*, when the requirements of growth are decreasing, allows the nestling to divert energy resources towards the development of adult behavior.

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NOTE ADDED IN PROOF: Recent studies on nestling Red-winged Blackbirds and Barn Swallows indicate that energy requirements for maintenance and temperature regulation are considerably greater than for growth. Because the former are related to weight and the development of thermoregulation rather than the rate of growth, they do not decrease at any time, but reach a plateau approximately when the nestling has reached its maximum size. When the young bird leaves the nest, its energy requirements will increase still further due to added activity and the abandonment of the insulative qualities of the nest. The increased demands are critical until the young bird becomes self-feeding and presumably capable of gathering more than enough food for its own requirements.

In view of these considerations, a causal relationship between changes in nestling behavior and changes in total energy requirement is highly questionable. More likely, new and more flexible behavior is by way of preparation for fledging which will place the young in a new situation. In the Red-winged Blackbird, a species with a short nestling period (10–11 days), new behavioral features (awareness, flexible begging behavior, fear reactions and changes in vocalizations, roosting behavior and defecation) occur at about 8 days, when energy requirements are still increasing.

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THE DEVELOPMENT OF GRASPING AND BALANCING COORDINATION IN NESTLINGS OF SEVEN SPECIES OF ALTRICIAL BIRDS

Larry C. Holcomb

Studies of nestling development in the summer of 1963 included the recording of grasping and balancing coordination in several species: the Catbird (*Dumetella carolinensis*), Cedar Waxwing (*Bombycilla cedrorum*), Cardinal (*Richmondena cardinalis*), Field Sparrow (*Spizella pusilla*), Traill's Flycatcher (*Empidonax traillii*), Indigo Bunting (*Passerina cyanea*), and Goldfinch (*Spinus tristis*).

There has been very little description previously of this phase of the development of nestlings. Lea (1942) found that Cedar Waxwing nestlings were able to move their toes but not grasp objects when 2 days old. Further, at 4 days of age the nestlings were unable to right themselves when placed on their backs. By the seventh day, the eyes were reported opening and nestlings could right themselves. On the ninth day they could support themselves on a perch.

King (1955) reported that Traill's Flycatcher nestlings sat erect on their tarsi on day 8 and on day 10 were able to perch on a finger. Laskey (1944) reported young Cardinals perching in the nest shrub when 9 days old. To my knowledge, no one has ever made a study comparing different species of nestlings with regard to the time when they could first balance on a perch. Since ability to grasp and balance on a twig or weed stem at fledging may have an effect on the success of the young bird in becoming an adult, the study of these characters may increase our understanding of age-specific mortality as discussed by Young (1963).

METHODS

These studies were made inside the city limits of Toledo, Ohio from mid-June through mid-September. The nesting areas were predominantly second-growth vegetation, railroad sidings, and dense hedgerows. Most nests were found before incubation had started; thus, the egg weights given in Table 1 represent fresh eggs that had not lost weight appreciably through incubation. Eggs were weighed to the nearest tenth of a gram with the use of a Harvard double-beam balance, on the day following the laying of the final egg.

Once a nest was discovered, it was checked daily for appearance of more eggs and to determine when incubation started, and when the eggs hatched. Individual eggs were not marked.

TABLE 1
AVERAGE EGG WEIGHT AND LENGTH OF INCUBATION PERIOD IN SEVEN SPECIES OF ALTRICIAL BIRDS

Species	Number of eggs weighed	Range of egg weight in grams	Mean egg weight in grams	Incubation period (days)	Source for incubation period
Cardinal	3	4.1–4.6	4.43	12 or 13	Laskey, A. R. (1944)
Catbird	8	2.6–3.5	3.08	12 or 13	Bent, A. C. (1948)
Cedar Waxwing	8	2.6–3.0	2.80	12.2	Putnam, L. A. (1949)
Indigo Bunting	7	1.5–2.3	1.89	12–13	Author
Field Sparrow	18	1.4–2.1	1.69	11 ± 0.5	Crooks, M. P., and G. O. Hendrickson (1953)
Traill's Flycatcher	17	1.4–1.8	1.58	12–14	Stein, R. C. (1958)
Goldfinch	153	0.8–1.6	1.26	12 days 21 hours	Walkinshaw, L. H. (1938)

Nestlings were checked daily for growth rate and gross morphological changes; this included recording of development of grasping and balancing coordination. A small weed or tree stem was used as the grasping and perching foothold. The ability of the young nestlings to grasp the stick was tested daily by placing them feetfirst on the stick and they were always given a second chance if they failed in their first attempt, but were not given more than two chances on a single day. This prevented any artificially induced development of abilities in the nestlings. If they could not grasp the stick they were not allowed to fall more than 2 or 3 inches to the hand of the investigator. The day of hatching was considered as day one.

Notation was made of time delay after hatching when nestlings acquired the ability to (1) grasp a stick for at least 5 seconds without balancing, (2) balance unsteadily, and (3) balance with good coordination.

RESULTS

Table 1 indicates that the average weight of eggs differs considerably among species, with a low of 1.26 grams in Goldfinches and a high of 4.43 grams in Cardinals. Catbirds and Cedar Waxwings also had larger eggs than did the other four species. The incubation period, however, varies but little among the seven species. Goldfinches had the smallest eggs, but they have an incubation period as long as the Cardinal and Catbird that have the larger eggs. Before reviewing the data, I assumed that perhaps the Goldfinches

TABLE 2

WEIGHT OF FLEDGLINGS AND DAY POSTHATCHING WHEN LEAVING NEST

Species	Day leaving nest	Approximate weight when leaving nest
Cardinal	11	30 g
Catbird	12 or 13	29 g
Cedar Waxwing	16	30 g
Indigo Bunting	10	12 g
Field Sparrow	7–9	10 g
Traill's Flycatcher	13 or 14	12 g
Goldfinch	13 or 14	12 g

might have hatched in a somewhat advanced developmental stage due to the relatively long incubation for such a small egg; due to this advanced development they might be advanced in their ability to grasp a foothold and balance earlier than Catbirds and Cardinals.

The results of the experimentation with nestlings are only given for those nests where the young developed normally; i.e., all of the nestlings received enough food.

Table 2 indicates the day after hatching on which the birds left the nest and also gives the approximate weight of fledglings in grams when they left the nest. It is readily apparent that the Goldfinch, Indigo Bunting, Field Sparrow, and Traill's Flycatcher are about the same size at this time. Cardinal, Cedar Waxwing, and Catbird fledglings all weighed nearly 30 grams when they left the nest. Some young birds left the nest before being able to balance well, thus the final column in Table 3 does not always represent the total number of nests observed.

As observed in Table 3, the Goldfinches were the earliest to develop the ability to *grasp* the stick (fifth day); the Catbirds were the latest in their ability to *balance* well (11th, 12th and 13th day). There was little variation (within species) in time after hatching when the remaining species could grasp well, except in the Traill's Flycatchers the time ranged from the sixth through the ninth days. There was little variation (within species) in the day after hatching when six of the seven species could balance well. The Catbirds appear to lag behind all the others in development of good balance.

When the young birds were first able to grasp the stick, they would always slip underneath and hang bottom-side up. As they attained better ability to grasp and balance they would hang from the side of the stick, attempting to use their wings as a balancing aid. However, in early development the alar tract was not feathered and therefore aided them but little. As good balance

Table 3

The Development of Grasping and Balancing Coordination of Nestlings given in days Posthatching

Species	Number of nests	Grasping	Unsteady balancing	Good balance
		(1)	(1)	(1)
Cardinal	1	7	9	10
		(1)(3)	(1)(2)(1)	(1)(2)(1)
Catbird	4	8, 9	10, 11, 12	11, 12, 13
		(2)	(2)	(2)
Cedar Waxwing	2	7	8	9
		(2)(1)	(1)(1)(1)	(1)
Indigo Bunting	3	6, 7	7, 8, 9	8
		(3)(1)(1)	(1)	
Field Sparrow	5	6, 7, 8	8	—
		(2)(1)(3)(2)	(1)(2)(4)	(2)(1)(4)
Traill's Flycatcher	8	6, 7, 8, 9	7, 8, 10	9, 10, 11
		(14)(11)	(2)(12)(8)(1)	(1)(10)(11)(1)
Goldfinch	25	5, 6	7, 8, 9, 10	8, 9, 10, 11

Numbers in parentheses designate the number of nests of nestlings represented for that day.

was attained the birds sat up well and used their wings but little, if any, as an aid for balance adjustments.

Ability to grasp the stick was present often before full vision was present. However, there was never good ability to balance until the eyes were fully open. Thus, the visual senses may be important for good balance. The early use of the vestibular apparatus, peripheral sensory receptors, gastrocnemius, and peroneus longus muscles, and especially the flexors of the digits aiding in perching may be of great importance. Feathers in the alar tract also may aid in later stabilization of balance, for often the nestlings spread their wings using the weight of the wing and the surface area of the feathers to aid in balancing.

DISCUSSION

Attentiveness in incubation or higher brooding temperature in the species laying larger eggs may account for the relatively small differences found in development of grasping and balancing in six of the seven species studied. In other words, perhaps birds laying larger eggs were more attentive in incubating their eggs or perhaps the birds laying smaller eggs were less attentive.

Skutch (1962) reported that increased constancy of incubation may possibly decrease the incubation period for some species. However, Prescott (1964) did not expect that increased constancy shortens the incubation period of the Scarlet Tanager. Stoddard (1946) reported that the Bobwhite is more attentive to the nest in cool weather than on warm days, thus indicating that the constancy of incubation is effected by the environmental temperature. Wetherbee (1961) reported that artificially incubated eggs of the Catbird required a maximum of 317 ± 3 hours for incubation. Berger (1951) and Burns (1915) reported periods of incubation for the Catbird lasting up to 15 days which would be about 360 hours. Wetherbee also reported a maximum of 298 ± 9 hours of artificial incubation for the Cardinal, whereas Laskey (1944) found the incubation to be 12 or 13 days, a possible 312 hours. The evidence above indicates that constant incubation does shorten the length of time required for hatching.

Skutch used a formula for calculating the constancy of incubation which can be applied to some data from other sources. The formula is:

$$T = \frac{100\,S}{S + R}$$

where T is the constancy, S is the average length for the sessions of incubation, and R the average length of the recesses.

Putnam (1949) and Kendeigh (1952) found a constancy of 89 and 85 per cent, respectively, for the Cedar Waxwing. Applying the above formula to their data the same percentages are derived.

Laskey (1944), in reporting on the Cardinal, included limited data on the time the female was on and off the nest. A constancy of 90 per cent was found when the formula was applied. Application of the formula to Kendeigh's data on the Goldfinch gave a 94 per cent constancy for this species.

Zimmerman (1963) found an incubation constancy of but 64 per cent for the Catbird, and Kendeigh (1952) and Skutch (1962) reported a constancy of 75.9 and 78 per cent, respectively, for the Catbird. I could find no data indicating the constancy of incubation in the Indigo Bunting, Field Sparrow, or Traill's Flycatcher.

Skutch (1962) reported that instances of the acceleration of embryonic development by constant sitting are difficult to find. However, while there may be very little interspecific difference in the length of incubation as given in Table 1, the complete ontogeny of the nestlings may be somewhat slower in species whose incubation is less constant. The details of growth patterns and the development of coordination may reveal indirectly the effect of the constancy of incubation. Of the four species about which information is available, the Cedar Waxwing, Cardinal, and Goldfinch all have an incubation constancy above 85. The highest incubation constancy reported for the Catbird is about 78, ranging to a low of 64. The Catbird nestlings were the slowest in their ability to grasp or balance. This retardation of ability to coordinate body movements or develop muscle tonus, etc., may be due to retarded development at hatching due to effects of incubation while in the egg. On the other hand, the exceptionally rapid development of ability to grasp and balance in the Goldfinch may be due to the relatively faster development of the embryo as a result of more constant incubation.

The development of abilities to grasp and balance may be faster in nestlings of some species because of genetically controlled characters that have adaptive significance. Sutton (1959) described the nestling Goldfinches as follows: "Nestling Goldfinches are wholly unlike the young of other fringillids which breed on the Reserve in that, during the latter days of their fledging period, they use their toes in clinging to the nest. There is a possible correlation between this propensity and the position of the nests far out on branches that toss in the wind, as well as between it and the clinging, climbing habits of the adult while feeding. Young Goldfinches which I have banded have clung so tenaciously to their nests that I have lifted the lining out with them." This may in part explain why the Goldfinch nestlings in the present study were the earliest in their ability to grasp and balance.

Wetherbee (1961) suggested that the whole life history of a bird and its biogenetic burden are involved in any real understanding of the developmental condition of the young at hatching. Perhaps when the embryos begin to develop, there may be faster development of anatomical structures which are prominent as adaptive characteristics of the species.

SUMMARY

Seven species of altricial birds were studied with regard to development of coordination in grasping and balancing.

There was little variation in incubation time among these species.

There was considerable variation in egg weights among species. Most nestlings could grasp a perching stick for at least five seconds by the seventh day after hatching.

Most nestlings could balance upright well by the 10th day.

Catbirds appeared slowest in development of this character among species studied.

Vision and equilibrium changes, development of peripheral sensory elements, muscular strength, and alar plumage may effect the development of grasping and balancing.

Greater nest attentiveness and/or *higher brooding temperature* may speed the development of the embryos of species laying the larger eggs, but incubating for nearly the same time interval as species laying smaller eggs. This may account for small differences noted in the day after hatching when grasping and balancing is well developed in nestlings of these different species.

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THE MANNER OF FEEDING FLEDGLING WOODPECKERS

Amelia R. Laskey

Apparently very little has been published concerning the manner of parental feeding of fledgling woodpeckers, although there are more data on the feeding of nestlings. Many of the latter observations are based on the motions made by the adult as it fed the concealed young from the cavity entrance.

In 1964 from 20 May through 9 June, I watched a pair of Downy Woodpeckers (*Dendrocopos pubescens*) with their brood of three fledglings (one with red on the crown, presumably a male (Forbush, 1927:61)). They came to a feeding station a few feet from house windows where they fed the young on a dead tree which provided a completely unobstructed view of all actions.

At 5:30 PM on 20 May, the female arrived with a large fledgling in female plumage which rested on a horizontal branch of the dead tree while the parent took several bites of suet, then flew to the fledgling. As the adult waited beside the youngster, the latter pecked at her bill several tims to secure the food. This procedure was repeated a number of times at this feeding, always in the same manner. Not once was the adult's bill inserted into the mouth of the fledgling nor were its mandibles noticeably parted. No begging posture or gaping occurred. The fledgling sometimes pecked the bark as the parent gathered more food.

This manner of feeding is similar in some respects to an observation made many years ago (9 August 1941) when a female Yellow-shafted Flicker (*Colaptes auratus*) and a large fledgling fed on our lawn. The details were written for my file at that time. The adult hunted food, followed by the vociferous fledgling which was fed several times. When ready to feed, the adult opened her bill slightly, gave several rapid forward movements of her head while the fledgling poked its bill into hers from the side, near the base of her bill. On one occasion, the adult worked on what appeared to be a cicada pupa case, pounding it with her beak to remove the hard shell. She made several attempts to swallow it before she got it down. Immediately afterward, she offered a feeding to the youngster. The first item that it received was the cicada which it attempted to swallow. When it did not go down immediately, it was rejected and thrown a few inches. Feeding at the mother's bill was resumed. At termination of the feeding, the adult retrieved the cicada and swallowed it (Laskey, 1943).

In 1964 the Downy Woodpeckers with their brood of three came regularly to feed at the dead tree. At every feeding, the pecking method was used. On 21 May the female fed the fledgling male on suet; on 25 May she shelled sunflower seeds taken from a suspended glass jar. She poked a seed into a bark crevice, pounded off the hull, then carried it in her bill to a female fledgling which pecked it in small bites from her bill. Later that day a fledgling fed itself suet by clinging to the wire container, but the female continued the feedings several times a day.

On 27 May the adult male arrived with the fledgling male, fed him by the same pecking method, then the female arrived, chased her mate, fed the young male herself, then fed one of the females, mainly on hulled sunflower seeds. The male parent was never seen taking a sunflower seed. Later in the day the mother arrived with the two females. She chased one, fed the other.

Feedings were mainly given by the female, but on the first of June, the family of five came together. By 6 June the parents were noticeably ignoring the young and only occasionally gathering food for them to peck. On this date the young male gave the adult call, and flew at his sisters. On the following day (7 June) a female fledgling gave the adult call. On 9 June the female gave a sunflower seed feeding to a female, the final one for the brood.

On 10 June the young male helped himself to a sunflower seed from the glass feeder, placed it in a crevice where the mother had hulled most of them, was unsuccessful in hulling it there, tried several other crevices unsuccessfully, then flew off with it.

In 1965 two sets of parent Downy Woodpeckers carried suet from the same dead tree to their broods, one flying east, the other to the west. In late May the fledglings were being fed there by this same pecking method.

This manner of feeding fledgling woodpeckers may be more common than is indicated in the literature, but I have been unable to find any similar observation. It is contrary to the published accounts of nestling and fledgling feeding. It has value in leading fledglings to independence by practice in pecking for their own food. When hand-raising young of several other species, I have noticed that there is often a transition period when gaping to the forceps or finger gives place to pecking the food as it is offered, which is soon followed by pecking on the ground and independence.

Bent (1939) has compiled a number of reports by various observers on the manner of nestling feeding by several species of woodpeckers. Most of these report regurgitation, some without actually seeing the contact of bills between parents and nestlings, but based upon the motions of the adult outside of the cavity.

Concerning the Downy Woodpecker, Bent (op. cit.:57) states: "How the young are fed in their earliest days has not been determined," then he quotes A. A. Allen: "Certainly by the time that the young are 4 or 5 days old entire insects are brought in the parent's bill; I have photographic proof of this."

Reporting on flickers, Roberts (1932:666-667) states that they furnish the best opportunity for studying the "stab" method of feeding the young. He also calls it the "pumping" method, a practice common to woodpeckers and hummingbirds.

Bent (op. cit.:275) quotes W. Brewster that flickers are fed by regurgitation, stab method, and states that I. G. Wheelock (p. 290) reports a western race fed by regurgitation. Sherman (1910) watched flickers feed nestlings inside the nest box. She stated "they secure the parent's bill and suck." She also stated the young grasp the parent's bill from the side. Terres (1960) described the feeding of two flicker fledglings on a lawn. They assumed the begging posture of crouching with open bills before the female parent who fed each in turn by thrusting her bill into their mouths. In 1949 a brood of four was brought to me when their nest tree was cut. At first they gaped but they soon learned to peck food as offered.

Pileated Woodpeckers (*Dryocopus pileatus*) are also reported as feeding by regurgitation by B. Christy and I. G. Wheelock (Bent, op. cit.:180 and 193). Roberts (op. cit.:670) states that large nestlings are fed by the stab method exactly like flickers. He saw a full-grown fledgling being fed for several days by regurgitation by a worn female. However, he shows photographs (p. 665) of a female flicker with a large feeding of insects in her bill at the nest cavity and a Pileated Woodpecker (p. 668) with an insect in the bill. In both photographs, the young have heads protruding from the nests with mandibles parted.

The Yellow-bellied Sapsucker (*Sphyrapicus varius*) is reported by A. DuBois as fed by the "poking" method and I. G. Wheelock reports regurgitation for a western sapsucker (in Bent, op. cit.:131 and 147).

Concerning the Hairy Woodpecker (*Dendrocopos villosus*), C. Bendire states that feeding is by regurgitation as does Wheelock for a western race (Bent, op. cit:16 and 34).

L. Achilles is quoted on the Arctic Three-toed Woodpecker (*Picoides arcticus*): "Once in a while grubs could be seen in their bills, but from the actions of the birds when feeding their young, they appeared to be regurgitating" (Bent, op. cit.:110).

A study of parental feeding in the woodpecker family offers challenging problems for fieldwork.

SUMMARY

A manner of fledgling-feeding by two species of woodpeckers, not previously described, and which is contrary to those considered typical for the species was observed for Downy Woodpeckers and Yellow-shafted Flickers.

In 1964 (20 May through 9 June) a pair of Downy Woodpeckers fed three large fledglings by allowing them to peck food from the adult bill. In 1965 two pairs of Downy Woodpeckers fed their fledglings in the same manner.

In 1941 a large fledgling Yellow-shafted Flicker took food from the mouth of the mother.

Details of feeding are given and published data on feeding of young by a number of observers for a number of woodpecker species is reviewed.

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MAINTENANCE ACTIVITIES OF THE ROSE-BREASTED GROSBEAK

David W. Dunham

The Rose-breasted Grosbeak (*Pheucticus ludovicianus*) is usually placed in the New World subfamily Richmondeninae of the family Fringillidae. Although the behavior of most "finch" groups has been studied, at least superficially, no richmondenine finch has yet been studied ethologically.

This first of several papers on *P. ludovicianus* treats maintenance activities, which are of interest in themselves, and are also of importance in understanding sexual and agonistic behavior. It is among these activities that we find the nonritualized precursors of reproductive and agonistic displays, and therefore an understanding of maintenance activities is basic to any study of the evolution of a communication system, or the causal motivation of its displays. (The term grosbeak refers to the Rose-breasted Grosbeak throughout this paper unless stated otherwise.)

METHODS

Grosbeaks were studied in the wild through three breeding seasons, 1961–63. Captive birds were also studied during the breeding seasons of 1962 and 1963 in 13.1 × 26.2 × 32.8 dm outdoor planted flight cages of wood and 16 mm hexagonal mesh wire, and during the winters of 1961–63, the first year in individual wood, wire, and glass cages and the last two in 13.1 × 26.2 × 26.2 dm welded wire cages of 8 × 16 mm rectangular mesh.

The laboratory diet was a mixture of sunflower seeds and various grains. Cuttlebone and grit were available. Mealworm (*Tenebrio molitor*) larvae, pupae, and adults were fed, as well as fresh fruit of many kinds. Birds in outdoor cages had access to wild insects and some individuals ate a mixture for insectivorous birds (Ficken and Dilger, 1961). Commerical liquid vitamins (e.g., Zymadrops) were given every week or two during the winter in the drinking water.

The field studies were made primarily in a tract of wet woodland at the head of Cayuga Lake, Ithaca, Tompkins County, New York. Field observations were concentrated in the period from the arrival of the first males until the young had fledged, and were made without an observation blind. Notes in the field and in captivity were recorded on a small tape recorder for later transcription. Still and motion pictures were made in the field and laboratory.

RESULTS

Feeding.—Flying insects, and the buds, flowers, fruits, and/or young leaves of various trees and shrubs were eaten. Fine gravel and seeds were consumed in ground foraging. In captivity this species will eat almost any seeds or other fruits offered, although there are individual preferences, as Kear (1962) noted in British carduelines.

McAtee (1908) reports that the Rose-breasted Grosbeak consumes an average of 52 per cent animal matter and 48 per cent vegetable matter on its breeding grounds.

Foraging is most commonly done at the periphery of the tree canopy (at all levels) where there is maximum leaf cover (see Table 1). Foraging in the understory is less common in the spring than later when certain understory plants are in fruit (e.g., *Rubus* spp.). The male and female of a foraging pair may feed at the same level in a tree or at different levels in a tree or in nearby trees. There is no consistent difference in foraging level between the sexes as there is in some species.

When on the extreme ends of fine branches, the grosbeak sometimes hangs upside down, somewhat like foraging tits (Paridae). At other times it flies out or up and grabs food in the bill, tearing it off as the bird returns to the starting perch or one nearby. Flying insects are captured on the wing and are eaten on the orginal perch or one nearby (Selby, 1912, and pers. obs.), but regular perches are not used for this purpose as they are by tyrannids. If a moth or other flying insect enters a cage containing a grosbeak the bird fixates the insect and follows its movements by head movements of its own. It may fly out and capture the insect in midair, but normally it waits until the insect comes within range, snapping it up with a rapid thrust of the head and neck. Insects flying outside of a cage are also fixated and their movements followed. Young were first seen to capture flying insects at 47 days after hatching.

Progress on the ground is by hopping and no specialized feeding movements such as scratching the substrate or overturning objects were noted. Food items on the ground or on the cage floor are fixated briefly, then seized and eaten or carried to a perch and eaten there. Mealworms presented in a dish are usually seized only after a period of monocular fixation. A hand-reared bird, however, will seize a mealworm immediately if offered from the hand. Young were first seen to follow forceps with the eyes at 7 days, to peck at forceps at 8 days, and to seize and consume mealworms and nonlive food from the forceps at 11 days.

Food is never held with the foot as it is in some species.

With the possible exception of soft-bodied larvae, insects brought to the nest were thoroughly crushed in the bill before they were fed to the young (Ivor, 1943, 1944*b*; pers. obs.). In captivity grosbeaks seize a mealworm and move it back and forth crosswise between mandible and maxilla with the aid of the tongue, breaking the heavily sclerotized body of the larva. Soft, white

TABLE 1

FORAGING LEVELS OF THE ROSE-BREASTED GROSBEAK IN ITHACA, TOMPKINS COUNTY, NEW YORK, MAY–JUNE 1961–1963

Stratum	Observations	Per cent
Ground	5	2.6
Shrubs	17	8.7
Trees	173	88.3
Vines	1	0.4
Totals	196	100.0

mealworms which have recently molted are often eaten without crushing, as are other mealworms if the bird has been recently deprived of insects. Occasionally the larva is crushed in the bill for 10 to 20 seconds, the gut squeezed out and eaten, and the remaining flat exoskeleton dropped. The grosbeak was never seen to strike an insect against a branch or perch as does for example the Chaffinch (*Fringilla coelebs*) (Marler, 1956). However, Ivor (1944*b*) reports "hammering" of large moth larvae before feeding the young. Mealworm beetles were broken up before swallowed; the elytra were sometimes removed by this action, but usually were not.

Sunflower seeds are seized in the bill, oriented with the longitudinal axis parallel to that of the bill, and then the pericarp is cut down the center or to one side of center. I have never seen grosbeaks (or Black-headed Grosbeaks (*P. melanocephalus*) or Cardinals (*Richmondena cardinalis*)) split a sunflower *edgewise*, as Kear (1962) describes for the Hawfinch (*Coccothraustes coccothraustes*) and Evening Grosbeak (*Hesperiphona vespertina*). Sunflower seeds were first given to young at 26 days and at that time they were opened efficiently without practice. Small seeds were first consumed at 17 days of age but husking was not seen before 27 days. Ivor (1944*a*) reports young first taking seed at 28 days.

Drinking.—The head is dipped down so that the bill is immersed in water, and the bill is opened slightly; there are throat movements. The bill is closed and the head is tipped back with throat movements as the water is swallowed. Throat movements while the bill is actually immersed are not found in the Chaffinch (Marler, 1956).

Defecation.—Young in the nest defecate 2 to 3 seconds after being fed. If fed twice in a visit, a second smaller fecal sac may be voided. Defecation of young is dependent upon food in the throat or upon actual ingestion, since placing of empty forceps in the mouth does not result in defecation. Backing toward the nest rim prior to defecation was first noted at 6 days of age. The fecal sac is lost on the 12th day, corresponding to the approximate date the young leave the nest (Chase, 1899; Ivor, 1944*a*; pers. obs.).

Bill-wiping.—This is one of five methods used to clean the bill, and is seen commonly after bathing, drinking, and feeding. The head and anterior part of the body are lowered and the bill is wiped across the perch from base to tip. The bill is commonly wiped once on each side of the perch, but a series of wipes may follow in rapid succession. The bill may either be closed or slightly open, and sometimes a stropping noise is produced. Bill-wiping is a common displacement activity.

Incomplete bill-wiping terminates short of contact with the perch. This was first seen at 7 days of age. At 10 days the alternate wipes of the bill were evident but no contact was made. At 11 days both complete and incomplete bill-wiping was seen, and on the 13th day bill-wiping with the mouth open was first seen.

Licking the tomium.—The mouth is opened and the tongue licks the tomium. Such licking was seen following, or associated with, bill-wiping after feeding. This was first seen in 11-day-old young.

Head-shaking.—The head may be shaken repeatedly from side to side after feeding if the bill is very dirty; the bill may be open or closed. This was seen when Vermiculite from the cage floor adhered to the bill. Head-shaking as a food rejection movement was first seen at 6 days of age. This serves to dislodge food which is improperly placed in the throat or is otherwise unacceptable.

Scratching.—The head and adjacent regions are scratched with the foot, often producing a whirring sound. In adults the foot is brought over the trailed wing (sensu Andrew, 1956*a*); this was first seen in young 9 days old. In one individual of this age, 8 to 10 attempts were made to scratch the head over the wing; each resulted in the bird losing its balance. It then scratched the head twice by bringing the food under the wing. At 10 days of age attempts were seen to bring the foot up to the head, and then to bring the head down to the foot, before the foot was brought over the wing and balance maintained. The wing is trailed and the foot is concomitantly brought behind and over the top of the wing. The foot itself is compressed laterally such that the two outer front toes lie alongside the longer middle toe, and the hind toe is oriented parallel to the tarsometatarsus. As determined by analysis of motion pictures, actual contact is made by the middle toe. The foot is moved very rapidly during scratching, and the mouth may be opened (first seen at 14 days of age). The area scratched may be ruffled or not.

Twenty-five areas scratched with the foot are listed in Table 2. Scratching may shift from one area to another without interruption, and in such cases the head is moved relative to the foot rather than the converse. *Head-rolling* is movement of the head while the foot is in contact with it, resulting in scratching some part of the head not initially contacted by the foot. In a sample of 67 scratches (from three females and one male in captivity), 25 per cent involved head-rolling. Intention movements occur here, as in bill-wiping, and scratching is also a displacement activity.

Rubbing the head.—The feathers of the head are ruffled, the head and anterior part of the body are lowered, the bill is closed or is opened wider than in bill-wiping, and the base of the bill and/or the whole side of the head is rubbed against the perch. The rubbing movement may progress from the front of the head toward the back, or, as in bill-wiping, from the back toward the front, or may begin from front to back but continue as a circular motion. Several rubs may follow in succession, but normally only one side of the head is rubbed in any one bout. This behavior is often associated with bill-wiping, and one can see a bird wipe the bill with a single stroke on one side of the perch and rub the head with a single movement on the other. Rubbing the head is common after bathing. It was first seen in 9-day-old young. Hailman (1959) has seen "perch-scratching" in emberizines and wonders if it might be characteristic of that subfamily. His description resembles rubbing the head and this movement is found in at least one richmondenine finch.

Preening.—Preening often occurs in bouts including scratching and fluffing. It also occurs after bathing, but not always, and is seen in birds moving through wet vegetation (as noted by Heinroth, 1912, 1938). Dislodged feathers were dropped and were not seen to be eaten. At 7 days of age the wings were first preened (Van Sant, 1901; pers. obs.) on both dorsal and ventral surfaces, although the quills had not yet broken open. The breast and shoulders were also preened. Tail-preening and touching the uropygial gland were not seen until the 11th day.

Cleaning the feet.—Grosbeaks peck at the feet to clean them. The foot was never raised from the perch for cleaning. The toes were first seen to be cleaned on the 16th day. The tarsometatarsus is cleaned by small nibbling movements as the bill moves along its length, from the tibiotarsus to the foot. Metal bands used for identification were always picked at for the first day after application. Bands that fitted loosely were pried with the bill by inserting the tip of the mandible between the band and the tarsometatarsus. Such bands were eventually removed in this manner.

Yawning.—Yawning, or stretching the jaw muscles, is common in the Rose-breasted Grosbeak and was first seen in young 6 days old. Several birds caged together tend to yawn, stretch, preen, bathe, feed, rest, etc., in bouts (Van Sant, 1901; pers. obs.), suggesting possible social facilitation of these activities. In yawning the mouth is opened wide and then closed; the tongue may be lifted.

TABLE 2

AREAS SCRATCHED WITH THE FOOT IN CAPTIVE ROSE-BREASTED GROSBEAKS (THREE MALES AND ONE FEMALE)

Areas and Scratching Frequencies			Percentage
Top of head	5	(1 right) (4 left)	3
Side of head	46	(24 right) (22 left)	31
Back of head	16	(11 right) (1 center) (4 left)	11
Forehead	1		1
Neck	13	(5 right) (8 left)	9
Over the eye	3	(2 right) (1 left)	2
Throat	38	(15 right) (13 center) (10 left)	25
Shoulder	8	(4 right) (4 left)	5
Bill	10	(8 right) (2 left)	7
Base of bill	10	(1 top right) (0 top left) (2 side right) (1 side left) (4 under right) (2 under left)	7
Totals	150		101

Stretching.—The wings are either stretched together above the back, or down along the side separately; both patterns were first noted in 6-day-old young. In the first instance the wings are raised together above the back until they almost touch, about half-open, and then returned to the side. In 7-day-old young the wings are stretched downward together before replacement at the sides. This is rarely seen in adults as is the case in *Emberiza* (Andrew, 1956*a*). In separate stretching the wing is stretched downward and held out slightly to the side so that it extends below the perch, then opened fully, and finally returned closed to the side. In adults such a wing stretch usually involves a concomitant stretch downward of the leg on the same side and this results in the spread toes touching the spread wing. This pattern was first seen at 7 days of age, but differed from the adult patterns in that the leg was moved laterally along the perch, not lifted and stretched downward. The latter was first seen at 12 days of age. The tail is frequently spread and swung toward the side of the wing and leg stretch. When the wing is stretched downward without the leg stretch, the tail may be spread and swung toward the opposite side from the stretched wing. Downward stretching of one wing is often followed by stretching of the other wing and also by stretching of the wings over the back. When both legs are stretched together (first noted at 7 days of age), it is the body which is raised relative to the perch, causing an arching of the back. Stretching the legs without wing stretching is common in the Rose-breasted Grosbeak but apparently absent in some emberizines (Andrew, 1956*a*; Nice, 1943), although Sutton (1943) notes it in the Vesper Sparrow (*Pooecetes gramineus*). In 8-day-old young a single wing stretch is combined with stretching both legs together.

Fluffing the plumage.—The plumage is fluffed (sensu Morris, 1956) in bouts of preening, scratching, and other maintenance activities, when the temperature drops, when sleeping, sometimes when brooding or incubating, and often before ruffling. The fluffed breast feathers cover the anterior edge of the closed wing. As Morris indicates, fluffing places the body plumage in a position for maximal insulation. Certain areas of the body are fluffed in displays, resulting in a larger appearance of these areas relative to the rest of the body.

Ruffling and shaking the plumage.—Ruffling and shaking the body plumage occurs by itself or in bouts of other activities and is sometimes accompanied by tail-flicking. It is very frequent during and after bathing, and is also seen after sunning. Females ruffle and shake after copulation, and males sometimes after chasing. Ruffling alone occurs during sunning and during incubation or brooding in hot weather, often with the bill held open, and places the plumage in a posture for minimal insulation. Ruffling occurs in agonistic displays. Ruffling and shaking permit thorough wetting or irradiating the body in bathing and sunning, respectively, and may also remove foreign particles from the plumage. Shaking was first seen at 6 days of age, a day before any quills began to open.

Bathing.—Drinking usually precedes bathing. Carpal flicks, then crouching and other hopping intention movements, and head flicks to the side, result in a final hop into the water. As soon as the lowered head and breast touch the water the wings beat, throwing water over a wide area and thoroughly wetting the bird. No pecking into the water occurs, as it does in *Emberiza* (Andrew, 1956*a*), where a sidewise bill movement is used in bathing and in feeding. The absence of such a movement in the grosbeak indirectly supports Andrew's hypothesis that this bill movement of *Emberiza* in bathing and a very similar one in feeding might be homologous. The wing movements involve partly opening and then closing the wing with concomitant raising and lowering the wing into and out of the water. Strong head flicks to the side (as in *Emberiza*) and vertical movements of the spread tail aid the wings in wetting the now ruffled plumage during frequent immersions. Some preening takes place during bathing. The "alternate wing movement, motion 3" of Nice (1943) was not seen.

In captivity the Rose-breasted Grosbeak bathes at least daily and invariably bathes when given fresh water.

An adult will brood young while still wet from bathing, and this results in wet natal down. Depending on the ambient temperature this could be advantageous or deleterious. Twenty-four-day-old young were subjected to light rain for several minutes but showed no bathing movements. Two days later they were given water in a dish for the first time and bathed immediately. The head and bill were *not* dipped in the water. The breast was depressed in the water with ruffling and wing-fluttering which was sporadic compared to adult bathing; the movements gave the impression of incompleteness.

After bathing.—After bathing the plumage is shaken, and bill-wiping, preening, scratching, and head-rubbing are common. The uropygial gland is touched with the bill and sometimes the bill is scratched immediately thereafter, doubtless transferring some of the oil to the foot and allowing oil transfer to those parts that cannot be preened with the bill but only scratched (see Table 2). In some cases the head is then immediately scratched (Nice, 1943; pers. obs.). The head was not seen to be rubbed on the shoulders after oiling as it is in *Emberiza* (Andrew, 1956*a*). Young 26 days old drying after bathing for the first time used sporadic movements and remained wet longer than an adult.

Grosbeaks were not seen to bathe in dust. Although Sutton (1943) saw dust-bathing in young Field and Vesper sparrows, he did not see it in Cardinal or Indigo Bunting (*Passerina cyanea*) young.

Sunning.—In sunning, the plumage is ruffled, the wings drooped—the one toward the sun may be partly spread, and the head is usually turned so that one side faces the sun or a lamp above the cage in the laboratory. The body is held at an angle such that one side receives maximal radiation, and the tail is turned toward the illumination source and may be spread but not drooped as in *Emberiza* (Andrew, 1956*a*). The bill is held open and the eyes are often open; this agrees with Hauser's (1957) Level III except that the plumage here is ruffled, not fluffed. This attitude is held for several minutes, with interruptions for scratching, ruffling, shaking, and looking around.

Sleeping.—The young sleep at first in a prone position. Later the sleeping posture is that of a resting adult. At 11 days the head is turned to rest on the carpals, and later in the same day the bill is tucked beneath the scapulars, completing the transition to the adult sleeping posture. Van Sant (1901) noted a similar change in sleeping posture over a 3-day period.

Locomotion.—Locomotion from branch to branch or tree to tree is by flight. Hopping is done along a branch, from one branch to another, on the ground, or from the ground to a low shrub or sapling (jumping). Young can hop and jump at 7 days of age, and can fly short distances at 9 days although they do not always leave the nest at this age in the wild. When hopping, the body is often pivoted from side to side, probably aiding the bird in spotting food and predators. The grosbeak appears to move through a 90- to 120-degree arc. Pivoting in place also occurs in certain conflict situations. Grosbeaks do not walk or step, except in a reproductive display. Hopping on the ground is straight ahead and hopping on a perch is sidewise progression. Hopping may be slow or very rapid. A second method of sidewise movement on a branch is sidling, where one foot is moved before the other in a shuffling manner. A sidling bird moves slowly and sidling is common when a bird is feeding at the ends of branches.

Tail-flicking is not a conspicuous feature of grosbeak locomotion. The tail is flicked horizontally in the sense that the tail appears to change orientation after the body has done so, and the resultant time lag gives the impression of a short flick. This is usually so slight as to be very difficult to see. Small movements in the vertical plane also occur (Types Up-Down and Down-Up of Andrew, 1956*b*), but usually in combination with lateral movements, giving the impression of a tiny arc being described. Strong vertical flicking was seen only in displays and even then it is not common.

Flight intention movements consist of crouching on the perch with sleeked plumage, head held up and oriented in a presumed direction of flight, and often wing-flicks.

SUMMARY

The maintenance activities of the Rose-breasted Grosbeak were studied in the wild and in captivity.

This species forages mostly in the forest canopy, but also in shrubs and occasionally on the ground. Insects are gleaned from the foliage or, less commonly, caught in the air. Seeds, buds, fleshy fruits, and young leaves comprise the bulk of the vegetable matter eaten.

Locomotion during feeding is by hopping, sidling, and flight. Seizing vegetable matter in flight is an adaptation for feeding at the ends of branches. Insects are caught in flight, but regular perches are not used for this purpose.

Insects are crushed in the bill but not struck against a perch before eating. Food is not held with the foot.

The bill is cleaned by wiping on the perch, licking with the tongue, shaking the head, scratching, or rubbing against the perch. The foot is not raised from the perch for cleaning.

Downward stretching of both wings in the young persists as an occasional activity in the adult. Leg-stretching develops from a lateral movement of the leg in the young. Leg-stretching without wing-stretching is common. In young a single wing stretch may accompany stretching both legs.

Bathing does not begin with pecks into the water. Alternate wing movements do not occur in bathing.

The head is not rubbed on the shoulders after oiling.

Sidewise switching during hopping describes a 90- to 120-degree arc.

Tail-flicking during locomotion is inconspicuous, and is Up–Down or Down–Up with small lateral movements.

Head-rubbing is not restricted to the Emberizinae among the fringillids, but occurs in at least this one richmondenine finch.

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HAWK MIGRATION OVER THE WESTERN TIP OF LAKE SUPERIOR[1]

P. B. Hofslund

Since 1951, members of the Duluth Bird Club and the Minnesota Ornithologists' Union have spent slightly more than 922 hours of 201 days in counting the hawks that pass over the city of Duluth during the fall migration. In this time we have tallied 159,397 individuals, an average of 172+ hawks per hour of observation.

The pattern of flight can be discerned to some extent by studying Tables 1 and 2. The 93,187 Broad-winged Hawks (*Buteo platypterus*) and 33,475 Sharp-shinned Hawks (*Accipiter striatus*) make up nearly 80 per cent of the count (actually they probably make up over 80 per cent, as the 16,852 unidentified hawks more than likely contain a great percentage of these two species). The relative position of the other 12 regular species perhaps does not express accurately the true picture of the flight. There is a bias due to an uneven distribution of observation periods through the three main months of the flight. Prior to 1961, only 28 days were given to the period following the end of the big Broadwing flights in September. Consequently, we have missed, in most years, the peak Red-tailed Hawk (*Buteo jamaicensis*), Rough-legged Hawk (*B. lagopus*), and Goshawk (*Accipiter gentilis*) flights. Prior to 1961, only 80 Goshawks were tallied; since 1961, 1,117 have graced our tally sheets. It was not at all unusual in 1963 to count more Goshawks in a single observation period than we had tallied as a total during the first 10 years of observation. With the exception of these species (Redtail, Roughleg, and Goshawk), the peak flight is over by the first of October. The Broadwing flight drops so abruptly that while there may be thousands recorded by the fourth week of September, only 39 birds have been seen in October, and no migrant Broadwings have been counted after 12 October.

There is some movement before the first of September. The Kestrel (*Falco sparverius*) movement actually may be well under way by this time as large numbers are seen along the telephone wires on North Shore roads. However, there has been no organized August observation, and since Kestrels hug the lakeshore more than do other species, they are missed from the usual observation posts.

One other pattern to round out the picture: on 14 days we have had what we term "AA" flights when average counts per hour were over 400 (the range has been 435 to 2,299). All of these "AA" days have occurred in

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TABLE 1

THE DISTRIBUTION OF TOTAL NUMBERS OF HAWKS RECORDED FROM 1951 THROUGH 1963 AT THE DULUTH FLYWAY

The days and hours of observation of each month are also shown

Year	Days and Hours of Observation								Sharpshin	Cooper's	Goshawk	Broadwing	Redtail	Roughleg	Kestrel	Merlin	Peregrine	Osprey	Marsh Harrier	Turkey Vulture	Bald Eagle	Golden Eagle	Others	Unidentified	Total Hawks	Hawks/Hour
	Sept.		Oct.		Nov.		Dec.																			
	D	H	D	H	D	H	D	H																		
1951	4	31.7	0	0	0	0	0	0	686	136	7	3,231	71	2	53	9	4	20	69	12	7	6	0	4,616	8,929	281+
1952	4	33.5	1	7.5	0	0	0	0	1,777	304	24	5,338	99	74	144	50	13	32	372	20	7	1	3	5,046	13,304	324+
1953	4	34.2	0	0	0	0	0	0	973	133	4	4,906	223	2	58	9	5	16	256	36	0	1	3	596	7,231	211+
1954	6	33.5	0	0	0	0	0	0	1,704	49	6	1,852	45	0	366	26	4	26	57	36	4	2	0	335	4,512	134+
1955	6	44.7	6	20.2	1	3.5	0	0	3,708	38	16	1,638	716	63	122	39	18	13	176	56	6	1	0	1,320	7,930	115+
1956	7	51	6	12.5	2	2.7	0	0	2,043	87	2	1,309	855	14	108	14	4	25	68	34	6	0	1	569	5,139	77+
1957	10	55.2	2	4.5	0	0	0	0	2,790	31	7	11,124	291	5	245	63	4	39	240	26	6	0	10	340	15,221	255–
1958	6	40.5	0	0	0	0	0	0	5,157	81	5	9,991	113	3	298	50	4	33	339	123	2	0	5	1,898	18,102	447–
1959	9	57	0	0	0	0	0	0	910	8	0	63	23	1	85	8	2	18	49	1	0	0	0	244	1,412	24+
1960	7	39	9	27.7	1	2.5	0	0	2,056	38	9	6,864	636	20	95	14	7	39	117	84	3	1	1	457	10,441	151–
1961	18	88.2	17	35.5	0	0	0	0	5,997	74	69	23,642	661	30	369	20	34	60	426	281	10	2	2	965	32,642	264–
1962	21	116.5	18	51.6	5	5	0	0	3,668	50	333	20,603	1,223	81	217	10	4	45	126	62	8	3	3	279	26,715	154+
1963	16	85.1	11	28.7	3	9.1	1	1.3	2,006	37	715	2,626	1,612	261	133	7	10	39	147	26	15	7	1	187	7,829	63+
Total	118	710.1	70	188.2	12	22.8	1	1.3	33,475	1,066	1,197	93,187	6,568	556	2,293	319	113	405	2,442	797	74	24	29	16,852	159,397	172+

September. "A" days (100–400/hour) have been recorded on 24 days in September and 17 after this month. Forty-one days (23 in September) have had an average of 50 to 99 per hour, "B" days. On 105 days we have tallied less than 50 hawks per hour, "C" days, and these have been divided almost 50/50 between September and the months following it.

Essentially, this presents the picture of what we have seen over 13 years of fall hawk watching. Why we have been able to see it at all has been a question whose answer we have been trying to piece together for a number of years. The pieces are now beginning to fall into place.

A most obvious requirement of a large hawk flight is a terrain suitable for soaring hawks. The production of thermals or updrafts seem necessary for major flights of buteos. The combination of a long range of hills bordering a large body of water such as we have at Duluth, provides this requirement (Olson, 1952:112–113). This free ride down the updrafts was a generally satisfactory answer for the first two years when two weekends of each year yielded a total of over 22,000 hawks. Later our failure to find records of large flights any farther north than Two Harbors (27 miles northeast of Duluth) put considerable doubt on our original interpretation.

It now was obvious that Duluth itself was a concentration point at the tip of the funnel provided by the Sawtooth Range and Lake Superior. By 1954 we had come face-to-face with the fact that every day, even if the weather was nice, was not productive. An examination of weather reports indicated that we could not expect large flights without winds with a westerly component. This has been borne out since, because we have no "AA" days unless the average winds were from the west to north–northwest. There was one "A" day in which the average winds were east–southeast, but a check of the direction on an hourly basis showed that 1,029 of the 1,251 hawks counted were seen during hours when the winds were north–northwest.

While we have had no days when there were big flights without westerlies, we have had several days with westerlies when the counts were average or even below average. However, most of these have been after the main Broadwing flight had passed and before the big Redtail push had started.

Two other weather patterns of some consequence were that the origin of large flights usually followed a day or two after the passage of a cold front and frequently on a rising barometer.

Prior to 1963, I was quite confident in predicting that, if we observed with reasonable frequency during the month of September, we would have no trouble in seeing 30,000 to 40,000 hawks each season. My confidence was greatly shaken after the 1963 season. We had our favorite lookout manned during 19 days in September and daily checks were made on other days to make sure that no major flight escaped us. Yet, our total September count

TABLE 2

THE DISTRIBUTION OF HAWKS RECORDED AT THE DULUTH FLYWAY PER WEEKLY PERIOD OF OBSERVATION

Date	No. Observation Days	Hours of Observation	Sharpshin	Cooper's	Goshawk	Broadwing	Redtail	Roughleg	Kestrel	Merlin	Peregrine	Osprey	Marsh Harrier	Turkey Vulture	Bald Eagle	Golden Eagle	Others	Unidentified	Total	Avg/day of observation	Avg/hour of observation
1–7 Sept.	6	24.5	2,335	60	3	1,117	26	0	184	13	2	11	182	14	2	0	3	1,456	5,408	901	221
8–14 Sept.	37	239.2	8,162	543	33	33,143	234	4	842	133	23	152	631	60	21	1	16	3,488	47,486	1,283	199
15–21 Sept.	40	270.6	10,506	241	49	47,171	817	60	734	101	52	178	1,051	271	21	11	9	9,012	70,284	1,757	259
22–28 Sept.	29	158.5	4,355	113	76	11,718	596	9	338	33	25	49	250	356	17	3	0	1,350	9,288	320	58
29 Sept.–5 Oct.	23	71.5	2,850	48	211	15	667	49	126	18	4	9	150	55	1	0	0	182	4,385	190	61
6–12 Oct.	24	67.2	4,456	55	116	23	1,028	37	59	13	3	5	111	35	4	0	0	236	6,181	257	92
13–19 Oct.	14	39.2	787	5	96	0	1,738	44	9	8	4	0	63	5	0	4	0	850	3,613	258	92
20–26 Oct.	7	12.7	21	0	57	0	89	24	0	0	0	0	2	0	0	0	0	160	353	50	27
27 Oct.–10 Nov.	20	38.2	3	1	552	0	1,373	329	1	0	0	1	2	1	8	5	1	118	2,395	119	62
25 Dec.	1	1.3	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	3
Total	201	922.9	33,475	1,066	1,197	93,187	6,568	556	2,293	319	113	405	2,442	797	74	24	29	16,852	159,397	792	172

was only 4,543 and 2,593 of those came through on one day. I felt that the unusually fine weather throughout this month had delayed any mass movement and that as soon as we got a westerly, we would get our flight. This never did materialize. During the month we had 14 days of winds with a westerly component. Four of these came the first week, four during the middle and usually most productive part of the month, and four during the last week. On the eight days that we had observers on the hill, not one produced a count above the "C" category. We considered three possibilities: the main flight preceded the first of September; the flight passed over at such a height that we failed to detect it; and that a major concentration just never formed. My personal opinion leans toward the latter. I believe that westerlies have only the power of concentration at particular lookouts, and that the hawks move in everything but inclement weather once the migration gets under way.

With all these things in mind, it seems necessary to look into the origin of our flight in order to understand why they should concentrate at Duluth at all. Duluth is not a natural concentration spot in the same way that the point of land in Ontario bounded by Sarnia–Amherstburg–Toronto–Midland would be. Therefore, it is necessary that several factors operate and that the supply of birds come from more than one area.

When we first see the hawks from the Skyline Boulevard advantage point, we see them almost directly east or northeast of the lookout. On a few occasions a large group may be seen to the north, but this is rare. When they pass over the lookout they are moving west to southwest. If they drift along the shoreline, they invariably turn west by the time they have reached an area adjacent to Minnesota Point. It can be seen on the map (Fig. 1) that were the hawks to turn south, they would turn and go along the point into Wisconsin. We assume, although our evidence is only circumstantial, that the Broadwing is moving toward the southwest through the Texas–Mexico passageway into Central and South America. Our assumption is based on the decided directional trend of the flight leaving Duluth, and the character of the spring migration in Duluth.

Spring migration of hawks in Duluth is considerable, but does not assume the proportions that we expect in the fall. Missing from spring flight are the large numbers of Broadwings; the Redtails, accipiters, and falcons providing most of the interest. The only record that I have of a major Broadwing flight comes from the account in Roberts (1932:321) of thousands that alighted in the tree claims and groves near Wheaton in western Minnesota. If the fall movement is to the southwest as we believe, then the return could be expected to be from this region and therefore there would be no pileup in the Duluth area.

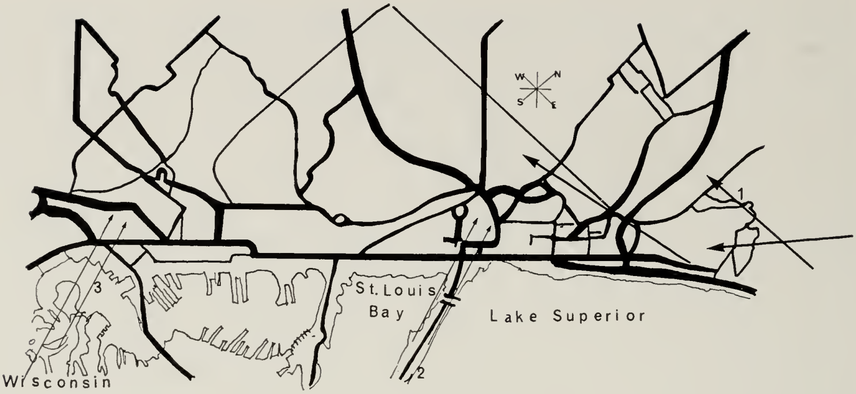

FIG. 1. Duluth. The coarse arrows on the right side of the map show the primary paths of the fall hawk flight. The fine arrows show the primary spring flight paths as they cross Minnesota Point (2) and Spirit Lake (3). Number "1" indicates the site of the chief lookout.

The major spring movement of hawks that we have detected in Duluth proceeds from south to north along a noticeable front extending from Spirit Lake in West Duluth to Minnesota Point, therefore coming from Wisconsin into Minnesota.

There seems to be a tendency for the avoidance of even small bodies of water by large numbers of migrants, occasionally groups making abrupt right angle turns and following a stream rather than crossing it. And yet, migration over the Gulf of Mexico (Lowery, 1946) is well documented and Perkins (1964:294–299) lists 17 flyways across the water of the Great Lakes. It is interesting to note that in reports such as that of Perkins, no major hawk flights over the lakes have been cited.

If, then, we have no major lake flight, and there is no known following of the north shore of the lake, why do they appear in Duluth in such large numbers?

The correlation between water barriers and a southwestward trend to the major movements (see Fig. 2) would indicate that major crossings of water should occur just before the flight reaches Lake Ontario, at the triangle formed by Lake Huron, Lake Erie, and Lake Ontario, and in the Whitefish Bay area. A look at this map would suggest that the heaviest concentration would be in the Huron–Erie–Ontario triangle, and this by all reports is true. It would not suggest a heavy flight on western Lake Superior. Then it seems logical that perhaps some island hopping is done to bring flights east of Duluth to the area. Dr. A. E. Allin of Fort William (personal correspondence) frequently has suggested that large numbers may leave via Isle Royale striking the shore just north of Duluth. He based this belief on the lack of concentration near Fort William and reports of some numbers near Silver Islet and Isle Royale. A secondhand report that I received of a pilot noting "thousands" of hawks over the lake might lend additional supportive evidence. However, as yet, none of our observers have noted signs of a major concentration over water, although this could be because of observer position, and because frequently flights of major proportion are so high that the casual observer would not notice them.

Mueller and Berger (1961:183) suggested that wind drift caused flights to be brought in against the shores of large lakes. Since the lakes served as guidelines and because of a natural tendency to avoid water passage, large concentrations might occur at certain points. I find this difficult to accept as an explanation for our area. All of our observations have shown that the hawks quarter into the wind, shifting their position with even slight wind shifts and even using a different vertical position under conditions where it appears that the wind direction is different at altitudes under other than ground conditions. However, thermal drift may have some bearing. Flights that form in the valley below our lookout do not start until there is a thermal to rise on. There seems to be little doubt that these thermals are important in the mass migrations of at least the buteos. They use these thermals to rise, sometimes to tremendous heights, and then, peeling off, they glide sometimes for long distances to the next thermal. On some days it appears that they do not use flapping flight at all while they are in the range of our binoculars. If these thermals are free entities and not fixed columns of air (Cone, 1962), then these may serve as concentrators, also. The drifting of the bubbles on westerly winds would present the possibility of considerable drift of kettles of hawks east of the normal directional trend, eventually piling up against the large body of water (Lake Superior) where the thermals are not formed (Hofslund, 1962:91).

One last point, and this is one that may have been ignored by most persons searching for factors explaining hawk concentrations, is the distribution of vegetation. The large forested areas that serve as the main reservoir for woods-dwelling hawks form a triangle that terminates at the Great Lakes (Fig. 2). There is a possibility that these hawks have a reluctance to leave wooded areas and, therefore, the temperate steppes and grasslands of central North America may prove to be just as important a barrier as large bodies of water. It should be noted here that we get only a scattering of the hawks that could be considered as westerns. We have no record of the Ferruginous Hawk (*Buteo regalis*), Prairie Falcon (*Falco mexicanus*), or Swainson's Hawk (*Buteo swainsoni*) using the flyway in the fall. The Krider's race of Red-tailed Hawk, the melanistic phase (so-called Black Redtail) usually associated with

Fig. 2. The cross-hatched portion shows a rough distribution of the coniferous forest areas; the dotted, deciduous forests; and the striped, the steppes and prairies which affect the Great Lakes flight. Arrows indicate possible sources of supply for major Great Lakes lookouts: 1. Duluth, 2. Midland, 3. Sarnia, 4. Amherstburg, 5. Port Stanley, 6. Toronto, 7. Hawk Mountain.

the western race of the Redtail, and Harlan's Hawk (*B. harlani*) are our only evidence that there is an eastward movement into our region. We have been unable to get a picture of the banding operations carried on in Minnesota or to the north of us. However, it is worthwhile to notice that the three forms not seen in Duluth are essentially those of the treeless area, while the other forms might be more closely associated with forests or at least tree claims. If the above assumptions are true, then at least a portion of our flight does come from the west and concentration near the tip of Lake Superior could be expected.

There remains a considerable amount of work necessary for checking the validity of our guesses, and we are considering the use of radar, airplane reconnaissance, further consideration of the operating meteorological factors, and, of course, continued observations during the full flights. As time, equipment, and money become available, we expect to present a more accurate picture.

SUMMARY

Duluth, Minnesota, can lay claim to one of the great hawk flyways of the world. The consistency of the flyway through the fall migration is quite remarkable when one considers that it does not appear to have the natural features apparent in some of the other Great Lakes areas. Therefore, it is paramount to search for more than one factor operating toward making it a major migration focal point. The factors that we believe are important are: a modified funnel formed by the lake and a range of hills, with Duluth at the funnel tip; a forest triangle that would direct both western and eastern breeding birds toward Duluth; a natural tendency of the hawks to move toward the southwest; free-moving thermals that could pile up against the lake on winds with a westerly component; and the possible effect of Lake Superior as a guideline. We assume because of these factors, that our supply comes from the east through a possible island hopping, the west from natural tendencies to stay with the forested areas and the movements of thermals on a westerly wind, and from the north by virtue of the natural funnel previously mentioned.

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THE SPRING HAWK MIGRATION AROUND THE SOUTHEASTERN SHORE OF LAKE ONTARIO[1]

John R. Haugh and Tom J. Cade

Eaton (1904) was perhaps the first person to indicate the possibility of a major hawk migration along the southern shore of Lake Ontario. In his comprehensive work "Birds of New York" (1910) he makes several references to species of hawks migrating through this area in the spring. Although scattered observations have frequently been made since 1910, little has been done in the way of a concerted study to gain a better understanding of the characteristics of the hawk passage around Lake Ontario. Moreover, the lack of any detailed study of spring hawk migration in North America, especially in relation to meteorological factors, further prompted us to undertake this investigation.

Our study was conducted during the springs of 1963 and 1964 at Derby Hill, which is located approximately 5 miles north of Mexico, in Oswego County, New York (Fig. 1). Derby Hill is a local name for a ridge which fronts on the southeast corner of Lake Ontario and runs away from the lake in a direction slightly east of south. Not only is the crest of this hill the highest land for several miles around, but it is also the only high land which is relatively clear of trees, summer homes, and cottages. The ridge is, however, transected by three low hedgerows running from east to west. The hill drops off as a perpendicular cliff at the edge of the lake. These topographic features provide a favorable opportunity to observe migrating hawks moving along the shoreline.

Observations were made on 45 days between 7 March and 12 May in 1963, mainly on Tuesdays, Thursdays, Saturdays, and Sundays. When possible, observations were made on other days. In 1964, observations were made on 63 days between 25 February and 4 May, and once the hawks began to migrate the only days not covered were those on which inclement weather conditions, such as snow, rain, or high winds, probably prevented the hawks from flying. Scattered data collected by members of the Onondaga County Audubon Society from 1955 to 1962 were generously made available for use in our study.

We kept data on the species composing the flights, the number of individuals passing, the direction and speed of the wind, temperature, cloud cover, and barometric pressure. Temperature was recorded on a thermometer at the study area, as well as on a nearby maximum–minimum thermometer. Wind direction and speed were determined by the use of a Windscope, a device

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[1] Presented in part at the Symposium on Hawk Migration in relation to the Great Lakes, Forty-fifth Annual Meeting of the Wilson Ornithological Society, Kalamazoo, Michigan, 2 May 1964.

TABLE 1

NUMBERS OF HAWKS OBSERVED AT DERBY HILL IN SPRINGS OF 1963–64

Species	Years	
	1963	1964
Broad-winged Hawk (*Buteo platypterus*)	7,289	21,387
Sharp-shinned Hawk (*Accipiter striatus*)	1,335	2,256
Red-tailed Hawk (*Buteo jamaicensis*)	971	1,125
Red-shouldered Hawk (*Buteo lineatus*)	867	489
American Kestrel (*Falco sparverius*)	216	506
Harrier (*Circus cyaneus*)	235	363
Rough-legged Hawk (*Buteo lagopus*)	193	116
Osprey (*Pandion haliaetus*)	53	209
Cooper's Hawk (*Accipiter cooperii*)	116	133
Goshawk (*Accipiter gentilis*)	81	53
Turkey Vulture (*Cathartes aura*)	32	77
Merlin (*Falco columbarius*)	3	19
Bald Eagle (*Haliaeetus leucocephalus*)	4	10
Golden Eagle (*Aquila chrysaetos*)	2	7
Peregrine (*Falco peregrinus*)	0	4
Gyrfalcon (*Falco rusticolus*)	1	0
Unidentified	351	264
Total	11,686	27,018

consisting of an anemometer and a direction indicator. A continuous record of barometric pressure was kept by a recording barometer located in a home a few hundred feet from the study area. Although these local weather determinations were of definite value to the study, the daily weather map published by the United States Weather Bureau was even more useful. The weather map made it possible to obtain a wide view of the weather conditions existing at stations in all directions from the study area.

THE SPECIES OF HAWKS AND THEIR TIMES OF MIGRATION

A major part of our study was concerned with determining the species of hawks using the flyway around the southeastern corner of Lake Ontario, the relative abundance of the different species, and the time of the spring when each species migrates through the area. Such descriptive information is a prerequisite for any kind of analytical study of the factors which influence migration.

Approximately 38,567 falconiforms of 16 species were recorded during the observations in 1963 and 1964. The species totals are given in Table 1. Except for the Broad-winged Hawk, the totals represent actual counts of individuals as they passed over the crest of the hill at the study area. Broad-winged Hawks frequently passed over in flocks, sometimes numbering

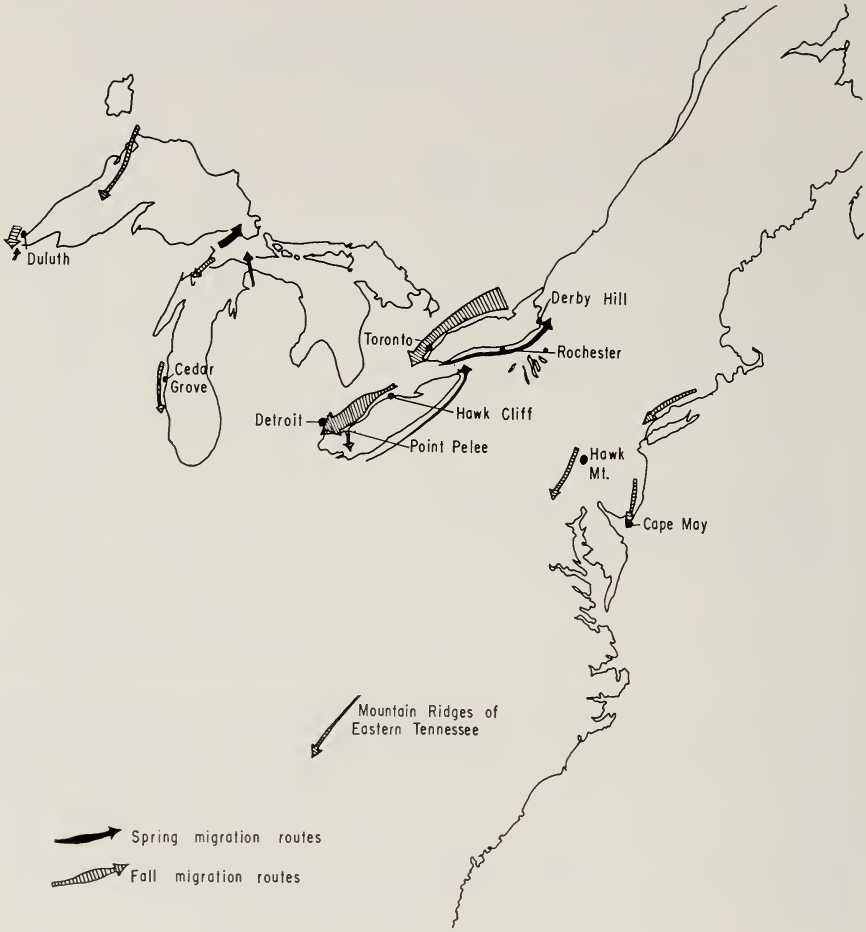

FIG. 1. This map shows the location of major known hawk flyways in eastern North America. The size of the arrows indicates the relative number of hawks using that particular flyway. Well-known points for observing the migration along these flyways are also indicated.

several hundred individuals, and at such times it was often necessary to estimate the number of birds of this species in each flock.

The passage of a number of species occurred throughout most of the spring migration period and exhibited little evidence of having a well-defined peak. This group includes the Cooper's Hawk, American Kestrel, Harrier, Red-tailed Hawk, and Rough-legged Hawk. The Red-tailed Hawk is typical of the group. Counts of over 100 Red-tailed Hawks were made as early as 17 March and as

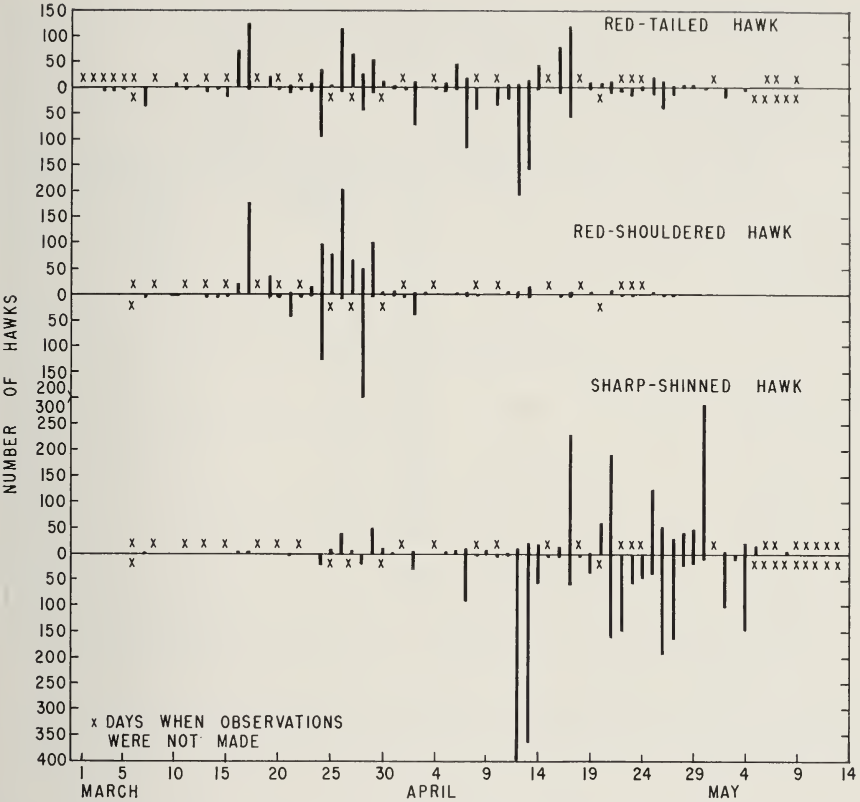

FIG. 2. Comparison of number of Red-tailed Hawks, Red-shouldered Hawks, and Sharp-shinned Hawks observed at Derby Hill in 1963, indicated by bars above the base lines, and in 1964, indicated by bars below the base lines.

late as 17 April Any time between 10 March and 20 April, when weather conditions are favorable, a large number of these buteos is likely to be observed (Fig. 2).

A second category includes those species which exhibit well-defined peaks during their migration periods. Included in this group are the Sharp-shinned Hawk, Osprey, Red-shouldered Hawk, and the Broad-winged Hawk. The Sharp-shinned Hawk was observed in greatest numbers during the last 2 weeks of April, the Osprey during the last week of April, the Red-shouldered Hawk during the last 2 weeks of March, and the Broad-winged Hawk during the last 10 days of April (Figs. 2 and 3).

Because relatively few individuals of the remaining species were observed, it was not possible to determine whether or not they have a definite peak in

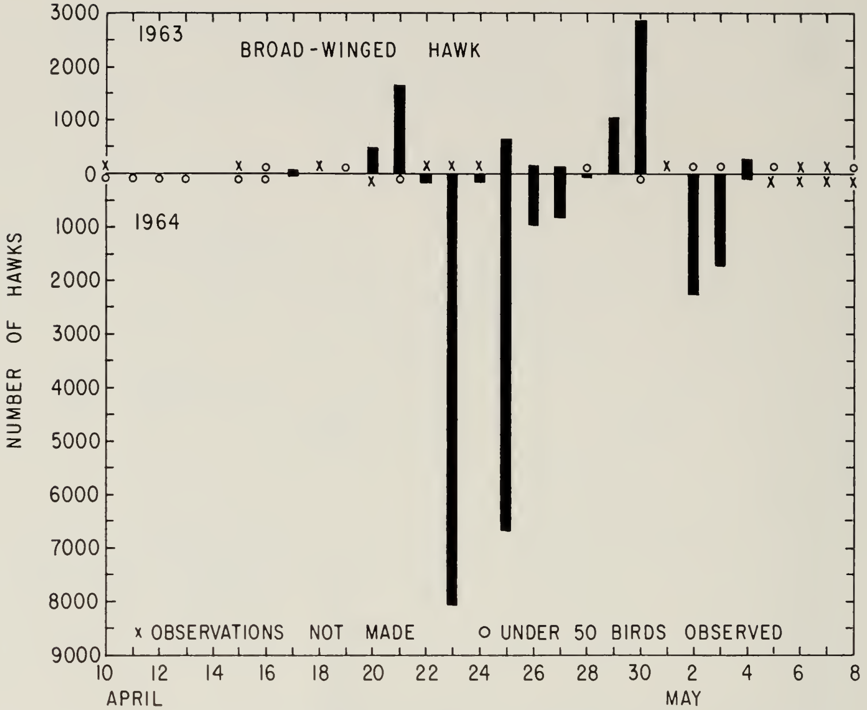

FIG. 3. Comparison of number of Broad-winged Hawks observed at Derby Hill in 1963 and 1964.

their migration. Classified in this category are the Goshawk, Peregrine Falcon, Merlin, Golden Eagle, Bald Eagle, and Turkey Vulture. The Gyrfalcon observed in 1963 was most likely a rare visitant to the flyway along the southern shore of Lake Ontario.

The range and peak period of spring migration are summarized in schematic form for the 10 commonest species in Figure 4.

ASSOCIATION OF HAWK MIGRATION WITH METEOROLOGICAL FACTORS

Modern meteorological study is based on the concept of large moving masses of air (areas of high pressure), the physical properties of which are more or less uniform over large areas but with an abrupt transition occurring between these air masses (Petterssen, 1941). Within these air masses there is a tendency for the air to revolve about a center in a clockwise direction. In the abrupt transition area between air masses, great contrasts of energy are often found, and it is here that low pressure areas or depressions develop. The air circulates in a counterclockwise direction about a low. Usually a

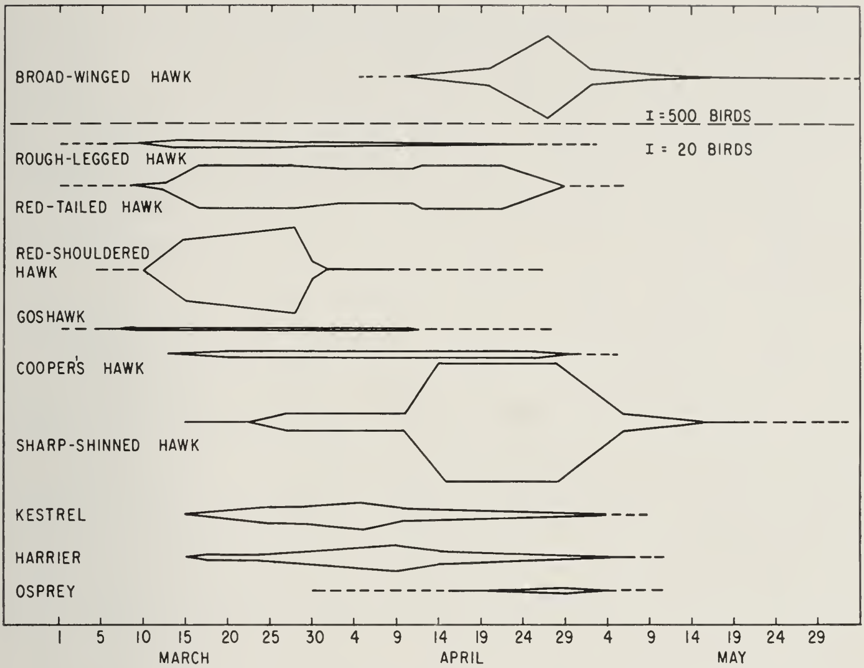

Fig. 4. Schematic representation of the average number of hawks passing Derby Hill on a good migration day during different times in the migration period. The figure is meant to indicate the range and peak periods for each of the principal species. The information used in construction of this figure was obtained from the 1963 study records as well as from various scattered observations made by members of the Onondaga County Audubon Society during the previous 7 years. It should be stressed that this figure does not represent actual counts, but only the average number likely to be seen at a given time during the migration period.

"front" extends from the low and separates the two masses of air. These large masses of air, with their associated fronts and depressions, move across the North American continent in a generally easterly direction.

Within the large air masses, there is a tendency for air to move outward from the center and to disperse in such a way as to make conditions at various points within the air mass similar. By contrast, in the depressions there is a tendency for surrounding air to move inward toward the center with the result that conditions on different sides of the low are markedly different. Thus the low is the boundary of the two air masses, just as is the front which is associated with it.

As an area of high pressure approaches from the west, the air circulation in front of it tends to be from a northerly direction because of its clockwise circulation. The air is generally cool and dry. Once the high has passed on to the east, a southerly flow of air generally develops behind the high. This air is usually slightly warmer than the air in front of the high, but the difference is not great because of the uniformity of the air within the mass. As the high moves farther eastward, a depression usually follows. The counterclockwise circulation of the low reinforces the southerly circulation of the previous high and typically brings warmer and more moist air, which continues until the low also moves on to the east and another northerly circulation occurs between it and the next advancing high.

Hawks migrating north from their southerly wintering grounds encounter Lake Erie and Lake Ontario, which form something of a natural barrier to northward movement, as many species of these birds seem to be reluctant to fly over large expanses of water (see Moreau, 1953, for a detailed account of hawks using short sea passages across the Mediterranean). The combined southern shorelines of Lake Erie and Lake Ontario are over 400 miles long. When confronted with this barrier, many hawks fly in an easterly direction along the southern shores of these lakes and continue their northward movement around the eastern end of Lake Ontario. This tendency for hawks to move around the lakes concentrates the numbers flying on any particular day and provides an opportunity to associate the number migrating with the meteorological patterns outlined above.

Wind direction.—Observations at Derby Hill and at other locations along the southern shore of Lake Ontario have shown a good association between the number of migrating hawks observed and southerly winds (Figs. 5 and 6). In order to determine whether a greater number of hawks do fly on southerly winds, or whether this apparent association is an illusion produced by the hawks simply being concentrated in a narrower flight path along the shore by southerly winds, observations were made at various points inland from the lake when there seemed to be a possibility that some of the hawks were not flying directly along the shore. Even with additional observers watching for hawks inland, the total number observed in association with northerly or westerly winds was much less than the number observed when southerly winds were blowing (Table 2). Such observations indicate that more hawks do fly along the shore of Lake Ontario when winds are from a southerly direction.

In addition, we have observed that hawks usually begin to migrate earlier in the day when southerly winds occur and continue later than they do when northerly or westerly winds are blowing. During our study, an average of 24 hawks per hour was observed between 0800 and 0900 hours on 20 days with southerly winds (before 20 April), but an average of only one hawk per hour was observed during the same time period on 31 days with northerly or westerly winds Likewise, the only days on which migration occurred after

TABLE 2
RELATION OF HAWK FLIGHTS TO WIND DIRECTIONS

Wind direction	Number of days with this wind between 15 March and 20 April	Number of days with over 100 Hawks	Average number of hawks per day
ESE–SSE	14	11	281
S	3	3	469
SSW–WSW	3	3	127
W	12	1	39
WNW–NNW	20	1	24
N	4	1	40
NNE–ENE	1	0	86
E	0	–	–

1600 hours (before 20 April) were days on which southerly winds occurred.

Late in the migration period (after 20 April) there is considerable variability in hawk movements, and some flights do occur on westerly or northwesterly winds. This deviation seems to apply especially to Broad-winged Hawks, which are concentrated in large groups along the southern shore of the lake at this time (see later).

Temperature.—The number of hawks observed during our study shows an association with air temperature. Most large flights of hawks occurred when temperatures were higher than they had been on previous days (Figs. 5 and 6, Table 3). Temperature fluctuations are difficult to evaluate as a possible influence on migration since they tend to be closely associated with wind direction and advancing low- and high-pressure areas.

Barometric pressure.—Falling barometric pressure, associated with an approaching area of low pressure and its frontal system, shows the best relation to the spring movement of hawks past Derby Hill. Only when rain or snow was falling did the approach of a low from the west fail to elicit a large passage of hawks during the migration period. When a low was intense and relatively slow-moving, so that its effect was noted on the local recording barometer for more than one day, the number of migrants was usually significantly greater on the day when the depression was closest to the study area and when the pressure was lowest. Often the situation was complicated, however, by precipitation, which frequently accompanied the low-pressure area. Figure 5 shows that the large hawk flights of 17, 26, and 29 March 1963 occurred when a low-pressure area was close to Derby Hill and the barometric pressure reached a comparatively low point. The migrations on 25 and 27 March were undoubtedly abbreviated, and the observed number of hawks was reduced by precipitation. Figure 7 shows the development and

Fig. 5. Relation of the number of migrating hawks in 1963 to barometric pressure, maximum daily temperature, wind direction, and other meteorological factors at Derby Hill. An open circle indicates wind was calm or light and variable. A solid circle indicates the migration was influenced by rain. An open triangle means observations were made for only half the day, and a solid triangle means observations were made for less than 2 hours. Solid bars indicate days of observations.

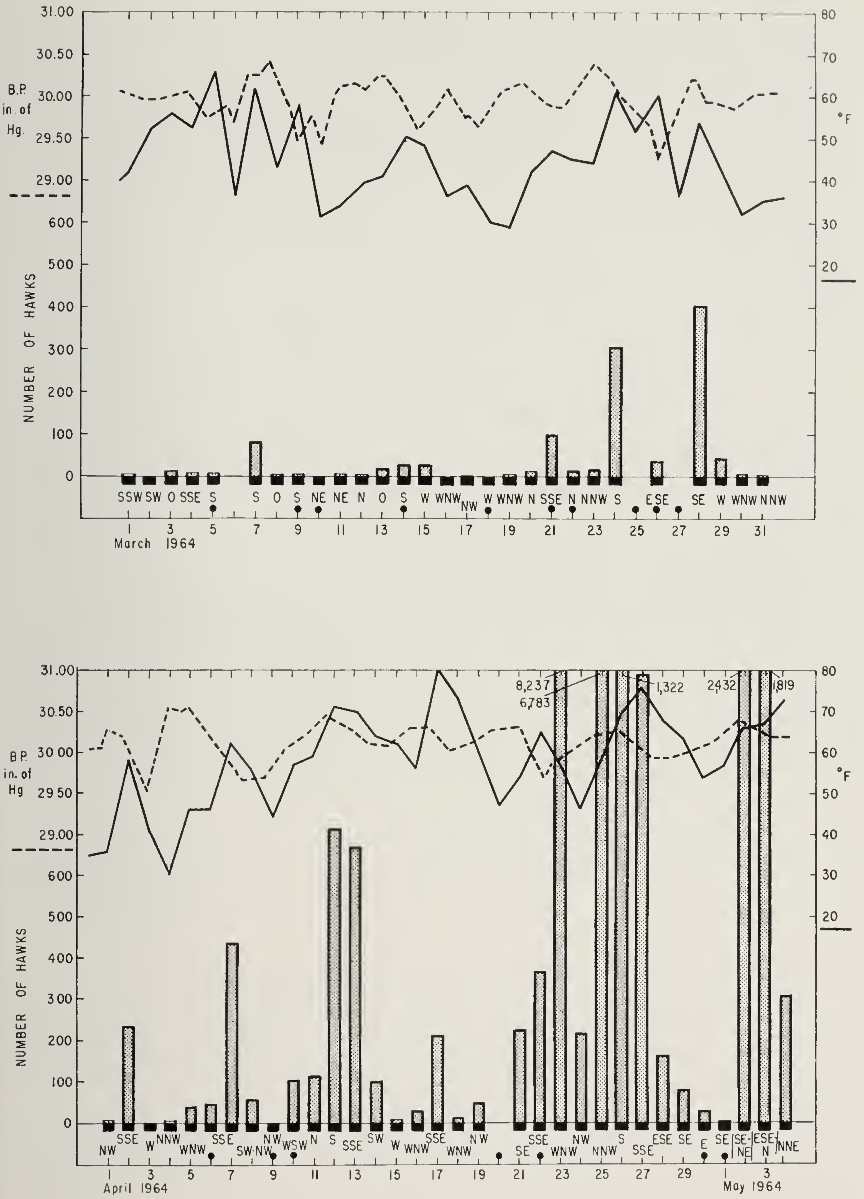

FIG. 6. Relation of the number of migrating hawks in 1964 to barometric pressure, maximum daily temperature, wind direction, and other meteorological factors. Symbols same as in Figure 5.

TABLE 3

RELATION OF HAWK FLIGHTS TO BAROMETRIC PRESSURE AND TEMPERATURE

Weather factor	Number of days with this weather factor between 15 March and 20 April	Number of days with over 100 Hawks observed	Average number of hawks per day
Falling barometric pressure	27	17	235
Rising barometric pressure	23	4	36
Falling temperature	18	3	40
Rising temperature	29	18	207

movement of the low-pressure area which resulted in the hawk movements on 16 and 17 March.

High-pressure areas and rising barometric pressure usually result in limited hawk flights at Derby Hill. During the peak period of the Broad-winged Hawk migration in 1963 only 183 and 58 birds were counted on 27 and 28 April, respectively, as high pressure was centered over the Great Lakes. On 29 April, as a developing low approached from the west and the high moved on to the east, a flight of over 1,000 hawks occurred On 30 April, as the low moved over Lake Ontario, a flight of over 3,000 hawks was observed (Fig. 8). This flight, consisting mainly of Broad-winged Hawks and Sharp-shinned Hawks, took place from 1200 to 1400 hours, between the passage of thunderstorms associated with the nearby low-pressure area and front. After a thunderstorm at 1400 hours, the front passed, and the sky cleared rapidly. The barometric pressure began a rapid rise, and the migration stopped.

A similar situation developed between 4 and 7 April 1964. Only three hawks were observed on 4 April when high pressure was centered over the Great Lakes. As low pressure approached on 5, 6, and 7 April, the number of hawks gradually increased to a peak of 433 hawks on the 7th, the last day before the low-pressure area passed on to the east (Fig. 9).

The above patterns are typical of those observed during our study. They illustrate the importance of low-pressure areas to the spring hawk migration along the southern shore of Lake Ontario.

A situation which occurred on 29 March 1963 is somewhat atypical of the normal pattern and provides further insight into the possible relation of migration to areas of low pressure. On 29 March at 0100 hours a region of high pressure was centered over Vermont and a region of low pressure over Minnesota. At dawn southerly winds and a falling barometer were noted at Derby Hill in connection with the approaching low. It appeared as though the pattern would be a typical one with the low pressure moving over the

FIG. 7. The weather maps show the normal development and movement of a low-pressure area from 14 March to 17 March in 1963. This system resulted in the first major hawk flights at Derby Hill that spring. Weather maps locate patterns as of 1300 hours Eastern Standard Time.

Great Lakes. The hawk migration began reasonably well in the morning, but then something unusual happened. Instead of continuing its eastward movement, the low moved northeastward so that by late afternoon it was centered over James Bay and moving away from Lake Ontario. Although the wind continued from the south and temperatures continued to increase along the southern shore of the lake, the number of migrating hawks declined rapidly in the afternoon as the low ceased its approach.

On 10 April 1964 the weather was mild during the morning, and winds were variable but generally from a southerly direction. The sky was clear, and there was no sign of an approaching front or low. Later in the morning, however, a small, weak low-pressure area and weak cold front developed and began moving south out of the St. Lawrence Valley. Until this time, only

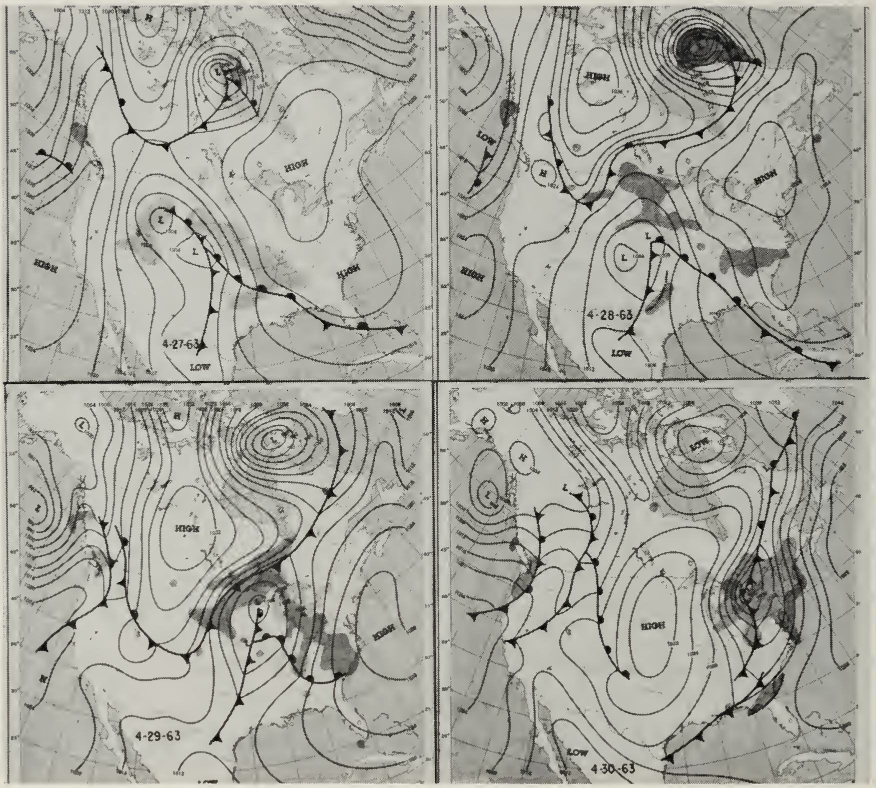

FIG. 8. The weather maps show the movement of pressure patterns from 27 April to 30 April in 1963. The extremely large high-pressure area which covered eastern North America on 27 and 28 April resulted in comparatively few hawks being observed at Derby Hill (see text). As the low-pressure area approached on the 29th and 30th large numbers of migrating hawks flew past the study area. Weather maps locate patterns as of 1300 hours Eastern Standard Time.

17 hawks had been counted in 2 hours of observation. As cloudiness began to develop, 35 hawks were observed in the next 90 minutes. The number of hawks continued to increase, and within the 30 minutes preceding the passage of the front 53 hawks flew past, 30 of which were flying on the leading edge of the front immediately ahead of an approaching rain.

THE INFLUENCE OF LOCAL WEATHER FACTORS ON THE MOVEMENT OF HAWKS

Daily time of migration.—On the average, the hawks usually began flying between 0800 and 0900 hours, but some species start moving earlier than others. In general, accipiters, falcons, and Harriers began moving earlier than soaring species such as buteos. Accipiters frequently were migrating in

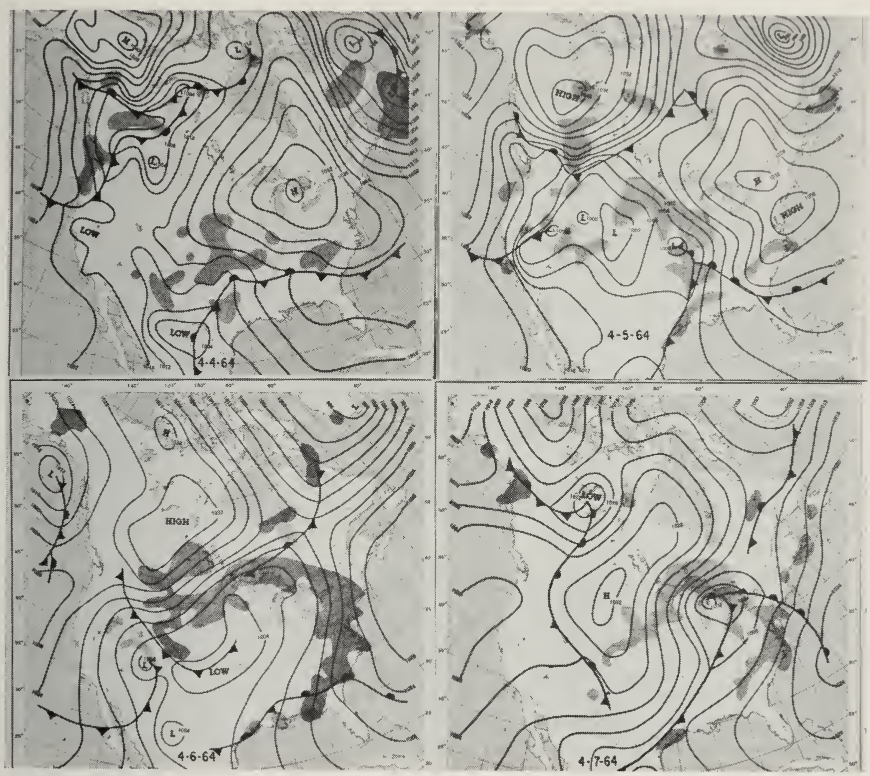

FIG. 9. The weather maps show the movement of pressure patterns from 4 April to 7 April 1964. Only three hawks were observed on 4 April when high pressure was centered over the Great Lakes. As low pressure approached on 5, 6, and 7 April the number of hawks increased to a peak of 433 hawks on the 7th. Weather maps locate patterns as of 1300 hours Eastern Standard Time.

peak numbers by 0900 hours and did not increase significantly after this time. Species more dependent on rising air currents usually did not reach peak numbers until approximately 2 hours after the accipiters (Fig. 10). When a low-pressure area and front were approaching close to the study area, all species generally began to move earlier.

Wind speed and thermals.—Most large hawk flights during our study occurred when the ground wind speed was between 10 and 25 miles per hour. Within this range the wind speed seemed to be relatively unimportant. When winds were in excess of 35 miles per hour, migration usually did not occur. Occasionally, when overtaken by a front with associated high winds, hawks would continue to move for a brief time with winds in excess of 35 miles per hour, especially in the case of Red-tailed Hawks.

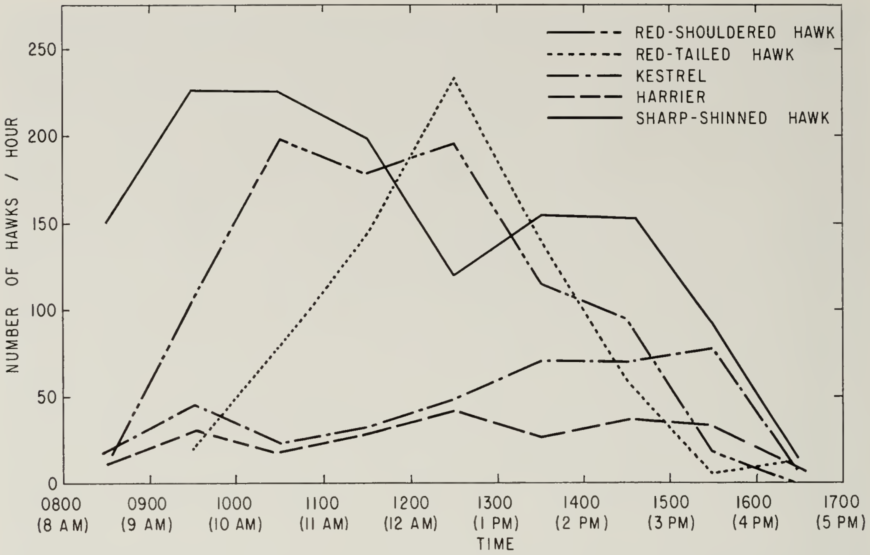

FIG. 10. The daily migration pattern for five species of hawks at Derby Hill. This figure is based on 10 days with southerly winds during the migration period of the Red-shouldered Hawk, Red-tailed Hawk, Kestrel, and Harrier. Since the Sharp-shinned Hawk migrates later, it was necessary to select 5 similar days during its migration period in order to compare it with the other four species.

When surface winds were light and thermal activity well developed, hawks frequently look advantage of the situation to soar to great heights on these rising currents of air. At times in April hawks were observed soaring on thermals at such great heights as to be invisible to the naked eye. An excellent example of such a situation occurred on 26 April 1964. In the morning hawks were flying at moderate heights. By noon the thermal activity had apparently increased, for very few birds were visible to the naked eye. If an observer had arrived at Derby Hill at this time he would probably have assumed that no migration was occurring, unless he was familiar with the conditions and knew enough to search in the right place with his binoculars.

Thermals do not rise equally over all areas but are affected by geographic features so as to be present over some areas and not over others (see Mueller and Berger, 1961). It is interesting to note that hawks passing Derby Hill have sometime been observed to soar to great altitudes on a thermal and then to glide forward (eastward) and downward until they reached the next thermal, at which time they began to soar and gain altitude again.

Wind direction.—Although large flights of hawks may occur on winds from any direction between southeast and southwest, the most spectacular flights during our study have usually been observed on south–southeasterly winds. The easterly component of this wind is a head wind to the hawks moving along the shore of Lake Ontario and caused them to fly lower than they normally would. This head wind also reduced the forward speed of the hawks, so that they were observable for longer periods of time.

Westerly winds, or winds which are very light, resulted in hawks flying extremely high so as to be difficult to observe. With the westerly winds they also moved more rapidly and rarely flapped or soared. Under such conditions, the hawks were often difficult to identify.

Northerly and westerly winds resulted in hawks being dispersed over a much broader front than did southerly winds. Even so, this front seemed to have a definite limit to its width. With westerly winds hawks rarely moved inland more than a mile. With northerly winds the width of the migration front may be increased to 3 miles, but appeared not to exceed this distance. Northerly and westerly winds affected different species in different ways. Falcons often continued to follow the shore. Accipiters drifted inland but not as far as buteos.

Southerly winds tended to push birds following the shore out over the water. The degree to which different species resisted this drift was much as would be expected. Species which commonly nest in woodland habitats and have little association with flat open country or large lakes (such as the Accipiters, Red-shouldered Hawks, and Broad-winged Hawks) showed the greatest resistance to a southerly wind and were frequently observed tacking into the wind in order to remain over land. Species which are usually associated with open country or water, and species which are exceptionally strong flyers, showed less resistance and often were observed flying across the corner of the lake.

Cloud cover.—Cloud cover appeared not to reduce the number of migrating hawks to any degree, if it developed after the hawks had already begun to fly. If, however, clouds were heavy at dawn, the number of hawks migrating was reduced or the beginning of the flight was delayed. Few observations have been made under these conditions, and so it is impossible to say whether or not cloud cover was actually the factor of major importance. Cloud cover may only have delayed the development of thermals.

Rain and snow.—Hawks generally ceased migration when they encountered rain or snow. Nevertheless, some exceptions have been noted, especially among Harriers and Broad-winged Hawks. Although Harriers have been observed to fly in light rain or snow at various times during the migration period, most other species only did so when a frontal system was approaching or at times near the end of the migration period for that particular species. It almost seemed as though late-moving hawks were trying to make up for lost time. Since snow does not usually occur late in the migration period of any species, fewer birds have been observed in light snow than in light rain.

DISCUSSION

Various studies in North America have attempted to relate bird migrations to meteorological conditions. Cooke (1888), one of the first workers in this field, found that southerly winds in front of a low-pressure area were favorable for spring migration. Later (1913) he concluded that the spring arrival of birds is associated with rising temperatures, although temperature alone is probably not the factor of major importance. More recently, authors have associated the arrival of birds with the following meteorological factors: (1) frontal movements and pressure areas (Bagg et al., 1950), (2) cold fronts (Bennett, 1962), (3) southerly winds (Robbins, 1949; Bagg et al., 1950; Imhof, 1953; Devlin, 1954), (4) southerly winds and low pressure (Smith, 1917; Dennis, 1954), (5) change in wind direction (Hassler et al., 1953), (6) stable airflow and following winds (Raynor, 1956), and (7) temperature (Main, 1932, 1938).

Although considerable work has been done relating the arrival times of birds to meteorological conditions, relatively few attempts have been made in North America to associate diurnal, visible movement of birds with these factors. Notable exceptions are Hochbaum's (1955) observations on spring and fall waterfowl migrations, Mueller and Berger's (1961) study of the fall hawk migration at Cedar Grove, and Broun's (1951, 1963) observations on fall migrating hawks at Hawk Mountain.

Hochbaum (1955) associated large fall flights of waterfowl with conditions existing after the passage of a low-pressure area and its cold front, that is, rising barometric pressure, falling temperatures, decreasing humidity, and northwest winds. Mueller and Berger (1961) found similar conditions associated with fall hawk migrations, but believe this association is "simply, a correlation with the occurrence of conditions suitable for updraft formation and hence, good conditions for soaring and gliding." Broun (1963) found that large movements of hawks in the fall at Hawk Mountain occur with northwest winds, but stated that a low-pressure area passing to the north a couple of days previously is also important.

Hochbaum (1955) related spring migrations of waterfowl to conditions associated with an approaching low-pressure area, that is, falling barometric pressure, rising temperatures, and southerly winds. Spring hawk movements in North America have not previously been studied in relation to meteorological events.

We have documented the fact that spring hawk migration tends to be associated with a number of concurrent events such as southerly winds, rising temperatures, and the approach of a low-pressure area and cold front. Others, as noted above, have observed that fall hawk migration is associated with falling temperatures and northerly winds, after a low-pressure area and cold front have moved past an observation point.

Although temperature cannot be eliminated as a possible stimulus for the movement of hawks, some observations seem to cast doubt on its importance. Little migration occurred in late February and early March (1964) at Derby Hill, even though temperatures were quite mild for that time of year, sometimes averaging 8 or more degrees above normal. Later in March temperatures were cooler than normal, but migration still occurred. From these observations it appears that temperatures above or below normal for extended periods have little effect on the migration of hawks. If temperature is of significance, its importance probably lies in its day-to-day variations rather than whether or not it is above or below normal for a given time of the year. Sudden temperature changes could serve as a clue to the occurrence of associated atmospheric phenomena which are important for migratory flight.

During the last 20 years most American authors have tended to regard temperature as a relatively unimportant factor in stimulating birds to move, compared with pressure patterns and wind. Nevertheless, it is interesting to note that Lack (1960), after an exhaustive review of the American and European literature, concluded that some northern species of migrants probably respond to immediate temperature changes.

Southerly winds in spring and northerly winds in fall are undoubtedly advantageous to migrating hawks. Even if they were being lifted by rising air currents, they would find it difficult to move forward against a head wind. These "tail winds" enable hawks to fly farther for a given expenditure of energy, and conservation of energy is probably important to migrating hawks, especially those which must make long passages through areas where food is inadequate (see Skutch, 1945).

In eastern North America, most large flights of hawks occur with the approach of a low-pressure area in the spring and after the passage of a low in the fall. Also, we have observed at Derby Hill that when a low-pressure area with its associated front is near, hawks seem to be more stimulated to move. In contrast to this situation, little migration occurs in the spring when high pressure dominates the weather. Likewise, little migration occurs in the fall at Hawk Mountain when high pressure is dominant (Broun, 1963).

If a low-pressure area is important as a stimulus to movement, it would seem to be necessary for the birds to perceive the approaching low. Mueller and Berger (1961) noted, however, that hourly variations in barometric pressure occurring locally are not usually greater than a bird would experience flying from the ground to the top of a tree. This fact does not eliminate the possibility that birds can sense such pressure changes, but it does reinforce the improbability that birds use atmospheric pressure changes as a clue to the approach of a low. It seems more likely that hawks respond to conditions associated with the low.

In our opinion, the most likely explanation for the movement of hawks in spring in advance of a low-pressure area (and cold front) is the advantage of the situation created by the rising air combining with southerly tail winds. The tendency for hawks to move behind low-pressure areas in the fall also argues for this hypothesis. In the fall the "lift" of the low combines with the northerly circulation of the air behind the low to provide the most favorable conditions. Southerly winds occurring on the western portion of a high and northerly winds on the eastern portion lack the "lift" associated with the low. Thus, from the standpoint of energetics it would certainly be advantageous for hawks to fly in front of a low in the spring and behind it in the fall. In both cases, tail winds and rising air currents should enable birds to migrate farther with less effort.

The only major exceptions to the tendency of hawks to move on southerly winds in advance of low-pressure areas in the spring have been observed with the Broad-winged Hawks. Large flights of Broad-winged Hawks occurred in 1964 on west–northwest and north–northwest winds. Perhaps the best explanation for these flights can be found in the migration urge of this species. Broad-winged Hawks migrate a much longer distance than do most other species of hawks (see Bent, 1937). For this reason they arrive on their breeding areas late in the spring and depart early in the fall. Since they have a more limited amount of time in which to nest and raise young, they may experience a stronger drive to complete their migration, regardless of atmospheric conditions, than other species of hawks.

Regarding daily time of migration, the development of rising air currents is probably of importance in delaying the initiation of migration until midmorning in the case of soaring species, but other factors are also possibly involved. We observed that many hawks passing over the study area in the morning had full crops. In addition, many hawks, especially Harriers and Sharp-shinned Hawks, have been observed hunting in the area at this time. Such observations suggest that many hawks may feed, or attempt to feed, before beginning to move. The Broad-winged Hawk seems to be the only species which usually does not feed during passage around the southeastern corner of Lake Ontario.

The tendency for hawks to rise to great altitudes on thermals has already been mentioned. Thermal development appears to be at a maximum with light southerly winds on a clear day, for it is then that hawks have been observed soaring to their greatest heights. The possibility cannot be dismissed that an unknown number of hawks fly by Derby Hill, under these conditions, at such a high altitude that they escape detection by the observers below.

With southerly winds of approximately 10 miles per hour, hawks have been observed to soar on air currents at considerable heights over the lake. Apparently these air currents are thermals which have been displaced over the lake by light southerly winds. Although at such times hawks are nearly always continuing their eastward movement, the possibility exists (although we have no evidence of it) that once hawks reach this great height over the lake they may glide across to the north shore without ever rounding the eastern end.

Little is known about the air which lies over Lake Ontario near its surface, but observations at Derby Hill give some indication of its nature. During the spring the air over the lake is much cooler than that over the land. With a southerly wind blowing toward the lake, the air temperature at Derby Hill was usually within a degree or two of the air temperature at Syracuse, New York, some 40 miles to the south. With a northerly wind blowing from the lake the temperature averaged between 5 and 10 degrees cooler than in Syracuse. The difference in air temperature probably has a profound effect on the flight of hawks.

This cooler air over the lake apparently is like an invisible bubble which extends above the lake to an unknown altitude. Being cooler than the air above, conditions are not favorable for the formation of rising air currents. The lack of such air currents is probably one important reason why hawks rarely cross over the water.

Although the bubble of cool air over the surface of the lake probably reduces the formation of thermals, a possible secondary effect of this cool air may be of importance. It is well known that when a warm mass of air meets a cooler air mass, the tendency is for the warm air to move in over the cooler air or to be deflected upward by the cooler air. It seems logical to assume that a similar situation occurs when a warm southerly airflow comes in contact with the cool bubble of air over Lake Ontario. The general tendency would be for the warm air to be deflected upward and for rising air currents to occur along the shore. Strong southerly winds would probably reduce this effect by causing the cool bubble of air to retreat northward over the lake and also by disrupting updraft formations which would occur with lighter winds. It is interesting to note that we observed hawks to fly closer to the shore and in a narrower flight path when southerly winds were under 15 miles per hour, especially in the morning before they began taking advantage of thermal activity. With wind speeds above 15 miles per hour, hawks sometimes actively seek to avoid the shoreline. The effect of the Great Lakes on air currents over them is well worth further study from the standpoint of understanding hawk movements along their shorelines.

SUMMARY

Although much is known about the fall migration of hawks from studies made at Hawk Mountain, Cedar Grove, and at other locations near the Great Lakes and along the Atlantic Coast, relatively little study has been done on spring hawk migration. The location of a major spring hawk flyway along the southern shore of Lake Ontario presented an excellent opportunity for study.

A promontory on the southeast shore of the lake, known locally as Derby Hill, was selected as a study area, and observations of hawk movements were made during the spring migration periods in 1963 and 1964. Particular attention was focused on the different species of hawks migrating at different times and on the effects of weather conditions upon the movement of the hawks.

It was found that in general each species of hawk tends to migrate within a definite part of the migration season, although occasional individuals may migrate early or late. Some species, such as the Goshawk, Red-shouldered Hawk, Red-tailed Hawk, Rough-legged Hawk, American Kestrel, and Harrier are most common late in March or during the first week of April. Other species, such as the Broad-winged Hawk, Sharp-shinned Hawk, Turkey Vulture, and Osprey are most common during the last week of April or during the first week of May. The Red-tailed Hawk, Harrier, and Cooper's Hawk tend to have migration periods which extend over most of the spring migration season.

Large spring movements of hawks are associated with southerly winds, rising temperatures, falling barometric pressure, and the approach of a low-pressure area and cold front. Because of the tendency for these weather factors to occur together, it has not been possible to isolate any one as being of primary importance in stimulating spring hawk movements. It appears doubtful, however, that temperature or actual change in atmospheric pressure directly stimulates spring movements. More likely, the factors which are of major importance are the southerly winds and rising currents of air which occur in front (east) of an approaching low-pressure area. It would be advantageous for hawks to fly on southerly winds when rising currents of air are also occurring. Such "tail winds" and rising air currents enable hawks to migrate farther for a given expenditure of metabolic energy. The only hawk which frequently does not show a good association with an approaching low-pressure area is the Broad-winged Hawk.

The tendency for hawks to migrate within certain hours of the day is probably related to daily variations in local weather factors and to the methods of flight which the hawks employ, although the feeding and hunting habits of these birds may also be of some importance. Those species which depend largely on soaring fly when updraft formation is greatest. Such updrafts probably result from the general tendency of air to rise in a low-pressure area, from thermal activity, and from the tendency of warm southerly winds to be forced up by the cool air mass over the lake. Species which employ soaring flight less frequently often begin migrating earlier in the day and continue later than those species that depend on the thermals to a greater degree.

Migrating hawks also exhibit other responses to local weather conditions. They tend to remain close to the lake when winds are southerly and to move inland for various distances when winds are from other directions. Hawks generally fly higher and move forward more rapidly when winds are from a westerly direction. It has also been noted that hawks usually cease migration in rain or snow.

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DEPARTMENT OF ZOOLOGY, SYRACUSE UNIVERSITY, SYRACUSE, N. Y., 29 APRIL 1965

LETTER TO THE EDITOR

Dear Sir,

The International Ornithological Congresses have by tradition generally been held in the breeding season, and the host country has organized excursions before and after the meeting, so that visitors have been able to see something of unfamiliar birds in the field under expert guidance. In the three congresses that I have attended British ornithologists have been amongst the chief recipients of this hospitality. It is therefore with shame, as well as regret, that I find that next year's congress, at Oxford, is to be held in July, and that there is to be only one, highly specialized, excursion, so that American visitors will have no opportunity to see the ordinary English birds in the breeding season.

I should like to do what I can to make amends, and am prepared to offer hospitality, in the form of accommodation and transport, so far as my teaching and other commitments allow, to as many American ornithologists as possible. If anyone interested will write to me saying when he will be in England, I will do my best to arrange something. I shall not be available from 19 June through 3 July. My chief interests are in woodland birds.

Yours sincerely,
W. B. Yapp.

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ENERGY AND NUTRIENT REQUIREMENTS OF THE RED-WINGED BLACKBIRD

FRED J. BRENNER

VARIOUS factors in the environment affect the existence energy requirements of birds and variation in the existence energy requirements of a particular species may influence various phases of its life history. This study investigated the relationship of environmental changes to the existence energy requirements and hence the nutritional requirements of the Red-winged Blackbird (*Agelaius phoeniceus*). The existence energy of a population represents the energy metabolized when the birds maintain a constant weight; thus the energy is used for standard metabolism, heat regulation, food assimilation, and securing food and water. Net energy (productive energy) is that energy metabolized beyond that required for existence. By taking into account all losses in metabolism, net energy is that portion of the metabolized energy that appears as product (fat, egg production, etc.).

Breeding birds arrive in central Pennsylvania in mid-March when the photoperiod is between 12 and 13 hours and the average daily air temperature is between 5 and 7 C. The photoperiod during the breeding season in May and June is between 14 and 15 hours, and the average air temperature is 17 C (mean of 70 years). After the breeding season, in July, the birds leave the breeding grounds and are joined by birds from other areas, including migrants. Red-winged Blackbirds depart from central Pennsylvania in October and November when the photoperiod is between 10 and 11 hours and the average air temperature is between 5 and 8 C (Brenner, 1964). However, it has not been determined whether the birds observed in October and November are summer residents, migrants, or both.

METHODS

The birds were captured in mist nets near State College, Pennsylvania, and in Florida. The birds, confined in the laboratory for 2 or 3 weeks before the start of experiments, were housed in groups of four or five in large artificially lighted cages (6 ft × 6 ft × 3 ft). Eight separate measurements of the existence energy requirements and body weights of 10 birds (two groups of five) were made per month during March, April, and May. During this time the photoperiod was increasing and environmental temperatures averaged between 21 and 25 C. Eight individual measurements per month (July–August and October–November) were made of the existence energy requirements and body weight of eight birds (two groups of four) at a decreasing photoperiod and temperature. The existence energy requirements and body weight of eight birds (two groups of four) held at 10 hours of light was determined from 32 separate measurements (eight measurements per month). These measurements were made to determine whether decreasing temperature alone influenced the existence energy requirements of birds. These two experiments were undertaken simultaneously. The windows were open in the laboratory in an attempt to subject the birds to fluctuations in environmental temperature. The ambient temperature in the laboratory was determined from the temperature recorded every 2 hours by a continuous 7-day recording thermograph.

The method of measuring food consumption and excrement loss, described by Kendeigh (1949) and also employed by Seibert (1949), Davis (1955), and West (1960), was followed. Two foods were used: high protein poultry laying pellets and cracked corn. All birds were fed ad libitum. In order to minimize diurnal differences, the birds were fed and weighed at approximately the same time each day. The birds were supplied a weighed amount of food and at the end of 5 days the uneaten food and the excrement were collected, dried, and weighed. The excrement was saved for caloric determination and chemical analysis. The caloric content of the feed and excrement was determined in a plain oxygen bomb calorimeter. The nutrient content of the two types of food was determined by standard biochemical methods as described by Maynard and Loosi (1962).

The existence energy was determined by subtracting the caloric content of the excreta from the caloric content of the food consumed (gross energy). The coefficient of metabolizable dry matter was calculated from the food intake (dry weight) minus the dry weight of the excreta divided by the food intake. The coefficient of metabolism of the various nutrients was then multiplied by the grams of the nutrient in the food per 100 g in order to determine the grams of nutrients metabolized per 100 g of food intake.

The reserve energy supply (fat) was determined by the following method described by Brenner and Malin (1965). The reserve energy available to a bird was calculated from the following equation:

$$\frac{1\text{ g fat}}{9\text{ kcal}}=\frac{0.08W}{X} \qquad X=0.7W$$

In this equation W = weight in grams, X = kcal, and 0.08 is the proportion of the live weight which is fat.

RESULTS

The decrease in the existence energy requirements of the birds from month to month in the spring (Table 1) was not significant ($P > 0.08$). The difference of 2.4 kcal in the existence energy requirements while feeding on the two types of food was not significant ($P > 0.50$). The mean existence

TABLE 1

EXISTENCE ENERGY REQUIREMENTS OF RED-WINGED BLACKBIRDS DURING AN INCREASING PHOTOPERIOD**

Month	Photoperiod	Temp. C	Existence Energy Requirements							
			Pellets*				Corn*			
			kcal/bird–day		kcal/g–day		kcal/bird–day		kcal/g–day	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE
March	12	21	29.4	0.19	0.60	0.009	27.6	0.38	0.59	0.067
April	13	25	25.7	0.28	0.52	0.046	21.6	0.35	0.48	0.063
May	14	23	22.5	0.36	0.60	0.042	21.2	0.18	0.47	0.008
Mean			25.9	–	0.54	–	23.5	–	0.51	–

* Five birds in each group.
** Ten measurements/month.

energy requirements of the birds on the two different foods was 24.8 kcal/bird–day.

The existence energy requirements of Red-winged Blackbirds increased from month to month in the autumn ($P < 0.05$) (Table 2). The existence energy requirements increased from a mean of 25.8 kcal/bird–day at 15 hours of light and 21 C to a mean of 45.5 kcal/bird–day at 9 hours of light and 11 C. The gross energy intake and excrement energy loss also increased as the photoperiod and temperature decreased ($P < 0.05$). However, the variation in photoperiod and temperature did not influence significantly the efficiency of metabolism by the birds ($P > 0.08$). Therefore, it may be assumed that the increase in the existence energy resulted from hyperphagia and not from a change in the efficiency of metabolism by the birds. The existence energy requirements of birds at a 14–15-hour photoperiod and 21 C (July and August) did not vary significantly from birds held at an increasing photoperiod and 23 C ($P > 0.50$). The difference in the existence energy requirements between the two types of food was not significant (Table 2) ($P > 0.70$).

TABLE 2

EXISTENCE ENERGY REQUIREMENTS OF BIRDS AT A DECREASING PHOTOPERIOD AND TEMPERATURE**

Month	Photoperiod	Temp. C	Existence Energy Requirements							
			Pellets*				Corn*			
			kcal/bird–day		kcal/g–day		kcal/bird–day		kcal/g–day	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE
July	15	21	26.3	0.45	0.44	0.066	25.2	0.34	0.46	0.023
August	14	21	30.2	0.90	0.51	0.057	23.9	0.19	0.44	0.090
October	12	17	40.4	0.26	0.68	0.039	35.4	0.34	0.65	0.066
November	9	11	45.2	1.08	0.74	0.083	45.7	0.39	0.88	0.058

** Eight measurements/month.
* Four birds in each group.

TABLE 3

EXISTENCE ENERGY REQUIREMENTS OF BIRDS AT A CONSTANT 10-HOUR PHOTOPERIOD AND DECREASING TEMPERATURE**

Month	Photo-period	Temp. C	Existence Energy Requirements							
			Pellets*				Corn*			
			kcal/bird–day		kcal/g–day		kcal/bird–day		kcal/g–day	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE
July	10	21	37.0	0.89	0.64	0.055	35.1	0.55	0.59	0.083
August	10	21	34.1	0.40	0.54	0.063	36.9	0.15	0.64	0.022
October	10	17	43.9	0.18	0.75	0.024	40.0	0.56	0.75	0.084
November	10	11	44.7	0.87	0.79	0.057	41.0	0.67	0.78	0.065

** Eight measurements/month.
* Four birds per group.

The existence energy requirements of the control birds held at 10 hours of light for 16 weeks increased during the last 8 weeks of the experiment ($P < 0.01$) (Table 3). The mean existence energy requirements increased from 35.5 to 40.4 kcal/bird–day during the latter half of the experimental period when the temperature decreased. The existence energy requirements of birds held at a 10-hour photoperiod and 21 C were significantly higher than the existence energy requirements of birds on the 12- to 14-hour photoperiod and 23 C ($P < 0.05$). The birds held at these photoperiods did not appear to be molting. However, nightly unrest may have occurred in either population (it was not measured). If nightly unrest did occur, this may account for the difference in the energy metabolized by the different populations. The existence energy requirements of the control birds were also significantly higher than those for birds held at 14–15 hours of light and 21 C ($P < 0.05$); however, at photoperiods between 9 and 12 hours of light and at temperatures between 11 and 17 C the existence energy requirements did not vary significantly from those of the birds held at a 10-hour photoperiod at the same temperature ($P > 0.050$). During periods of decreasing temperatures and low photoperiods both groups of birds increased their existence energy requirements above that required for birds during periods of an increasing photoperiod and constant temperature ($P < 0.001$).

The existence energy requirements of the birds in all three groups were also analyzed in terms of the energy required per gram of body weight in order to standardize the results. The existence energy requirements of birds in terms of kcal/g–day also increased when the temperature decreased (Tables 2 and 3). The body weight of the birds in the three groups did not vary significantly with temperature and hence the energy reserve (fat) of the birds which is related to the body weight did not vary (Fig. 1). Therefore, the energy intake was only sufficient to maintain the daily metabolic processes.

The theoretical existence energy requirements may be calculated by the

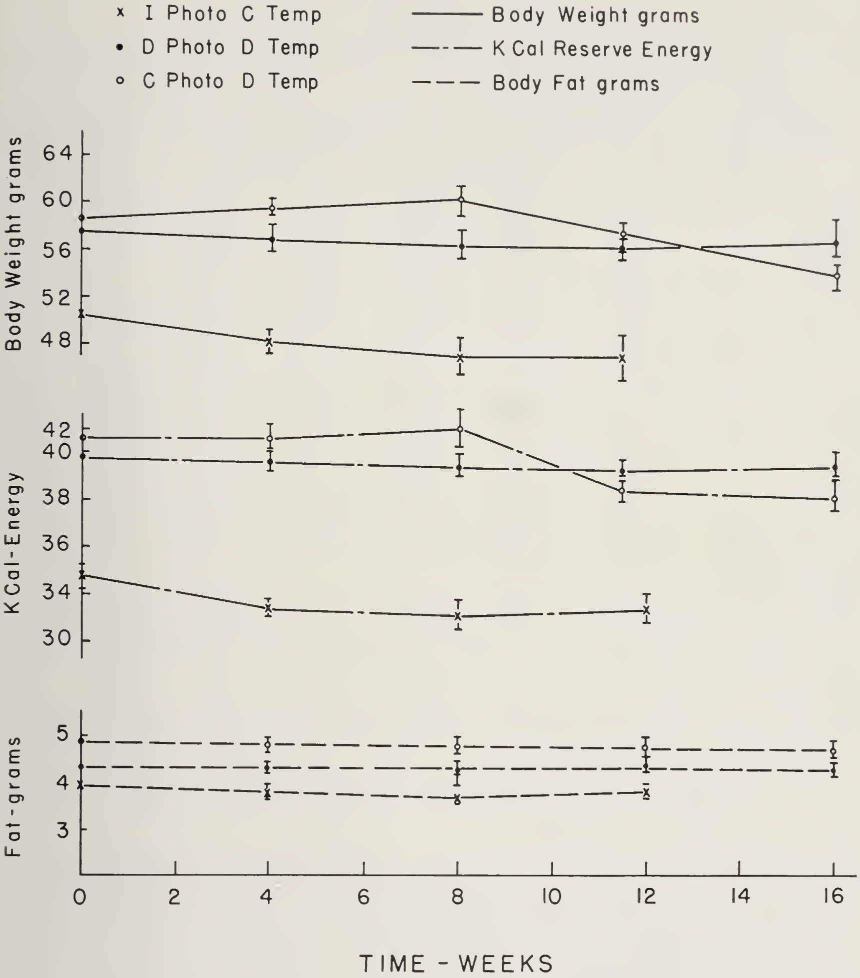

Fig. 1. Body weight, reserve energy supply, and estimated body fat of experimental birds under three different environmental conditions.

following formula modified from Maynard and Loosi (1962): $EE_{\text{kcal}} = 140\ W^{.75}$ where EE_{kcal} is the existence energy requirements and W is the body weight. This formula may only be used to calculate the existence energy requirements of birds within the thermoneutral zone for the particular species. The mean existence energy requirements of 30.4 kcal/bird–day for Red-winged Blackbirds in all three groups at a mean enviromental temperature of 22 C did not vary significantly from the theoretical value of 28.1 kcal/bird–day ($P > 0.40$); however, when the temperature decreased the

TABLE 4

METABOLIZABLE COEFFICIENTS OF NUTRIENTS, TOTAL METABOLIZABLE NUTRIENTS, AND METABOLIZABLE DRY MATTER UNDER DIFFERENT ENVIRONMENTAL CONDITIONS

		Environmental Condition					
		Decreasing photoperiod and temperature[1]		10-Hour photoperiod and decreasing temperature[2]		Increasing photoperiod constant temperature[3]	
Nutrient	Food	Mean	SE	Mean	SE	Mean	SE
Ether extract (fat)	Corn	92.44	0.238	91.04	0.243	90.30	1.240
	pellets	92.93	0.905	92.80	0.740	90.52	0.220
Crude fiber	Corn	56.92	3.500	69.06	2.300	54.21	3.240
	pellets	77.51	0.900	71.11	1.100	76.67	0.984
Ash	Corn	69.54	2.200	72.89	2.510	70.01	2.470
	pellets	62.85	3.570	72.45	3.210	62.01	3.320
Crude protein	Corn	59.88	0.800	59.31	0.764	72.54	0.977
	pellets	30.65	1.930	31.38	1.810	34.07	0.970
Nitrogen-free extract (carbohydrate)	Corn	94.13	0.241	94.36	2.410	94.21	1.410
	pellets	76.24	0.433	68.12	0.521	72.31	0.620
Energy	Corn	90.50	0.699	92.10	0.899	88.50	1.650
	pellets	70.20	1.600	72.60	1.710	66.00	1.910
Dry matter	Corn	90.50	3.270	89.90	3.410	90.40	0.570
	pellets	65.10	0.887	61.00	0.921	62.50	1.040

[1] Eight birds; [2] Eight birds; [3] 10 birds.

observed existence energy requirements were significantly higher than the theoretical value ($P < 0.001$).

The metabolizable coefficient of the various nutrients and energy did not vary with the different environmental conditions (Table 4), therefore, the grams of nutrients metabolized per 100 g of food remained the same regardless of the environmental condition (Table 5). The grams of carbohydrate (nitrogen–free extract) metabolized per 100 g of food intake was the only nutrient that was significantly different between the two foods. These data further illustrate that the nutritional requirements of the birds did not vary with the different environmental conditions.

DISCUSSION

The existence energy requirements of Red-winged Blackbirds increase in response to decreasing temperature and the gross energy intake of the birds also increased at the same time. Therefore, the increase in the energy metabolized by the birds was due to hyperphagia and not to an increase in the efficiency of metabolism by the birds. The total metabolizable nutrients

TABLE 5

GRAMS OF NUTRIENTS METABOLIZED PER 100 GRAMS OF FOOD INTAKE

Nutrient	Food	Environmental Condition					
		Decreasing photoperiod and temperature[1]		10-Hour photoperiod and decreasing temperature[2]		Increasing photoperiod constant temperature[3]	
		Mean	SE	Mean	SE	Mean	SE
Ether extract (fat)	Corn	2.63	0.018	2.59	0.016	3.44	0.073
	pellets	2.51	0.071	2.51	0.059	3.54	0.026
Crude fiber	Corn	2.28	0.142	2.76	0.122	2.71	0.131
	pellets	1.88	0.056	1.73	0.041	1.88	0.048
Ash	Corn	0.765	0.006	0.802	0.010	0.770	0.008
	pellets	1.54	0.150	2.07	0.125	1.77	0.141
Crude protein	Corn	6.76	0.140	6.70	0.131	5.25	0.093
	pellets	7.60	0.480	7.85	0.386	6.31	0.390
Nitrogen-free extract (carbohydrate)	Corn	69.49	3.09	76.21	2.79	78.10	2.87
	pellets	57.63	3.26	48.84	3.13	52.46	3.21
Total met. nutrients	Corn	92.17	0.742	92.13	0.721	90.27	0.732
	pellets	64.88	0.795	63.00	0.631	65.96	0.784

[1] Eight birds; [2] Eight birds; [3] 10 birds.

and the metabolizable dry matter did not change under the different environmental conditions. This coefficient of metabolizable dry matter (corn) of 90.5 per cent is the same as the 90.4 per cent for grain stated by Stevenson (1933) for 57 small passerine birds of different species.

The effect of photoperiod and temperature on the existence energy requirements of the Red-winged Blackbird may influence various phases of its life history. It appears that during the breeding season in central Pennsylvania the increasing environmental temperature results in a decrease in the existence energy requirements of the breeding population. Thus, it may be postulated that during the breeding season in May and June when the existence energy requirements are low the time required for feeding may be reduced, and therefore, the individuals may spend more time in defense of territory, caring for young, and other breeding activities.

At lowered temperatures, which normally occur during shorter photoperiods of the winter, the existence energy requirements are increased, and therefore, the birds have less feeding time available during a period of increased energy expenditure. Thus, it appears that migration serves as a survival factor in that it lowers the existence energy requirements due to the warmer environmental temperature of the winter range as well as providing an increased feeding period in the lower latitude. Low environmental temperature is correlated with the high existence energy requirements of birds. The birds held at a constant 10-hour photoperiod maintained a constant body weight while their existence energy requirements increased as the temperature decreased, indicating that the birds were ingesting only sufficient energy to maintain life. Temperature has a greater influence than photoperiod on the existence energy requirements of the species, because of the increased energy required for thermoregulation at low temperatures.

Most Red-winged Blackbird roosts occur in the eastern United States from Virginia south to northern Florida (Meanley and Webb, 1960). These birds are exposed to a photoperiod between 10 and 11 hours of daylight during the winter months. The existence energy requirements of birds at 11 C and 10 hours of light was 42.8 kcal/bird–day compared with 45.2 kcal/bird–day for 9-hour photoperiod which occurs in central Pennsylvania during the winter months. The birds migrating south in response to photoperiod would conserve only 2.5 kcal/bird–day at an environmental temperature of 11 C.

The Red-winged Blackbird inhabits the southern United States during the months of November, December, January, and February. The average temperature during these months for the six states where winter roosts of Red-winged Blackbirds occur ranged between 5 and 18 C (mean 10 C). The average temperature during these months for central Pennsylvania varied between 4 C and –3 C (mean 0.7) during the period from 1887 to 1956. The data presented here indicate that the energy requirements of birds increase with decreasing temperature. The results of this study further illustrate that at a low environmental temperature the existence energy requirements of Red-winged Blackbirds was significantly higher than the theoretical value of 28.1 kcal/bird–day, indicating that the experimental and control birds may have been exposed to environmental temperatures below their range of thermal neutrality. Siebert (1949) stated that migratory birds cannot metabolize energy fast enough during cold weather at short photoperiods to maintain life. Individual Starlings (*Sturnus vulgaris*) increased their metabolic rate under roosting conditions from 2.86 cc O_2/g–hr at 24 to 30 C to 5.83 cc O_2/g–hr at 2–4 C and the survival time decreased from 3 days to 1 day. However, when Starlings were grouped at 2–4 C, survival time increased from 1 to 3 days. The metabolic rate was also lower for birds grouped at 2–4 C than for birds roosting singly, indicating less heat loss per bird (Brenner, 1965). The increase in temperature in the wintering area plus the flocking behavior of the birds probably aids the Red-winged Blackbird in surviving inclement winter weather. The effect of light and temperature on the energy requirements probably influences the development of fall migration.

SUMMARY

The existence energy requirement of the Red-winged Blackbird was determined under different environmental conditions. The birds were fed two foods: high protein poultry laying pellets and cracked corn. The mean existence energy requirement of birds under an increasing photoperiod at an environmental temperature between 21 and 25 C was 24.9 kcal/bird–day.

The existence energy requirements increased from 25.8 kcal/bird–day at 21 C and 15 hours of light to 45.5 kcal/bird–day at 11 C and 9 hours of light. The existence energy requirements of birds held at a 10-hour photoperiod for 16 weeks also increased as the temperature decreased. There was no difference in the total metabolizable nutrients and metabolizable dry matter available to the birds under the different environmental conditions.

The effect of environmental temperature and photoperiod on the existence energy requirements in regard to the survival of the species and migration is discussed. The environmental temperature probably has a greater influence on the existence energy requirements of birds than has photoperiod.

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NEW LIFE MEMBER

A recent addition to the list of Life Members of the Wilson Ornithological Society is Dr. John T. Emlen, Professor of Zoology at the University of Wisconsin. A graduate of Haverford College, and holder of a doctorate from Cornell University, Dr. Emlen is one of the country's distinguished ornithologists. He is the author of over 100 scientific papers and his research interests have taken him to all parts of the United States, as well as to Africa to study the gorilla, and to the Antarctic to investigate the navigational abilities of penguins. In addition to his own work he has trained a number of students who are becoming prominent scientists in their own right. A member of the BOU, the Deutsche Ornithologische Gesellschaft, the AAAS, and the Cooper Society (past president of the northern division), Dr. Emlen has also been honored by election to the office of Vice President of the AOU. From 1956 to 1958 he served as President of the Wilson Society. He has three sons, all of whom are students of biology, and besides his professional work finds time to devote to conservation matters, as well as photography and biophilately.

GENERAL NOTES

The Cattle Egret on the Pacific Coast of Chiapas, México.—On 29 March 1965, I secured a Cattle Egret (*Bubulcus ibis*) from a group of five, approximately 32 miles southeast of Mapastepec, Chiapas, along the Pan-American Highway. The specimen, an adult male, had somewhat enlarged testes (3 × 8 mm) and weighed 314.5 grams. Although the species has previously been reported in the Atlantic lowlands of Chiapas (Dickerman, 1964, *Wilson Bull.*, 76:290), this apparently constitutes the first published record of its occurrence in the Pacific lowlands of that state.

In addition, I saw other Cattle Egrets in the Pacific lowlands of Chiapas (Soconusco District) in 1965 as follows: five near Mapastepec on 20–21 March and four there on 14 April; four near Pijijiápan on 30 March; and 16 between Tapachula and the Pijijiápan area on 20 April. With the exception of four birds seen in a tree near a pasture on 20 March, all of the egrets were closely associated with cattle.

As Cattle Egrets were apparently absent from this area as recently as early 1964 (Senor Miguel Alvárez del Toro, personal communication), it would appear that the species has just begun to colonize the Soconusco District of Chiapas. It will probably become an increasingly common bird in this area as the humid climate, extensive pasturelands, and abundant cattle provide seemingly optimal habitat.—JOHN P. HUBBARD, *The University of Michigan Museum of Zoology, Ann Arbor, Michigan, 26 May 1965.*

Behavior of Barrow's Goldeneye in Wyoming.—In July 1946 I led a pack-horse trip to Crater Lake in the Absaroka Mountains, southeast of Yellowstone National Park Wyoming. On our arrival there in the late afternoon, I observed a female Barrow's Goldeneye (*Bucephala islandica*) with 10 young swimming on a 50-yard-wide drainage pool in which the water was about 2 feet deep. As I ran in the direction of these birds, hoping to get a motion picture, the female became frantic, fluttering and quacking along the ground toward the edge of the deep water of the lake. I managed to capture two of the not more than one-week-old young while the female with the other eight escaped to the larger body of water. I wrapped the two young in a woolen shirt and placed them in my pack for the night in order that I might photograph them the next day.

The next morning I released these birds on the shallow pool where they began diving and catching various water insects and eating sprigs of succulent water vegetation. This behavior indicated that they were completely capable of obtaining their own food without the presence of the adult female.

When my photography was finished I attempted to wade out to catch them, but they were extremely elusive, swimming to the bottom in the clear water and along the bottom to the opposite bank. In order to catch them it was necessary to obtain the help of about a dozen boys who were part of the pack trip. When I approached the shore of the larger body of water I noted that the female and the other eight young were about 50 yards offshore. I released both of the young. They swam side by side toward the female and their siblings until they were within about 2 feet of the female. At this juncture the female stretched her neck in their direction, opened her beak, and made hissing noises. The two young evidently understood this behavior, because immediately they turned and, side by side, swam off by themselves. Both the female and her accompanying young and the two which had been rejected were observed at least 20 or 30 times during the ensuing days and they were always apart. They were still thriving

FIG. 1. Young Barrow's Goldeneyes, Crater Lake, Wyoming, 8 July 1946.

and apparently doing as well in their growth as the young under the care of the female when we left the area 10 days later.—WALTER P. NICKELL, *Cranbrook Institute of Science, Bloomfield Hills, Michigan, 12 February 1965.*

Migration of Rough-legged Hawks over Lake Erie.—It is generally thought that hawks of the genus *Buteo* will avoid crossing large bodies of water during migration. For instance, there is the well-documented migration route of Broad-winged Hawks (*Buteo platypterus*) in southwestern Ontario, where the hawks travel near the north shore of Lake Erie until they reach the Detroit River and then cross into Michigan (A. H. Kelley, D. S. Middleton, and W. P. Nickell, 1963. Birds of the Detroit–Windsor Area. Cranbrook Institute of Science, Bloomfield Hills, Michigan, pp. 34–35).

However, an observation made by me at Point Pelee, Ontario, on 6 December 1964 suggests that this behavior may not necessarily by typical of all buteos. On that date, Rough-legged Hawks (*Buteo lagopus*) were observed flying south off the point across Lake Erie. Between 9:00 AM and 10:30 AM, Rough-legged Hawks and Red-tailed Hawks (*Buteo jamaicensis*) were seen soaring in circles out over the water near the point. Then, at least four of the Rough-legged Hawks, flying with a few flaps and a sail, flew south from the point and continued to fly south until they were out of sight. There apparently had been a large influx of hawks into the Point Pelee area on that date since over 50 large buteos were observed. The weather data for this date were: cloud cover varying between 0.1 and clear; temperature varying between 10 and 15 F; and wind from the west–northwest or west at 6 to 8 mph. (Data from the Windsor Airport approximately 30 miles northwest of Point Pelee.)

Red-tailed Hawks also may have migrated off the point, although this actually has not been observed. It is hoped to get information about this in the future.—JOSEPH P. KLEIMAN, *3271 Albert Ave., Royal Oak, Michigan 48072, 20 March 1965.*

Common Terns nest on muskrat lodges and floating cattail mats.—On 16 June 1951 in a large cattail marsh (*Typha latifolia* and *T. angustifolia*) at Point Pelee, Essex County, Ontario, I noted about 100 adult Common Terns (*Sterna hirundo*) excitedly flying and calling over several nearby cattail concentrations. I spent 3 days, 16–18 June, canoeing in this marsh. During this time I found 35 nests of the Common Tern on two floating mats of cattail which had died, leaving only foot-high stubs with new growth around the outer edges. One of these mats held 20 nests with eggs, another 15 nests. The water under the floating mats was 5–7 feet deep. The mats were completely floating and were pushed from one location to another by the wind. The muck and cattail roots which held the mats together were thin, so that wave action had spattered the eggs with muck. Ten more nests with eggs were found on the tops of muskrat lodges, widely separated. One of these nests was at least one-half mile from its nearest neighbor.

Mr. A. A. Wood, a Canadian naturalist, collected three of these terns for me, and when these birds were compared with specimens at the University of Michigan Museum of Zoology, their identification as Common Terns was confirmed.

On 9 June 1956, at Tobico Marsh near Bay City, Bay County, Michigan, I found nine other nests of the Common Tern on the tops of muskrat lodges and widely separated, as had been part of those found at the Point Pelee marsh. As both years in which these marsh nests were found were times of higher-than-average lake levels, and as both marshes were connected with lakes, taking their level, I believe that the birds had been flooded off other nesting places on low-lying sand spits not too far away.

I have found one reference to Common Terns nesting on floating vegetation (Bent, 1947. "Life Histories of North American Gulls and Terns," p. 240) and one to this species'

FIG. 1. Nest of Common Tern on top of muskrat lodge, Point Pelee, Ontario, 17 June 1951.

nesting on the tops of muskrat lodges (Berger, 1961. "Bird Study." pp. 212–213). This latter reference was from my unpublished field notes.—Walter P. Nickell, *Cranbrook Institute of Science, Bloomfield Hills, Michigan, 12 February 1965.*

Observations on a captive Northern Phalarope.—On 31 August 1962 I captured a live Northern Phalorope (*Lobipes lobatus*) at a brine pond in a *Salicornia* marsh on the west shore of San Francisco Bay at Belmont, San Mateo County, California. The bird was in immature plumage and had suffered a gash about one-half inch long over the left shoulder, and was unable to fly.

The phalarope was placed in a washtub partly filled with freshwater. An anchored wooden platform served as a roost and for feeding. Later, when the bird was strong enough to fly, the washtub was covered with a metal grate. The bird was kept captive for 13 days (31 August–12 September) and then set free.

The following observations were made while it was in captivity.

Posture and locomotion.—The phalarope normally stood with its legs straight and the feet slightly "pigeon-toed," and its neck was not extended. Its body was so carried that the posterior end drooped slightly. It did not appear hunched over like many plovers and it did not teeter at any time like some other shorebirds do. It waddled slightly and pumped its neck while walking. When placed on a lawn for a few seconds, it ran swiftly toward some shrubbery. It kept its wings tightly folded against its sides, and when pursued, it ran in a zigzag course, maneuvering skillfully.

It was unable to perch securely on a narrow, rounded surface such as a pencil or finger because of a lack of flexibility in its toes.

Defensive behavior.—When frightened while on a solid surface, the captive immediately lay flat. Such a reaction probably reflects a response characteristic of the species for escaping detection when on land. As the area of confinement was too small to allow flight, the bird, when frightened on the water, swam rapidly to the dry surface and ran with much wing-flapping to a corner while continually looking in the direction of the disturbance.

It was silent unless disturbed. When I picked it up in order to change the water, it emitted often only one but sometimes two or three short, rasping squawks of low volume. This was the only type of sound I ever heard it utter.

Feeding.—During its first day of captivity, it quickly ate its food, either live or freshly killed insects, which was placed on the surface of the water. The bird would eat food placed either on the dry platform or on the water, but, in the latter case, the food had to be floating. Once, the bird was fed while the water was too shallow to permit swimming. Some cottage cheese was consumed from the platform but, in the process, small chunks fell into the water. Wading in the water, the bird spied a piece of cheese. The water was deeper than the total length of the bird's bill and while the phalarope attempted to pick up the cheese it would not submerge its bill past the nostrils. After several attempts, it gave up.

When eating, the bird had to cock its head to one side since its eyes were placed far back on the sides of the head. Food was grasped between the tips of the jaws and never speared. Small moths could be swallowed in a single gulp, but large noctuid moths and skipper butterflies (*Hesperia columbia*) were manipulated without use of the substrate as a brace until they were oriented headfirst and then were swallowed by means of several gulps.

The bird frequently sipped water by dipping only the tip of the bill and always followed the ingestion of any solid food with water. It was supplied with fresh tap water to which salt was never added.

The appetite of the captive was enormous. Particularly relished were live or freshly killed insects (adult flies, maggots, small butterflies, and moths), chopped raw meat, boiled egg yolk, and cottage cheese. The cottage cheese was more readily accepted if slightly soured, and was consumed after other foods were eaten. The bird either nibbled on or totally ignored chopped salad greens, chopped fruit, egg white, and canned dog food.

This successful retention of a Northern Phalarope suggests that the species may prove hardy in captivity, and thus available for laboratory studies in behavior and physiology. (See also Johns, 1964. *Condor*, 66:449–455.)

I would make the following suggestions as to the equipment necessary for retention of phalaropes in captivity: (1) confinement area of at least 2 square feet per individual; (2) water for swimming and drinking; (3) apparatus to allow the necessary frequent cleaning of quarters; and (4) large amounts of fresh food, live or freshly killed, or prepared material of animal origin.—SANFORD R. LEFFLER, *Museum of Natural History, University of Kansas, Lawrence, Kansas. (Present address: 1398 Geneva Street, San Carlos, California.) 21 November 1964.*

Comparison of the sexual responses of Common Grackles to normal females and to mounts of soliciting females.—The sexual behavior of the Common Grackle (*Quiscalus quiscula*) elicited by models is compared to studies of the natural reactions of the same population (Ficken, 1963. *Auk*, 80:52–72) with the purpose of emphasizing the necessity for caution in basing conclusions about normal behavior on observations using only abnormal conditions (e.g., mounts).

Stuffed female birds in the Soliciting posture were placed near colonies on grassy openings or tree limbs and the differences and similarities between reactions to the mount and the natural situation were recorded. Reactions to stuffed females in the Soliciting posture differed from all observed under natural conditions in the following ways: (1) more than one mounting occurred in a particular sequence (as many as 104 by a single male in 73 minutes); (2) males often mounted without preliminary display; (3) they pecked the model in various places; (4) they bit the model's head and bill; (5) they pulled out feathers; (6) they lifted the bill and wings of the mount with their bills; (7) *females* were attracted to the mount and occasionally directed Head Held displays at it; (8) males mounted the stuffed female when other males were standing a foot or two away; in fact, males mounted up to five times in a row although they were attacked each time by a nearby male; (9) two males defended the mount against other males by advancing toward the opponents with their bills lowered at an angle of about 15° below the horizontal and 15° to the side. *This posture was not seen in any other context.* It was associated with persistent and repeated advances toward other males up to 30 feet from the mount which invariably caused them to retreat. No nictitans blinking or eye closure common in threatening was associated with this, but rather the advancing bird seemed to "stare down" his opponents with his eye.

There were similarities between reactions to Soliciting female mounts and sexual interactions between wild males and females as follows: (1) the Head Down displays, mounting, and copulation were much the same; (2) females did not give any sexual responses to the model; (3) males defended the model against other males; (4) if a male mounted and another male was near, the other male was almost always attacked;

(5) more exaggerated Head Down displays were common when given toward a female on a limb but not when given to a female on the ground; (6) males did not threaten the stuffed female.

Thus, nine out of 15 reactions to female models were different from natural ones. This is in part due to the stationary position of the model in a constant strong Soliciting posture. Also, the males were presented with a continuous supernormal sexual stimulus during the period when their own females give only brief sexual responses, and are often aggressive toward the male when he directs precopulatory display (Head Down) toward them.

The two males which reacted by establishing a large territory around the model were completely dominant in this area. Moreover, they defended it by adopting a threat posture which was never seen in other situations but was more effective in elicting withdrawal than any of their threat displays. Perhaps these were unmated males with unusually strong aggressive-sexual motivation.

Experiments in nature are the only way of obtaining proof of numerous important assumptions. However, the results of these tests point out the need to interpret them in the light of normal behavior. Moreover, the natural situation should be duplicated as closely as possible.—Robert W. Ficken, *Laboratory of Ornithology, Cornell University, Ithaca, New York.* (*Present address: Department of Zoology, University of Maryland, College Park, Maryland.*) *13 April 1965.*

Dickcissel in Utah.—In recent years the Dickcissel (*Spiza americana*) has been reported from California and from several states west of the Rocky Mountains (California: Stager, 1949. *Condor*, 51:44; Northern Arizona: Bryant, 1952. *Condor*, 54:320; Nevada: Pulich and Gullion, 1953. *Condor*, 55:215; Western Colorado: Scott, 1957. *Audubon Field Notes*, 11:47). The four records above, plus the sight record in Utah noted below, were during the months of September and October. It is known that young birds disperse in many directions from their nesting grounds in the late summer and early fall. This random or vagrant migration (Wallace, 1963. "Introduction to Ornithology," Macmillan, New York, p. 260) might be one explanation for these scattered records.

On 1 October 1959 a sight record of five Dickcissels was reported in Salt Lake City (Scott, 1960. *Audubon Field Notes*, 14:60). Mr. Gleb Kashin, who saw the birds, stated that this "may be one of the first records for Utah." I have searched the literature and cannot find any earlier record. Thus, I consider the 1959 report as the first record of the Dickcissel in Utah.

On 25 May 1964 a Dickcissel was brought to me by a student who had seen the bird fly into the front window of a business establishment in Provo. This bird was an adult male (B.Y.U. No. 4752) with an ossified skull and enlarged testes (right 7.2 × 6.8 mm, left 9.4 × 6.1 mm). Although the feathers did not show signs of wear, the bird appeared to be in poor physical condition. There was no integumentary fat, and its weight of 19.6 grams was considerably less than the average weight of six individuals (33.5 grams) reported by Gross (1921. *Auk*, 38:15–17) from Illinois. The weight distinction could be due to the difference in the season since the Illinois birds were taken in August after nesting had been completed. Apparently the specimen I am reporting had just completed a migratory flight from its wintering locality in South America which could also account for the weight difference.—Herbert H. Frost, *Department of Zoology and Entomology, Brigham Young University, Provo, Utah, 19 March 1965.*

A partly chestnut specimen of Variable Seedeater.—On 30 March 1963, on the Navy pipeline near Gamboa, Panama Canal Zone, Horace Loftin and I collected an adult male Variable Seedeater (*Sporophila aurita*) with a considerable amount of chestnut in the plumage. There is a faint chestnut malar stripe and a narrow transverse band of chestnut across the throat. The flanks and crissum are chestnut and the only remaining white is the speculum and lining of the wing and the midline of the abdomen. The rest of the plumage is solid black. The bill shape and measurements are average for *Sporophila aurita aurita.* The skin is now in the American Museum of Natural History.

This species is extremely variable in Panama in regard to the extent of black and white in the plumage, and it is of interest that the chestnut in this specimen is present only in those places where black replaces white in blackish individuals of *S. a. aurita*—not in the speculum and lining of the wing and the midline of the abdomen, which remain white in such individuals. Mr. Eugene Eisenmann (whose aid is gratefully appreciated) writes me that the collection of the American Museum contains no other such example and that he knows of none reported in the literature.

The occasional occurrence of chestnut in place of black is known in the usually all black Thick-billed Seed-Finch (*Oryzoborus funereus*), an allied bird of similar distribution. Wetmore (1957. *Smithsonian Misc. Coll.*, 134:102–103) rejects de Schauensee's lumping of *funereus* in the same species with the South American *O. angolensis*, in which the breast, abdomen, and sides of the male are chestnut, and he interprets the "occasional occurrence of this chestnut marking in *funereus* as a deep-seated character that indicates ancient relationship to *angolensis* through some common ancestral stem," rather than an intergradation between these allied forms. Taking this view, the presence of chestnut in *Sporophila aurita* could indicate recurrence of characteristics still found in other species of the genus *Sporophila* with chestnut-colored underparts. More simply, it could be a tendency of two closely related genera (*Sporophila* and *Oryzoborus*) towards occcasional modification of the normal melanin giving a reddish effect.

If Harrison (1965. *Ibis*, 107:106–108) is correct in his conclusion that the pigment causing chestnut coloration ("erythromelanin") is genetically distinct from the pigment responsible for black coloration (eumelanin), then rather than a dilution of black to chestnut, the presence of chestnut in *Sporophila* would seem to be either a direct replacement of black by chestnut or a loss of black revealing underlying chestnut pigment.—STORRS L. OLSON, *700 Stiles Avenue, Tallahassee, Florida, 6 April 1965.*

Erythristic eggs.—Erythristic (red) eggs are so unusual among American birds that it is of some interest to report four successive sets of these abnormal eggs laid by a Herring Gull (*Larus argentatus*) in a nest located on Kent Island, New Brunswick.

In 1929 Mr. Allan Moses, the warden of the island sanctuary, obtained two sets of two erythristic eggs each from the same nest, the second set having been laid after the first had been removed. One of these two sets, which were presented to Mr. Robey Tufts of Wolfville, Nova Scotia, is now in the Museum of Science at Halifax, Nova Scotia. Mr. Moses collected a third set, of three eggs, in 1931, and in 1932 I collected a fourth set of two eggs from the same nest. This nest was in a slight depression on the top of a small knoll among a group of spruce trees. No other nests were near.

Both adult birds were of normal coloration, and while it is apparent that all four sets were laid by the same female, it is not known whether the male was the same individual in all 3 years.

The set of eggs which I obtained (now in the ornithological collection of Bowdoin

College, Brunswick, Maine) had the following weights and measurements when fresh: No. 1, 67.9 × 52.2 mm, weight 92 grams; No. 2, 69.5 × 50.5 mm, weight 89.5 grams. The colors ascertained by comparison with Ridgway's color standards (1912. "Color Standards and Color Nomenclature") were: Egg No. 1: ground color Shell Pink, marked with irregularly shaped spots of Hellebore Red interspersed with very faint markings of Vinaceous Gray; Egg No. 2: ground color Vinaceous Fawn marked with large spots of Prussian Red interspersed with a few faint markings of Light Vinaceous Gray. No other cases or erythristic eggs among North American Laridae have come to my attention. Figure 1 shows this set of eggs together with an albino gull egg.

Mr. Willam Rowan of Edmonton, Alberta, informed me that he collected two sets of erythristic eggs which were laid by the same Common Crow (*Corvus brachyrhynchos*) in successive years. He further stated that the same type of red eggs was found in the same nest for 7 successive years. There are a few published records of abnormal red eggs in the Common Crow. Bendire (1895. "Life Histories of North American Birds") described two sets. Sage (1913. "Birds of Connecticut") reported two sets, and Jacobs (1935. *Auk*, 52:189–190) describes a set from Pennsylvania.

Fig. 1.

The cases of the gull and crow cited above would indicate that if the first set of eggs is erythristic, subsequent sets may be of similar abnormal coloration. However, there are a few instances among European birds where there have been both normal and erythristic eggs in the same clutch. (Hellebreckers, 1949. *Limosa*, 17:84–88).

Jourdain and Borrer (1937. *Brit. Birds*, 7:246–260) have compiled records of erythristic eggs of British birds. Their list includes the Herring Gull and several members of the genus *Corvus*. Baker (1932–34. "The Nidification of the Birds of the British Empire") has reviewed the occurrence of these abnormal eggs in Indian birds and Hellebreckers (op. cit.) has discussed the general problem of erythrism in eggs.—Alfred O. Gross, *11 Boody Street, Brunswick, Maine, 16 November 1964.*

A new subspecies of the Boat-tailed Grackle from México.—In November 1963 while collecting in northern Yucatán with Kenneth C. Parkes, the authors noted that the Boat-tailed Grackles (*Cassidix mexicanus*) appeared small compared with the well-known nominate form in Veracruz. Specimens collected then were undergoing heavy molt and diagnostic measurements could not be made. However, series collected by us on a subsequent trip in January and February 1965 proved the population nesting on the Yucatán Peninsula to be a distinct subspecies which may be known as

Cassidix mexicanus loweryi new subspecies.

Type.—Adult female, No. CU 30,456. Louis Agassiz Fuertes Collection, Cornell University; Chicxulub Puerto, Yucatán, collected 25 January 1965 by Robert W. Dickerman. Original field number: 12,595. Skull ossified, little fat, no molt. Weight 127.0 gms.

Paratypes.—Nine females and one adult male collected in the Progreso, Yucatán vicinity, November 1963 and January and February 1965 bearing field numbers: (females) RWD 11,626; 11,627; 11,638 CU 30,476; ARP 6916; 6917; 6918; 8476 and KCP 2225; (male) RWD 11,639.

Diagnosis.—Adult and immature females are most similar to *Cassidix mexicanus monsoni* Phillips, and *C. m. prosopidicola* Lowery. However, dorsally *loweryi* in fresh plumage is darker brown on the crown and nape, this color extending as edgings over the entire dorsum as in *monsoni*, although to a lesser extent. *Prosopidicola*, in contrast, presents a brown-headed, somewhat more iridescent-backed appearance more similar to female *mexicanus*. All three subspecies are much paler than *mexicanus*. Ventrally, female *loweryi*, like *prosopidicola* and *monsoni*, differ from *mexicanus* in being paler and warmer buffy brown, less grayish; *loweryi* like *prosopidicola* is darker, less buffy than *monsoni*. In turn, *loweryi* is separated from *prosopidicola* in having a darker throat and in general is a richer brown.

Adult male *loweryi* are most similar to those of *prosopidicola* and *mexicanus*, but with the belly duller, less iridescent, and more bluish than in those races. All three Atlantic coastal forms differ strikingly from *monsoni* in lacking the rich purplish color of the back and belly so characteristic of that subspecies.

In size *loweryi* is so much smaller than adjacent *mexicanus* as to be noticeable in the field to those familiar with the nominate form. There is no overlap in measurements of length, extent, wing, or tail between series of adult females of the two forms, and only the extremes of males overlap in these measurements. There is no overlap in weights of males, a better indication of true size difference. *Loweryi* averages smaller than the more closely related *prosopidicola* and *monsoni* (see Table 1 and Fig. 1).

Range.—Essentially coastal, from Isla del Carmen, Campeche along the coast of the Yucatán Peninsula, south on the eastern coast to Turneffe Cay, British Honduras. In the interior of the peninsula, it occurs south at least to Chichén Itzá, and probably ranges through the semiarid zone.

Specimens examined.—*Campeche*: Isla del Carmen, 1♂, 7♀; Lerma, 3♀. *Yucatán*: Progreso, 3♂, 15♀; Río Largartos, 1♀; Temax, 1♂; Chichén Itzá, 2♀. *Quintana Roo*: Isla Mujeres, 2♀; Cozumel, 1♂, 7♀. *British Honduras*: Turneffe Cay, 4♂, 1♀. (No immature males were used in comparisons.)

Discussion.—Series from Isla Mujeres and Isla Cozumel, Quintana Roo, and a series of four adult males from Turneffe Cay, British Honduras are typical *loweryi*. One adult male and six adult and immature females from Isla del Carmen represent the western end of the range of *loweryi*. Three females collected in extreme western Campeche are intermediate towards *mexicanus* both in color and size.

TABLE 1

MEASUREMENTS OF ADULT *CASSIDIX MEXICANUS*
(with number, range, mean, and standard deviation)

Subspecies	Total length	Extent	Wing chord	Tail	Culmen form nostril	Weight
			FEMALES			
prosopidicola	(6) 355–372 (362.1)	(6) 473–484 (477.8)	(12) 142–157 (151.0) 5.0	(12) 145–166 (156.5) 6.4	(12) 23.2–25.8 (24.8) 0.7	(17) 109.0–129.5 (119.3) 5.5
mexicanus	(19) 371–401 (383.7) 9.4	(16) 483–515 (494.6) 10.6	(25) 155–163 (158.0) 2.2	(24) 156–181 (168.4) 6.4	(27) 26.2–30.5 (27.9) 1.0	(18) 124.5–163.1 (141.6) 10.0
loweryi	(11) 337–357 (346.6) 6.4	(9) 436–462 (451.8) 7.5	(16) 142–153 (145.8) 2.7	(13) 136–152 (144.5) 5.1	(22) 23.7–27.3 (25.8) 0.9	(17) 109.0–129.5 (119.3) 5.5
monsoni	(8) 348–375 (359.3)	(6) 444–475 (461.0)	(14) 143–156 (147.4) 3.5	(13) 147–165 (155.8) 6.1	(13) 22.3–26.7 (24.5) 1.2	(7) 106.0–123.7 (115.4)
			MALES			
prosopidicola	(3) 477–490 (482.6)	(3) 590–604 (598.3)	(12) 184–198 (189.9) 5.1	(9) 194–234 (216.2) 13.6	(12) 29.5–32.5 (30.7) 1.0	(6) 216.4–253.7 (236.0)
mexicanus	(14) 467–503 (486.8) 10.6	(11) 600–645 (616.9) 13.4	(20) 188–222 (200.7) 7.4	(20) 207–240 (229.0) 9.7	(20) 31.6–38.0 (34.6) 1.4	(14) 238.8–317.0 (264.6) 23.5
loweryi	(2) 428&459	(2) 565&580	(9) 180–192 (184.6) 3.8	(8) 187–216 (200.5) 9.8	(9) 30.1–34.8 (31.7) 1.7	(6) 188.5–214.3 (202.4)
monsoni	(2) 454&473	(1) 581	(19) 175–196 (187.0) 5.9	(19) 195–235 (216.2) 10.4	(17) 29.1–34.4 (31.0) 1.5	(11) 187.0–222.0 (203.2) 9.9

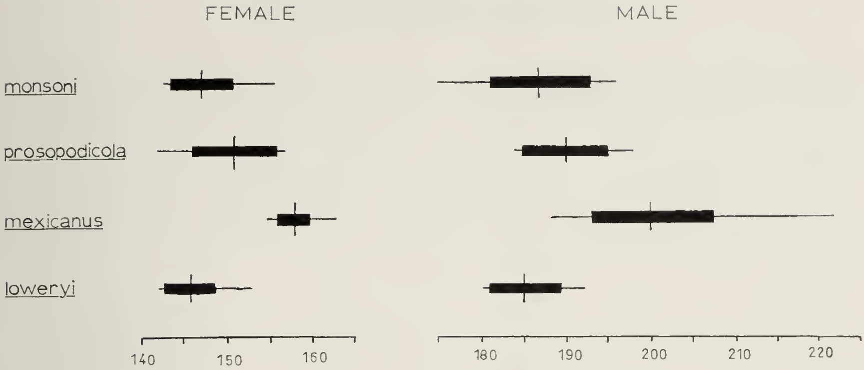

Fig. 1. Statistical analysis of wing chord in mm for adult *Cassidix mexicanus,* with range, mean, and one standard deviation on either side of the mean.

The recognition of this dramatically smaller and paler form on the Yucatán Peninsula at this late date is inexplicable. *Loweryi,* like the similar *prosopidicola* and *monsoni,* inhabits a semiarid zone but is separated from those forms by *mexicanus,* a large dark form of the humid areas of Veracruz and adjacent states. It is interesting to note that, like *monsoni* and *nelsoni* (Phillips, 1950. *Condor,* 52:78–81), *mexicanus* appears to be a vigorous form, extending its range where areas are open to it (e.g., the Valley of Mexico was recently colonized by this form). One wonders what might have been the history of these arid- and humid-adapted populations within the recent past, in the postglacial period, and more especially in the warm, dry Hypsithermal.

It is a pleasure to dedicate this subspecies to George H. Lowery, Jr., in recognition of his contribution to our knowledge of *Cassidix,* and his interest in Mexican ornithology.—Robert W. Dickerman, *Department of Microbiology, Cornell University Medical College, New York 21, New York,* and Allan R. Phillips, *Instituto de Biología, Universidad Nacional Autónomo de México, Mexico City,* *11 December 1965 (Originally received 25 May 1965).*

ORNITHOLOGICAL NEWS

All members of the Society should be anxiously awaiting the Annual Meeting at University Park, Pennsylvania on 28 April–1 May. It promises to be a very good meeting indeed. The feature of the program will be a Symposium on the Status of our Hawks. A distinguished group of speakers will present up-to-date information on this group of birds for which so much concern is being expressed. At this time of year the advance wave of the warbler migration should be arriving. Those members who have never experienced one are advised to come and see how pleasant a season is Spring in the Appalachian valleys (Regional plug from the Editor).

We have received word that Dr. Harry W. Hann of the University of Michigan died on 7 December 1965. Dr. Hann was one of our distinguished teachers of ornithology.

Rather belatedly we acknowledge the great loss to American ornithology in the death in October 1965 of Dr. Alden H. Miller of the University of California.

Mr. T. A. Beckett, III of Magnolia Gardens, Johns Island, South Carolina is studying the nesting status of the Caspian Tern in South Carolina. He would appreciate any information that readers of the *Bulletin* might have on this matter, and is especially interested in possible specimens of eggs of this species collected by A. T. Wayne which might be in distant collections.

The original records of the Bird Survey Committee of the Detroit Audubon Society are filed in the library of the Cranbrook Institute of Science, Bloomfield Hills, Michigan 48013. This makes them available for ornithological research.

There are 33,000 detailed individual nest cards for the 148 species known to breed in the eight counties of the Detroit–Windsor area filed by species in chronological order from 1945 through 1965. Report forms submitted by individual observers which show the numbers, date, and place of all birds observed are filed by season from 1947 through 1965. A third type of record includes the "Species Sheets" for the 10 years (1945–54) of the survey which resulted in publication in 1963. There is one sheet for each season for each year on which all occurrences reported for each species are entered on the proper date with the number seen. These sheets give a complete picture of the status and migration period of the migratory species as well as graphic illustration of the abundance or scarcity of permanent residents.

The Detroit Audubon Society and the Cranbrook Institute of Science hope that these records will find much use by students and others carrying out ornithological investigation.

Birds of Colorado by Alfred M. Bailey and Robert J. Niedrach, longtime staff members of the Denver Museum of Natural History, was off the press in late 1965. Published by the Denver Museum, the work is in two volumes (pages 12″ × 9″) with a total of 1175 pp. It is illustrated with 124 color plates made especially for the book by 23 bird artists of Britain, Canada, and the United States, portraying 420 of the 439 species listed from Colorado. In addition, there are more then 400 black and white photographs, many of nesting birds. The data given for each species covers recognition, range, status in Colorado and neighboring states of Nebraska, Kansas, New Mexico, Utah, and Wyoming, concluding with narratives of life-history activities of each Colorado breeding form. Price $35.00 (two volumes) postpaid.

ORNITHOLOGICAL LITERATURE

Birds of the Black Hills. By Olin Sewall Pettingill, Jr. and Nathaniel R. Whitney, Jr. Cornell Laboratory of Ornithology, Ithaca, New York, Special Publication Number 1, 1965: viii + 139 pp., 9 figs., 5 line drawings, map. $2.50.

This is a detailed account of the birds in "an island of mountains in a vast expanse of prairie" known as the Black Hills, covering about 4,500 square miles. Two-thirds of the area lies in southwestern South Dakota and one-third in northeastern Wyoming. Included are all known records of substance, a large share of the observations being supplied by the authors. Contributors other than the authors are specially acknowledged. For the more regular species, information is presented on occurrence and local status, distribution, habitats, nesting, and migration. In many instances useful data are given on behavior or "special habits." Subspecific determinations of specimens were made by John P. Hubbard and are carefully summarized, hence this publication will have special interest to taxonomists.

Listed in all are 226 species, of which eight are considered hypothetical and 87 are reported as rare, casual, or irregular. The remaining 131 species occur regularly from year to year. Helpful lists of permanent residents, summer residents, transients, and winter residents are given under "seasonal distribution." Terms expressing relative abundance have been defined, thus making comparisons with other areas feasible. Each species account includes substantial information on nesting, vocalizations, etc.; it is generally succinct and appears to have been carefully edited. Brief but informative descriptions of the geography, topography, drainage, climate, vegetation, and "man's impress on the environment" provide instructive background to the ensuing discussions of "ecological distribution" and "origin and peculiarities" of the birdlife of the Black Hills. Eight photographs, which suffer slightly from reproduction on nonglossy paper, show major aspects of the Black Hills, and will be of interest to those who may not have seen this area, or who may know the Black Hills chiefly as the site of the Rushmore National Memorial. A map of the Black Hills area, complete with highways, is reproduced on the inside front cover and repeated, without change, at the end of the species accounts where there is an extensive and useful gazetteer. Inclusion of a scale on the map would have been helpful. This book, which measures 6 by 9 inches, is made especially attractive by the cover design—a White-winged Junco drawn by George Miksch Sutton—and by five line drawings within the book by William C. Dilger. The typography is clean and open, making for pleasant and easy reading.

Preservation of natural areas depends to an increasing extent upon the provision of interpretative information for the public. Regional lists of this sort are valuable to that end. All those who contributed to the "Birds of the Black Hills," and the authors in particular, deserve credit for making this information available. Those persons who attended the annual meeting of the Wilson Ornithological Society in the Black Hills (17–20 June 1965) will recall that this publication was first made available on that occasion. Anyone planning a visit to the Black Hills will certainly want to have at hand a copy of the Birds of the Black Hills as a guide to the natural history and particularly the ornithology of the region.—Robert W. Nero.

The Bird Watcher's America. Edited by Olin Sewall Pettingill, Jr. McGraw-Hill Book Company, New York, 1965: 6 × 8½ in., 441 pp., many drawings by John Henry Dick. $7.50.

In the early 1950's Olin Sewall Pettingill, Jr. published a new type of bird guide—

"A Guide to Bird Finding East of the Mississippi" and "A Guide to Bird Finding West of the Mississippi." These "Baedekers" to bird-watching were immediately popular, and countless people have used them in visiting unfamiliar parts of the country. Many enthusiasts have even planned their vacation trips to include as many sites listed in the Guides as possible. With the passage of time the detailed instructions for reaching the various sites have become more and more obsolete, as new roads were built and the ever increasing urbanization took over. The army of increasingly peripatetic bird students have also turned up many interesting sites not discussed in the originals. Clearly the time had come for a revision of these useful guides.

Rather than carry out a routine revision, Pettingill has chosen a far different course, one which, while it serves almost as usefully, will resist the passage to obsolescence more readily. He chose this time to let a galaxy of regional authorities write accounts of the birding adventures to be found in their particular areas. Pettingill selected approximately 50 places which he thought worthy of inclusion, and then invited suitable persons to write accounts of these areas. Some of the original places were dropped for lack of an author, but the final result presents accounts of 46 areas written by 44 persons. The authors wrote freely on their own areas but were limited to about 2,500 words, and the editor placed the accounts in a uniform style.

The result is most satisfactory. Editor Pettingill has done a fine job of smoothing out each account so that most of the pitfalls of the modern "authorship by committee" have been avoided. The chapters are not strictly "guides" and only a few authors give anything like detailed instructions for reaching some of the places mentioned. We have, instead, 46 interesting descriptions of some of the finest birding spots in the country.

The authors range from Roger Peterson, George Sutton, and Allan Cruickshank, names which are household words among the ornithological fraternity, through such outstanding, but not so well known, biologists as Luther Goldman, William B. Robertson, Jr., and Howard Cogswell, and a few professional writers such as Herbert Krause and Fred Bodsworth to dedicated amateurs (both as writers and biologists) such as Doris B. Gates, R. Dudley Ross, and Edgar Kincaid. For each author Editor Pettingill has supplied a short biographical account, and these make fine reading for the person who is interested in ornithologists as well as ornithology. Prominent in each account is a mention of how the person first became interested in birds, a subject that I submit is worthy of deeper exploration at some time and somewhere.

The 46 accounts are divided into the following geographical, ecological, or topical groups: Atlantic Coast and Coastal Islands; Eastern Mountains and Foothills; Pacific Coast, Western Mountains, and Foothills; Alaskan Islands; The North Country; The Wetlands; Prairies, Deserts, Desert Mountains, and Canyons; The Lower Rio Grande Valley; Migration Spectacles; and Some Avian Specialties. The regions covered vary widely in size from some of the large National Parks—Glacier, Olympic, and Great Smokies, to some very small but vitally interesting areas such as Block Island, Rhode Island, the Kirtland's Warbler country of Michigan, and the hawk-watching stations at Hawk Mountain, Pennsylvania, and Duluth, Minnesota. About half of the areas represent classical bird-watching spots known to all birders (at least by reputation) while the rest offer descriptions of some refreshingly new spots. At least four of the areas covered (The Aleutians, The Pribilofs, Arctic Alaska, and Churchill on Hudson Bay) will hardly qualify for the average birder's vacation routes.

While the choice of areas was clearly the prerogative of the Editor, and no valid criticism can be made of his choices, I do want to offer some personal prejudice in this matter. The geographical distribution of the areas discussed is very uneven. The southeast is represented by only two areas (two others included are of a highly specialized nature) and the wide expanse of the Midwest from the Appalachians to the Rockies by only about five (again ruling out certain specialized areas). Even more disturbing to this reviewer was the fact that the great deciduous forest of eastern United States is represented by only one area (the Great Smokies). The several other areas included in this region are either outliers of the boreal forest or are the scenes of specialized activities such as the observation of hawk migration. The result seems to be that while the Easterner can profit by learning of the exciting birding grounds of the West, the visitor from the West can learn very little about some of the interesting and exciting (to him) spots in the deciduous forest region.

Besides the above invalid, and almost irrelevant, criticism my only complaint can be that the pleasure to be derived from reading the book doesn't last long enough, and I could only wish it were twice as long. The would-be traveler can profit immensely, and the armchair traveler can obtain several evenings of vicarious pleasures in good company. I cannot imagine anyone interested in birds who will not enjoy (and profit by) this book.—George A. Hall.

Birds Over America. By Roger Tory Peterson. New and revised edition. Dodd, Mead & Company, New York, 1964: 7 × 10 in., xvi + 342 pp., 105 photos by the author. $7.50.

Soon after Roger Peterson's "Birds Over America" was first published in 1948, Harold Mayfield reviewed it in *The Wilson Bulletin* (1949. 61:54–55). What he wrote is still applicable and I therefore quote it in part:

"Better than any other book I know, this one conveys the spirit of the enthusiasm in the sport of bird study. Its pages are filled with the 'shop talk' of the field ornithologist—query, speculation, anecdote of the kind we hear wherever members of the clan gather: Where is the Bachman's Warbler? How many birds are there is America? What bird is the most common? What are the prospects for survival of the Ivory-billed Woodpecker? Why is the Peregrine the favorite bird of so many people? What happens to birds in a hurricane? Where are the best places to see birds? What are the attractions (ornithological) of Maine, Cape May, Santee delta, Everglades, Tortugas, Louisiana swamp, Texas coastal plain, Arizona desert, California waters, Utah marshes?

"These and scores of other questions received thoughtful comment in the twenty-five chapters of this book. Through them we gain a new appreciation of the years of vigorous field work, the keen eye, and the precise mind which made possible the famous 'Field Guides'."

From the day of publication, Birds Over America enjoyed a wide response and was eventually the basis on which Dr. Peterson received the John Burroughs Award "for the excellence in nature writing." To students and other persons wanting to know "what bird watching is all about" beyond identifying and listing species, I always recommended this book because it explained by indirection while suggesting ideas and objectives that were both stirring and challenging. But in due course it became dated—though never in spirit—and went out of print.

In this welcome revision, Dr. Peterson has rewritten certain passages, sometimes changing the tense from present to past, and substituted new paragraphs that bring the text up to the minute. Pagination and type style are the same and so are the photographs. The latter, however, have lost in reprinting their freshness and sparkle that so beautifully enhanced the first edition.—Olin Sewall Pettingill, Jr.

THE NORTH AMERICAN NEST-RECORD CARD PROGRAM FOR 1966

The first year of the North American Nest-Record Card Program went very well. The Laboratory of Ornithology mailed out over 45,000 cards to individuals and regional centers from Florida to Alaska. We were encouraged at the response; over 23,000 completed cards were received from 700 individuals. We have accumulated over 500 cards each for several species; among these are Eastern Phoebe, Tree Swallow, Barn Swallow, House Wren, Catbird, Eastern Bluebird, Red-winged Blackbird, and Common Grackle. The Red-winged Blackbird has been selected for a trial run on the computer, and the data from our 2,300 cards on that species are now being punched onto IBM cards.

The principal aim of the program is to accumulate a large amount of data on the breeding biology of birds of the entire North American continent. These data will be stored on IBM cards in a form ready for analysis. These data, once processed, will be available to researchers interested in many areas of avian biology, such as annual and geographical variations in breeding seasons, clutch size, fledging periods, and nesting success. We hope that the program will also play a key role in the study of man's modification of his environment through marsh drainage, urbanization, and the use of pesticides.

We need data from all parts of the country. Observations from city parks and back yards, of the commonest species, are as important as those from remote parts of the continent. We need the co-operation of all competent field observers; please get in touch with your local organization and find out if it is cooperating as a regional center for the distribution of cards. If they are not, you may want to help organize a club effort. Individuals may also obtain cards directly from us. In any case, write for information and cards to North American Nest-Record Card Program, Laboratory of Ornithology, 33 Sapsucker Woods Road, Ithaca, New York 14850. Be sure to include your zip code with your return address.

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The Josselyn Van Tyne Memorial Library of the Wilson Ornithological Society, housed in the University of Michigan Museum of Zoology, was established in concurrence with the University of Michigan in 1930. Until 1947 the Library was maintained entirely by gifts and bequests of books, reprints, and ornithological magazines from members and friends of the Society. Now two members have generously established a fund for the purchase of new books; members and friends are invited to maintain the fund by regular contribution, thus making available to all Society members the more important new books on ornithology and related subjects. The fund will be administered by the Library Committee, which will be happy to receive suggestions on the choice of new books to be added to the Library. William A. Lunk, University Museums, University of Michigan, is Chairman of the Committee. The Library currently receives 104 periodicals as gifts and in exchange for *The Wilson Bulletin.* With the usual exception of rare books, any item in the Library may be borrowed by members of the Society and will be sent prepaid (by the University of Michigan) to any address in the United States, its possessions, or Canada. Return postage is paid by the borrower. Inquiries and requests by borrowers, as well as gifts of books, pamphlets, reprints, and magazines, should be addressed to "The Josselyn Van Tyne Memorial Library, University of Michigan Museum of Zoology, Ann Arbor, Michigan." Contributions to the New Book Fund should be sent to the Treasurer (small sums in stamps are acceptable). A complete index of the Library's holdings was printed in the September 1952 issue of *The Wilson Bulletin* and newly acquired books are listed periodically.

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LIFE HISTORY NOTES ON THREE TROPICAL AMERICAN CUCKOOS

ALEXANDER F. SKUTCH

The cuckoos of tropical America are a most interesting group of birds, comprising brood parasites and species which breed communally, as well as some which nest as isolated pairs. Yet the only members of the family for which we have somewhat detailed life histories from the American tropics are the Smooth-billed Ani (*Crotophaga ani*) (Davis, 1940*a*), the Groove-billed Ani (*C. sulcirostris*) (Skutch, 1959), and the Guira Cuckoo (*Guira guira*) (Davis, 1940*b*). I have long had in my notes observations on the Squirrel Cuckoo (*Piaya cayana*) and the Lesser Ground-Cuckoo (*Morococcyx erythropygus*) which I have withheld from publication in the hope of rounding out my accounts by further studies. But nests of these birds are by no means easy to find—year after year I searched in vain for another nest of the widespread Squirrel Cuckoo—and it seems best to put on record such information as I have about these birds, without indefinite delay. Some long-unpublished observations on the Smooth-billed Ani also seems worthy of inclusion in this report.

SQUIRREL CUCKOO

Cuckoos, at least the American species, are nearly all birds of pronounced character, easy to recognize by appearance or by voice. The Squirrel Cuckoo (*Piaya cayana*) is no exception. It is a fairly large bird, 16½ inches in length, nearly 11 of which are accounted for by its long tail. The upper plumage is rich chestnut, paler on the head, and deepening into bay on the tail, the strongly graduated feathers of which are broadly tipped with white and crossed by a broad subterminal band of brownish black. The chin, throat, and upper chest are vinaceous-cinnamon; the breast, abdomen, and sides plain gray, deepening into slate gray on the flanks and thighs and slate black on the undertail coverts. The undersurface of the tail is blackish, except for the white tips. The bill and naked region about the eyes are yellowish green; the big eyes deep red; the legs and feet light bluish gray. The sexes are alike in appearance.

The species occurs over the greater part of continental tropical America from central México to western Perú, northern Argentina, and Trinidad. In Central America, the Squirrel Cuckoo inhabits the wettest as well as the driest districts and ranges from sea level far up into the mountains. In Guatemala it has been found as high as 6,300 feet (Land, 1962:272). In Costa Rica I have met it at 6,300 feet in the Tablazo Mountains in November and at 7,300 feet on the excessively wet northern slopes of Volcán Irazú in the same month. At Vara Blanca, farther west in the same volcanic range, it did not appear to be resident even as high as 5,500 feet. Here I failed to see a single individual from July to the beginning of March, when a few arrived in the neighborhood of my dwelling and stayed for several months, probably breeding, although I found no nest. In México, the Squirrel Cuckoo extends upward to 7,800 feet (Friedmann et al., 1950:133); in the Coastal Range of Venezuela, to about 5,000 feet (Schäfer and Phelps, 1954:61). Nearly everywhere this cuckoo is most abundant at low altitudes, rare above 4,000 or 5,000 feet.

The Squirrel Cuckoo avoids unbroken forest and is at home in more or less open country with scattered trees. It inhabits cultivated districts in general, where it is particularly fond of hedgerows, coffee plantations with open shade, pastures and dooryards with well-spaced trees, and abandoned clearings where here and there a taller tree, almost overwhelmed by a heavy burden of creepers, has managed to struggle up above the disorderly welter of swiftly springing vegetation. It often hunts through the tangle of vines at the forest's edge and even the crowns of trees a short distance within the forest, but it consistently shuns the dark undergrowth. In semidesert regions, the Squirrel Cuckoo is most likely to be found among the taller trees along watercourses and in low ground.

I cannot recall ever having seen one of these birds undertake a sustained flight. Its journeys are short and it moves along from tree to tree and bough to bough, with now and then a swift dart across an open space. It prefers to gain altitude by working from limb to limb rather than by a single effort; but when it finds itself at last far up a hillside or high in the crown of a tree and wishes to return to lower levels, it sets its short wings and, with its great tail streaming, makes a long downward glide, uttering sharp metallic notes as it goes. Squirrel Cuckoos never flock but live in pairs at all seasons. The members of a pair do not as a rule keep close company either in flight or while hunting through the vegetation, but straggle along one behind the other, often several trees apart, keeping contact by means of their voices.

Food.—The Squirrel Cuckoo is, so far as I have seen, exclusively an insect-eater. It hunts among the trees, bushes, and tangles of vines in a fashion all its own, which combines deliberate motion and careful scrutiny with sudden darts and leaps of sometimes amazing length. Keeping itself usually well concealed by the foliage, it turns its head slowly from side to side and scans the surfaces of the leaves with wide, deep red eyes until it spies something to tempt it into activity. Then by a sudden pounce it makes the prey its own. A caterpillar crawling over the lower surface of a leaf above its head may cause the cuckoo to leap vertically upward for a distance of several feet.

When it has deftly seized its victim, it returns to a convenient perch, against which it may beat its prey into quiescence before gulping it down; or it may merely mash the morsel between its yellow-green mandibles. Then it sits quietly, or hops in a leisurely fashion from bough to bough, all the while scrutinizing the leafage until something else excites it to more vigorous action. Or it may shift its position by running with short hops or longer bounds along a horizontal or ascending limb, thereby earning for itself the name of *pájaro ardilla* or "squirrel bird."

One morning I watched a Squirrel Cuckoo capture a phasmid or walking-stick insect about four or five inches long. The insect was gray, with short wings, the under pair bright pink in color. It slipped from the bird's bill and fell to the ground, but the captor dropped down to recover it, carried it to a neighboring branch, and pounded it before swallowing it whole. According to Todd and Carriker (1922:212), the food of *Piaya columbiana*, which is sometimes considered conspecific with *P. cayana*, consists almost wholly of walking-stick insects, especially the larger kinds. But in Central America, Squirrel Cuckoos capture many insects of other sorts: a large proportion of them are green, and caterpillars enter prominently into the birds' fare. Moths are also eaten. With incredulous amazement, I have from time to time watched a Squirrel Cuckoo pluck a spiny green caterpillar from the foliage. Some of the most excruciating, long-continued pain I have ever suffered was caused by accidentally touching the venomous branched spines which cover all the upperparts of such caterpillars. Yet after mashing it somewhat in its bill, the cuckoo nonchalantly gobbles it down!

Voice.—The vocabulary of the Squirrel Cuckoo is surprisingly varied, so that for a number of years after I first made its acquaintance, I continued to discover new utterances, which mystified me until I traced them to this versatile bird. The call most often heard is a clearly enunciated trisyllable uttered in a dry and seemingly derisive voice. As I have heard it in Costa Rica and Panamá, this call is well paraphrased by the word *jícaro* (pronounced *híc-ă-ro*, the name of the calabash tree, *Crescentia cujete*). As I write this, I hear a cuckoo calling so in the dooryard. The sudden staccato first syllable and the somewhat lengthened final syllable alone are audible; the short middle syllable fails to carry so far. Cherrie (1916:313) recorded that in the Orinoco region the native name for the Squirrel Cockoos is *piscua*, which would also be a good rendering of the call of the Central American birds if written with an accent on the final *a*, causing it to be pronounced *pees-coo-aáh*. This was evidently the call which Chapman (1929:62), writing of Squirrel Cuckoos on Barro Colorado Island in the Panamá Canal Zone, set down as a "dry *piscátaqua piscátaqua*"; but I have not been able to detect a fourth syllable in our local birds' utterance. In Honduras I wrote this call as *wheék wheeu*;

but at an interval of years I cannot be sure that my different paraphrase represents an actual variation in the language of the cuckoos at points so far separated as Costa Rica and the northern coast of Honduras. Although the *jícaro* call is often loud and far-carrying, it may be given intimately in an undertone.

Another common utterance of the Squirrel Cuckoo is a loud and seemingly mocking dissyllable. *Eee-kah* I have written it in both Guatemala and Panamá. The final syllable may be long drawn out. This is doubtless the utterance referred to by Chapman as a "little staccato crow, *chick-kaw*, one of the most characteristic of tropical bird-notes." It is probably this call or its equivalent which Sutton and Pettingill (1942:15) heard far north in México and described as "an imperative *creep-rear* or *keep-rear*, like one of the Derby [Kiskadee] Flycatcher's cries, but louder."

Another very different utterance, heard chiefly in the breeding season, consists of a monosyllable repeated many times over in measured cadence: *whip—whip—whip—whip* . . . ; or sometimes the note has sounded more like *wic.* It may be either loud and sharp or low and soft; or the opening notes in the series may be loud and clear, while succeeding ones become weaker until the last are faint and squeaky. I have heard this utterance throughout the length of Central America; it is probably this which Sutton and Pettingill heard in México and wrote as "a loud *kweep, kweep, kweep, kweep*," rightly suggesting that it was in the nature of a song.

Quite different again, and not so often heard, is the Squirrel Cuckoo's long-drawn churr or rattle, delivered with the bill widely open and the lower mandible vibrating. Then there is a single, sharp, staccato *peek.* While making a long downward glide on set wings, the cuckoo utters a series of loud, sharp, metallic monosyllables—a somewhat hawk-like note which perhaps ensures a degree of safety to the weakly flying cuckoo during the brief period when it exposes itself beneath the open sky, by making it seem what it is not.

Courtship.—Over the years, I have from time to time seen a Squirrel Cuckoo present an insect or caterpillar to its mate. Early on the sunny morning of 13 April 1944, while watching the birds of many kinds which swarmed among the shade trees of my small coffee grove, my attention was drawn by a cuckoo who bounded along a branch in characteristic fashion, holding in his bill a green insect of moderate size. He presented this to his mate, and as she grasped it, he mounted upon her back. Continuing to hold onto the insect at the same time as she, he rested on her for the better part of a minute. Then he attempted the nuptial embrace, leaning far over sideways and crossing his long tail beneath hers. The size of his tail made it necessary for him to lean much farther out to the side than most small birds do in coition. The grasp which both members of the pair had all this time on the insect apparently gave him essential support; without it, he must have had much difficulty in maintaining his balance as he bent his tail beneath that of his mate.

A little later, my eyes caught this pair of Squirrel Cuckoos as they perched side by side on a horizontal bough, tugging at a green caterpillar, which was stretched far out between them. Finally, it broke under the strain, with the lion's share remaining with the male, while the female retained and at length swallowed only a tiny end. A minute later, I learned the manner in which this tug-of-war had probably originated. The male found another green insect and offered it to the famale, at the same time attempting to mount upon her back. But she was not ready for more of this and sidled away from him, this time carrying off all the prize, which she swallowed. In Africa, a male Emerald Cuckoo (*Chrysococcyx cupreus*) presented a large hairy caterpillar to a female, displayed, then mounted her (Haydock, 1950). Friedmann (1956: 405) believed that the feeding of young by the parasitic Didric Cuckoo (*Chalcites caprius*) results from the cock's failure to distinguish grown fledglings from females of his species.

Nest building.—I have seen only four occupied nests of the Squirrel Cuckoo, and in addition I have watched two pairs working at structures that were not used. The sites chosen for these nests differed so greatly that I shall describe each of them. The first occupied nest was in the basin of El General, Costa Rica, at an altitude of 3,000 feet. It was eight feet above the ground in a dense hedge of lemon trees that separated a pasture from a roadway used by many horsemen and pedestrians. Here it rested on horizontal vines and branches, well screened from the road by foliage. The next three nests were on our farm at Quizarrá in the basin of El General, at an altitude of about 2,500 feet. One of these, on a sterile hillside which the preceding year had been sown with maize, was only 30 inches above the ground in a tangle of tall bracken fern (*Pteridium aquilinum*) and the straggling composite *Eupatorium vitalbae*. Another occupied nest was in a bushy abandoned pasture, where, at a height of 39 inches, it was supported by a tangle of bracken, the same straggling composite, and calinguero grass (*Melinis minutiflora*). Close by grew a small bush of *Piper* that gave the nest a little shade.

After the premature loss of the eggs that this nest held, 19 years passed before I noticed another nest of the Squirrel Cuckoo on this farm. On the surprisingly early date of 14 January 1966, after 10 rainy days had followed a dry interval at the turn of the year, I found a pair building in the top of an orange tree near our house. Their site was about 25 feet above the ground in a tangle of slender dead vines amid clustered foliage and ripe fruits. The birds brought a number of sticks and leaves but, as far as we could learn, they never laid here. On 22 January, I watched a pair of cuckoos, evidently the same, completing a nest in a clump of tall timber bamboos, about 300 feet from the orange tree. Situated about 40 feet up on an arching spray, amid crowded twigs and leaves, this latest structure was difficult to see from the ground and quite inaccessible to a human climber. But it was in sight of my study window and afforded the best series of observations I have made on the breeding of this elusive cuckoo.

Another nest site differed greatly from all the foregoing and was hardly typical—certainly it did not furnish the cuckoos with the kind of foundation they needed to support their loose accumulation of sticks and leaves. On 21 May 1935, Miss Helena Emerson called my attention to a pair of Squirrel Cuckoos who were carrying material into the crown of the large mango tree that grew behind the main building in the narrow clearing in the forest on Barro Colorado Island. She said that she had seen only one member of the pair fly back and forth carrying sticks into the tree, while the other remained concealed amidst the foliage. I hunted carefully in the treetop without finding a trace of a nest. Next morning I resumed my search, with similarly disappointing results. But later in the day I found the cuckoos at work. They had no sign of a nest; but one member of the pair perched on a twig, 40 feet up in the treetop, which apparently had been chosen as the nest site, while the mate fetched material. The active bird brought, in mixed order, long fine twigs broken from neighboring trees, and dead leaves chiefly from the mango tree itself, and passed these contributions to the partner who remained on the perch. The latter stuck them beneath her, whence they promptly fell to the ground, for the single limb offered no adequate support. The ground beneath the mango tree was soon littered with these wasted twigs. It was difficult to follow the movements of the cuckoos, for they were trying to build in the very top of the tree, whose abundant dark foliage screened them from view. I could not make sure that the same bird always brought material while the other did nothing but sit and arrange it—which in this particular instance consisted in dropping it to the ground. Doubtless, however, this division of labor was regularly followed; and by analogy with anis which I have watched build their nests, and with pigeons, I suppose that it was the male cuckoo who brought the building materials, while the female received and disposed of them. While working in the mango tree, this pair called *ick-a-yuc* or *jícaro*, the loud derisive *eee-kah*, and frequently the low, soft *whip—whip—whip—whip* . . . in measured cadence; and once I heard the long-drawn churr or rattle.

For a week, these cuckoos labored to build a nest in the top of the mango, but after so much work they had nothing to show but an increasing litter of dead twigs on the ground beneath the tree. The supposed male tirelessly carried sticks and dead leaves to his mate, and she continued conscientiously to drop them as fast as received. Each day she had a definite perch where she accepted them—the point where, no doubt, she fondly imagined that she could build a nest—but the place was changed two or three times in the course of the week. If she happened to be in another part of the tree when the male approached with a contribution for her projected nest, she hopped through the branches to her most recently chosen site, took the object from his bill, tucked it carefully beneath herself—and dropped it to the ground. Possibly she was a young cuckoo attempting to make her first nest, and learning by dearly bought experience that a Squirrel Cuckoo's nest requires fine, close-set branches as its foundation—not coarse, widely separated twigs, as in a mango tree.

At about five o'clock on the evening of 28 May, the female cuckoo laid an egg while perching on the twig from which she had most recently been dropping material intended for a nest. Quite naturally, the egg followed the nest materials to the ground and came to rest among them—where should an egg lie but on such materials? It broke with its fall, and I had an opportunity to examine, inside and out, my first egg of *Piaya*. A week earlier I had found another white egg which reached the ground beneath the mango tree with only a slight hole in one side. I had suspected that this had been laid by the cuckoo but was not certain of this until I could compare it with the egg dropped in my presence.

After the cuckoos had been building in this hopeless fashion for at least five days, I made a basket-like framework by tying forked twigs together, and fastened this in the top of the mango tree, where the birds had apparently determined to have their nest at any cost. If the cuckoos deigned to use this ready-made foundation, I thought that they had a fair chance of completing a nest. For several days they neglected it. But when I returned from the forest on the evening of 31 May, one of the guests at the laboratory told me that during the day she had seen one member of the pair sitting in my framework, while the mate brought sticks, which the former placed upon it. But even this foundation was too open to be successfully used by a bird so unskilled as the female cuckoo; most of the sticks that she laid in it slipped through the meshes and fell to the ground, with the result that next morning only two remained in position. To give these hard-working but inept birds a little better start, I picked up a handful of twigs that they had dropped and, interlacing them in the framework, made them stay. Later in the day, the cuckoos came and added twigs and dead leaves, until by evening they had made quite a respectable beginning of their nest. To my regret, my busy sojourn on Barro Colorado ended next day; but I like to believe that the cuckoos completed the nest that I had started for them in the mango tree, and brought up a family there.

These cuckoos did not, like so many building birds, work most actively in the early morning. They built—or tried to—chiefly during the latter half of the forenoon, and returned to their task at intervals through much of the afternoon, sometimes continuing to carry sticks until 1630. In their greater activity during the middle half of the day, they resembled their relatives, the anis.

The pair which built in the orange tree in January brought many green and yellowing leaves, some of which were plucked from nearby guava trees. They also took to the nest a small twig with several green leaves attached to it, and at least one dead twig. When this pair transferred their operations to the bamboo clump, they broke coarse dead twigs from neighboring trees and took them to the nest, one at a time. As far as I have seen, the Squirrel Cuckoo does not descend to the ground for building materials, but collects all it needs in the trees.

The completed nests of the Squirrel Cuckoo that I have seen in Costa Rica had a loose foundation or framework of long, coarse, straight, inflexible twigs. Upon or within this was piled a great mass of whole leaves, some brown and others green when the nest was newly built. Mixed with the leaves in the middle and upper portions of the nest were, in one instance, a few fine twiglets. The top of the nest is best described as a shallowly concave platform. One nest was about 7 inches in diameter (not including the projecting ends of the long twigs) and 2½ inches thick or high. The central mass of another nest was 6 or 7 inches in diameter by 4½ inches in height. The diameter of the shallow depression in the top was about 3½ inches.

The eggs.—Two of my Costa Rican nests contained two eggs each, and close by the third nest were two fledglings, which the children who found this nest told me had left that same day. Cherrie (1892:326) likewise recorded a nest with two eggs in Costa Rica. The Squirrel Cuckoo's eggs are pure white, with a somewhat rough and chalky surface. In shape they are ellipsoidal, with scarcely any difference between the two ends. Those of my first set measured 34.9 by 26.2 and 36.5 by 25.4 mm; of the second, 34.9 by 26.2 and 34.1 by 25.8 mm. Cherrie gave the measurements of eggs as 35 by 24 and 33 by 24 mm.

In El General, the Squirrel Cuckoo has a long breeding season. At the earliest nest, incubation began in late January of 1966. Two nests held eggs in April, and from another the nestlings left in early June. This cuckoo seems to nest chiefly from April to June, which is the main breeding period for the majority of the birds of this region. But on 20 October 1965 I found parents feeding a stubby-tailed fledgling in a treetop in our dooryard. They were probably the same pair that nested in the bamboo in the following January. Dr. John Emlen told me that, on the northern coast of Honduras, he had seen a Squirrel Cuckoo feed a fledging as late as 5 September 1930.

Todd and Carriker (1922:212) recorded a set of three eggs of *Piaya columbiana* taken at Bonda, Colombia, on 10 July. They described the nest as "a frail platform of coarse twigs, without special lining, placed in the fork of an oblique branch of a *Banisteria laurifolia*, and so thin that it would easily be possible to count the eggs from below." If this nest, in its thinness and the absence of leaves differing greatly from those of the Central American Squirrel Cuckoo, is typical of *P. columbiana*, it furnishes an additional reason for considering this form to be specifically distinct from *P. cayana*.

Incubation.—Within a day or two after being laid, the immaculate white surface of the eggs becomes stained with brown from contact with the green leaves on which they rest. The heaviness of the staining increases from day to day, and long-incubated eggs are mottled with deep stains of brown. May not the function of the leaves be to cause these stains which mask the glaring whiteness that makes newly laid eggs so conspicuous in their shallow, open nest? By this device the cuckoos compensate for the failure of their oviduct to secrete pigment for the shell. They bring a few additional green leaves from time to time until the nestlings hatch. Meanwhile, small ants take shelter between the layered leaves which form most of the nest's bulk, and establish thriving colonies beneath the incubating birds.

The great tail of the incubating Squirrel Cuckoo, held tilted upward at a sharp angle, is a conspicuous object. Usually the bird sits steadfastly and permits a close approach by man, sometimes even permitting him to touch the tip of its long tail before it jumps from the nest. Then it may perch close by and twitch its head in a most peculiar fashion, while it watches the intruder. I have never known a Squirrel Cuckoo to protest my visit to its nest by voice or any more vigorous demonstration; it flies a good way off before calling to its mate. One cuckoo continued to cover its eggs while it watched me set a blind five or six yards away, an operation which necessitated cutting a certain amount of vegetation. I was confident that I should have no difficulty studying the mode of incubation at this nest; but for all its staunchness while attending its eggs, the cuckoo is canny. Stealing away without putting the bird from its nest, I left the blind in place the greater part of that day and through the following night. But when I returned at dawn with high anticipations of passing an interesting day and learning things I had long wanted to know about the elusive Squirrel Cuckoo, I found to my dismay that the eggs were unattended, cold, and wet. The birds had not resumed incubation by nine o'clock, when I removed the blind. Next day the eggs had vanished, apparently taken by some predatory animal. At the other nest with eggs, where I touched the tail of the sitting cuckoo, the density of the stand of bracken fern made it necessary to place my blind very close and to disturb the surrounding vegetation more than I liked. The birds stayed from their eggs as long as the blind was present, but returned after it was removed.

Accordingly, it was not until many years later, after this paper had been accepted for publication, that at the high nest in the bamboo I succeeded in learning some of the details of incubation. Although the body of the sitting cuckoo was invisible from the ground, its long tail often revealed its presence. On the evening of 22 January, the day when I found the pair actively building here, one of them was on the nest, where it remained through the night. On 23, 24, and 25 January, I frequently saw a cuckoo sitting; but sometimes, if present, it was invisible because its tail projected on the far side of the nest. On 26 January, I watched continuously from dawn until nightfall. The parent who passed the night on the nest stayed until replaced by its mate at 0650. The latter then sat continuously for six hours and 23 minutes, or until 1313, when it silently left. After only 12 minutes of neglect, the eggs were covered, at 1325, by one member of the pair. Now began a period of restlessness, the two partners replacing each other at 1327, 1329, 1433, and 1529. At all but the last of these changeovers, the returning partner brought a stick or a green leaf to the nest. The bird who went to the eggs at 1529 sat continuously until it grew dark.

I also watched this nest through the whole of 28 January and from daybreak until late in the afternoon of 30 January. From these observations it appears that, after the routine of incubation is well established, the two partners exchange places only twice each day and keep their eggs continuously attended. On 28 January the changeovers occurred at 0746 and 1535, so that the day shift lasted seven hours and 49 minutes. On 30 January, the changeovers were made at 0901 and 1612, and the day shift continued for seven hours and 11 minutes. The partner who went on the nest in the afternoon stayed at its post until relieved by its mate next morning. I could not tell whether the cuckoo who incubated through the night was the female or, as in the anis and some other members of the family, the male.

Sometimes the partner arriving to begin its long spell of incubation brought a leaf or a stick, but at other times it came with empty bill. The changeover was effected in silence, or with the utterance of a low *jícaro*. Although mostly it incubated silently, occasionally the sitting bird would call softly *whip whip whip* . . ., at the same time twitching its long tail feathers. These calls were especially likely to be heard as the time for its relief approached. Rarely the cuckoo rose from its eggs to hop around the nest and resettle on it facing in a different direction.

At the low nest found in April of 1943, both eggs were pipped 18 days after the second had been laid. Next day both shells had been pierced by the bills of the chicks trying to escape. Then the eggs were inexplicably deserted and never hatched. These observations would make the period of incubation about 19 days, but possibly it was somewhat lengthened by the disturbances caused by my unsuccessful attempt to use the blind and by the daily passage of laborers along a path close by the nest.

The nestlings.—After the desertion of these eggs on the point of hatching, ants entered through the perforation in the shell and killed the chicks within, if they had not already died from exposure. I opened an egg and found that the dead embryo's blackish skin bore sparsely scattered, hair-like down feathers. Similar natal down is present in cuckoos of the genus *Coccyzus*, but anis (*Crotophaga*) are quite naked when they hatch.

I did not learn just when the eggs hatched at the high nest in the bamboo, but by 13 February the parents were bringing food to it. In the first 5¼ hours of the morning, they came only four times, on each visit bringing a single massive insect. This regimen of infrequent but surprisingly large meals was maintained so long as the young remained in the nest. After another week, I frequently saw a single feathered nestling as it stood up to flap its wings or rested on the nest's rim, never two, although two nestlings may have been present at the beginning. From 0545 to 1100 on 19 February, this nestling was fed only four times, by both parents; and during the morning of the following day it received five meals. The winged or larval insects were usually green but sometimes of a darker color and were often badly mangled when the parent arrived with them. One meal consisted of a large green caterpillar bristling with stinging spines. After it was feathered, the nestling flapped its wings vigorously while taking its food on or beside the nest. Its open mouth revealed a bright red interior. Occasionally, after delivering food, the parent carried away a dropping.

I first glimpsed the nestling when it rose up to receive a meal on the morning of 19 February. It was already well feathered, with conspicuous white tips on its short tail feathers. Nevertheless, the parents continued to brood it much, through the night and in the morning until well after sunrise, in the late afternoon, and whenever it rained. On the showery afternoon of 21 February, I saw a parent brooding for the last time. The following day the young bird was out of the nest.

In contrast to many other birds, the young Squirrel Cuckoo's separation from its nest was a gradual process. As early as 19 February, it sometimes rested beside rather than in its nest, or hopped rapidly around or over it, amid the close-set bamboo twigs. While perching on the rim, it spent many minutes assiduously preening and scratching; then it would settle down in the nest where I could not see it. By 22 February it seemed to be spending most of the day perching or hopping amid the crowded bamboo shoots near its nest, to which from time to time it returned. When it was out of sight, I could not tell whether it had wandered farther off or was resting inside the nest. After it had spent two days in this manner, it moved away.

The fledglings that I saw close by the nest in the lemon tree that they had just left rather closely resembled their parents in plumage, but their tails were still rudimentary. Their eyes were brown instead of red as in the adults, their bills grayish horn-color, and the bare orbital region gray instead of yellowish green. At intervals these young cuckoos called out *eee-ka* very sharply. Their parents remained prudently out of sight while I was present. The nest and its surroundings were only slightly soiled by the droppings of the young cuckoos who had so recently left it, but this may have been in part a result of washing by the torrential rains of that period. The wet leaves in the lower part of the nest swarmed with ants, a variety of insect larvae, and other small creatures.

LESSER GROUND-CUCKOO

The Lesser Ground-Cuckoo (*Morococcyx erythropygus*) is a slender bird about 10 inches long. The general tone of its upper plumage, including the wings and tail, is brown, with bronzy and greenish reflections on the long central rectrices. The under plumage, from the chin and sides of the neck to the abdomen, is tawny-rufous. Each dark eye is surrounded by a yellow orbital ring, in front of which is a triangular area of bare yellow skin, while behind it is a similar area of bright blue skin. Each eye with its surrounding areas of featherless skin is enclosed by two black lines, which diverge from the base of the bill, curve over and under the bare patches, and meet again near the ear. To complete the striking color pattern of this bird, the rather slender bill is yellow, with a blackish band along its strongly downcurved culmen, and the legs and toes are bright orange-tawny.

One of the typical members of the Arid Tropical Avifauna of México and Central America, the Lesser Ground-Cuckoo ranges from the Mexican state of Sinaloa to northwestern Costa Rica. On the Pacific Coast, from the mouth of the Gulf of Nicoya northward, its distribution seems to be fairly continuous, but on the rainier Caribbean side of Central America it is largely confined to deep valleys, such as the middle reach of the Río Motagua in Guatemala, where enclosing mountain barriers intercept the rain-bearing winds and arid conditions prevail. In altitude, the ground-cuckoo ranges from sea level up to 4,000 feet in México (Friedmann et al., 1950:135) and somewhat less in Costa Rica. In this country, it is most abundant in the lowlands of Guanacaste and about the Gulf of Nicoya, where the dry season is long and severe. In the driest parts of its range, as in the Motagua Valley, the ground-cuckoo lives among cacti and sparse thorny scrub; in regions of heavier vegetation, it lurks in low dense thickets, such as occur on abandoned patches of cultivation, neglected pastures, and in the more open parts of light woodland. I have even found it in thorny thickets just inland from the beach and at the edge of a mangrove swamp.

Habits and voice.—While I stood watching a pair of Rufous-naped Wrens (*Campylorhynchus rufinucha*) building their nest in a thorny *Pereskia* tree in the arid Motagua Valley on 15 July 1932, I heard a low, weak whistle, repeated again and again. Tracing the notes to their source, I spied a bird of unique aspect walking over the ground beneath the spreading, orange-flowered tree. By its slender form, long tail, bare skin around the eyes, and curved bill, I at once recognized this bird, new to me, as a cuckoo, a conclusion which was strengthened later, when it flew up to a perch and I noticed that two toes on each foot were directed backward. The cuckoo walked sedately over the patches of bare ground between the low, scattered bushes, picking up whatever it could find to eat, and once it jumped several feet straight into the air, to snatch some insect from the foliage. At intervals the bird paused and, raising its head, uttered a low, mellow whistle that seemed to come from far away, although I was not 20 feet from it. When calling, it hardly opened its bill. From the distance came a faint answering whistle. Not in the least shy in my presence, the cuckoo continued to forage with no sign of constraint while I watched, fully exposed to its view, only six or eight yards away.

After a while, the cuckoo jumped into some bushes, where it rested a few minutes before it descended to the ground on the other side and began to toy with some fallen twigs. Finally it selected some very fine ones and walked away with them in its bill. I was elated by the prospect of finding a nest of this new bird still under construction, but it dropped its burden before it disappeared among low bushes. Disappointed, I followed through the shrubbery until, from a low bush on my left, a bird burst forth so suddenly that I had only a fleeting glimpse of it. Peering into the shrub, I found a nest.

The Lesser Ground-Cuckoo has other notes which I did not hear from this bird in the Motagua Valley. At the edge of a low, dense thicket on the Peninsula of Nicoya, a cuckoo perched a few feet above the ground while it tirelessly repeated a full, rather deep, pensive whistle. Then it delivered a high, clear, stirring, trilled whistle, clacking its mandibles together while it emitted the notes.

Nest and eggs.—The nest to which I was led by the first Lesser Ground-Cuckoo that I ever saw was situated on the ground, well concealed beneath a low, densely branched shrub rounded by browsing cattle, beside a dry watercourse in a pasture. It was a shallow bowl, loosely made of dry petioles and fine sticks, and lined with fine herbaceous materials, mostly in short lengths. The inside of the bowl was 3¼ inches in diameter by 1¾ inches deep. There were two white eggs with a chalky surface that could be scratched off by a fingernail. These eggs measured 27.0 by 20.6 and 27.8 by 21.0 mm. This nest, discovered near El Rancho in the Motagua Valley of Guatemala, elevation 900 feet, on 15 July 1932, is the only nest of the Lesser Ground-Cuckoo that I have seen, or of which I have found a record.

Incubation.—The chalky eggs in the crudely constructed receptacle left no doubt that I had found a cuckoo's nest; but I had had only the most fleeting glimpse of the bird that I had frightened from it, so to confirm the identification I returned cautiously a quarter of an hour later. A ground-cuckoo was covering the eggs, where it remained steadfastly while I bent over it for a closer view. Then the bird ran rapidly from the nest; but after going only three yards, it abruptly slowed down and walked deliberately away, as though with a painful effort. On a fallen log five or six yards from me, the cuckoo paused, to remain quietly while I wrote a description of the nest and measured the eggs.

When I revisited the nest in the afternoon, the incubating parent did not leave until my inclined head was almost above it. This time it walked away even more deliberately than before, with little mincing steps, until it reached a bare, sandy area beneath an organ cactus. Here it stopped, puffed out its contour feathers to make itself look bigger, relaxed its wings, depressed its fanned-out tail, and moved back and forth several times with short, slow steps. Although it did not grovel, beating the ground with its wings in a typical act of injury simulation, it was clearly trying to lure me from its nest by a distraction display. When I approached, it slowly retreated beneath some bushes and passed beyond view.

A few days later, a parent (whether the same or not, I could not tell) gave a somewhat different display after leaving the nest when I came close. This time it walked deliberately away for several yards, then, still in full view, crouched on the ground with fluffed-out plumage and spread, depressed tail. In this attitude it vibrated its relaxed wings, beating them against its own body rather than the ground, which it seemed to scratch with its feet. When I followed, the cuckoo moved off until out of sight. On another occasion, the cuckoo left the nest, as I approached, by jumping two feet into the air, then alighted on the ground and walked away.

Since I had not succeeded in distinguishing the two parents by their appearance, I tried to mark one of them before starting to study their mode of incubation. Using a method that I had employed successfully with Groove-billed Anis, I covered the end of a short twig with cotton, soaked the cotton in white enamel, and stuck this improvised paintbrush into the nest, with its end projecting over the eggs. When I returned 15 minutes later, I found that my brush had been carried away, doubtless by the cuckoo who was now sitting on the eggs with no visible spot of white on its plumage. A second attempt to mark a parent by the same procedure was similarly unsuccessful. The cuckoos sat so closely that I thought I might touch their backs with a wad of paint-soaked cotton on the end of a long, slender stick; but while the approaching object was still six inches away, the bird jumped from the nest and fled. Later I discovered that, while removing the short paintbrush, one of the parents had acquired a white mark at the base of its bill. I designated this bird as "A" and its mate as "B." I was eager to learn whether, as in anis, the male took charge of the nest through the night, but I was uncertain how I could determine the sexes of A and B without watching one of them lay an egg for a subsequent brood. In this manner, I have learned the sexes of several Groove-billed and Smooth-billed anis.

Having placed a distinguishing mark on one of the parent ground-cuckoos and set my blind before their nests, I watched continuously from 0700 to 1412 on 16 July. Cuckoo A, who had left the nest as I entered the blind, returned at 0743. At 0930, it turned the eggs and shifted its position, very slightly, for the first time in nearly two hours. When a half-grown calf walked within a yard of the nest, the incubating bird sat firmly. At 1015, it began to whistle, the notes at first very low but gradually becoming louder. At intervals its mate answered from the distance, and after a while these whistles sounded nearer. At 1024, B approached from the bushes to my left, flying low across the arroyo beside which the nest was situated. The newcomer alighted several feet from the nest, its bill full of fine material for the structure, and A left. Cuckoo B continued to approach the nest by walking, but when about two feet distant it seemed to suspect the blind, turned around, and marched away. But at 1041 B returned afoot, now with empty bill, and covered the eggs.

Cuckoo A had incubated continuously for two hours and 41 minutes when B arrived to replace it. Cuckoo B now sat for three hours and 26 minutes, never shifting its position nor turning the eggs in all this long interval. In the early afternoon, when the sun's nearly vertical rays reached the bird through the branches of the sheltering bush, it panted with open bill. Finally, at 1407, B deliberately arose, walked from the nest, and after proceeding a few steps called to its mate, whose voice had for some minutes been sounding in the distance. At 1412 A arrived, marching over the ground with a billful of fine material, which it added to the nest's lining. When the newcomer was comfortably settled on the eggs, I left.

My observations on this nest were interrupted by a bout of fever, which for parts of the next two days kept me in bed. The day after I resumed my study, the eggs vanished from the nest, leaving only a broken shell on the bare sand a few feet away. Before this tragedy occurred, I had learned that cuckoo A, who sat more steadfastly than B, passed each night on the nest. Apparently, incubation followed a simple schedule, A being in charge of the eggs most of the time, while B took a turn of three hours or more in the middle of the day. From my experience with anis, I had little doubt that A, the more devoted parent, was the male. But the loss of the nest, and the continuing fever which drove me up into the more healthful highlands a few days later, prevented the confirmation of these preliminary conclusions.

SMOOTH-BILLED ANI

The Smooth-billed Ani (*Crotophaga ani*), a long-tailed black bird with a high-arched, laterally compressed bill, has so often been figured and described that it hardly needs an introduction to the readers of this paper. In contrast to the two foregoing cuckoos, about whose breeding little or nothing has been published, this bird of strange appearance and curious communal nesting habits has, over a period of nearly two centuries, acquired a fairly voluminous literature, much of which is based on casual and uncritical observations. One of the best of the early histories of the ani is that of Gosse (1847). Recorded information on the habits of the ani up to 1939 is well summarized by Bent (1940); and at about the same time, Davis (1940*a*) published the most complete study of the life history of this species that has come to my attention. His field work was done in Cuba. Since on the mainland of tropical America the Smooth-billed Ani has been less thoroughly studied, it seems proper to put on record observations which I made on a small colony on Barro Colorado Island in 1935—the same colony whose fortunes Chapman (1938) followed, chiefly during the two ensuing years. A concluding section deals with the range expansion of the Smooth-billed Ani in southern Costa Rica during the last quarter-century.

The colony on Barro Colorado.—On a brief visit to Barro Colorado Island on 8 and 9 June 1929, I found a nest of the Smooth-billed Ani, with three nestlings about five days old, in the clearing in front of the main building. When I next visited the island in December of 1930 and January of 1931, four anis dwelt in this clearing, which was several acres in extent, bordered on three sides by forest into which the anis never ventured far, and on the fourth by a wide expanse of the open water of Gatún Lake, across which they were never seen to fly. Hemmed in between the woodland and the water, this small colony was rather effectively isolated. It seemed barely to maintain itself in an environment which subsequent experience showed to be far from favorable.

When I returned to Barro Colorado on 6 February 1935, three anis were present in the clearing. Dr. Frank M. Chapman told me that earlier in the year there had been four. On 1 February he had found a nest, situated six feet above the ground in a small orange tree growing on the steep grassy slope of the banana plantation, above the shore of the cove in front of the main building. It then contained two eggs, but the birds were bringing additional material and building up the structure. Chapman kindly placed this nest at my disposal for study. When I first saw it on 7 February, it was a roomy open cup, built largely of interlaced coarse twigs, and lined with leaves, many of which were still green—a typical anis' nest. It contained only three eggs, but later I noticed beneath the orange tree four eggs which had evidently been laid before I came and had somehow fallen from the nest. On 13 February the last egg was laid in this nest, which then contained nine eggs, which with the four on the ground made 13 that had been laid here.

These eggs were of the familiar ani type, oval or elliptical–oval in shape, with a pale blue or blue–green shell covered by a chalky white deposit that was easily scratched off and became darkly stained from contact with the withering leaves on which the eggs rested. The four fallen eggs were unbroken. When opened, one at least contained a small embryo, whose heart was beating after it had lain at least five days on the ground, demonstrating remarkable resistance to exposure. The number of eggs in and beneath the nest convinced me that two females had been laying. Since some of the eggs were fertile, a male must have been present. Hence I concluded that the group attending this nest consisted of two females and a male. Subsequent observations proved this assumption to be correct.

It seemed desirable to mark these anis in order to distinguish them individually. This was before the days of mist nets and all the methods that can be used for marking birds when one has them in his hand. Since I could not catch the anis, I stuck into the nest a little stick whose end, projecting over the eggs, bore a bit of cotton soaked in white enamel. I left it there much of the morning, replenishing the paint from time to time. All the anis rubbed against it and acquired white marks, but in varying degrees. All had pulled or bitten the cotton in an effort to remove it from the nest, as revealed by the paint on their black bills, but they did not succeed in carrying it away. At noon I took away the offending object.

One of the anis was well bedaubed with white on its crown, face, neck, and body. When I saw that this bird, who evidently had made the greatest efforts to remove the paintbrush, also took charge of the eggs through the night, I called him "Whiteface," the name I had given to a male Groove-billed Ani whom some years earlier I had marked in similar fashion. This earlier Whiteface had also incubated by night, and was more valiant than his mate in defending the nest. The present Whiteface was so extensively whitened that numerous other epithets having reference to this color would have been equally appropriate. His two partners were dubbed "Whitethroat" and "Whitebrow" from the marks they had acquired. I surmised that they were females, and at a later nesting proved this by watching them lay.

Incubation.—After the three anis were marked and easy to recognize, and had recovered from the excitement caused by the foreign object in the nest, I entered my blind to learn what share each would take in attending the eggs. I watched from 1335 until dusk fell at 1845 on 16 February, and next morning from daybreak at 0615 until 1241. Whiteface settled on the nest at 1708 on 16 February and remained sitting quietly while the sun set and the light waned. Next morning he continued to sit for about an hour and a half after early birds had become active, not leaving until he saw Whitebrow and Whitethroat approach together at 0745. Thus he had incubated continuously for 14 hours and 37 minutes. During the day, however, his two mates were in the nest far more than he. Whitethroat took three turns at incubation, sitting for 127, 49, then 94 minutes, making a total of 270 minutes. Whitebrow also sat thrice, for 1, 94, and 25 minutes, or a total of 120 minutes. Whiteface's three diurnal sessions lasted only 12, 4, and 23 minutes, a total of 39. The trio of anis had no regular system of alternation on the eggs, for any one might follow any other. Each did not always sit until the arrival of another to replace it, with the result that the eggs were left uncovered for periods of 3, 11, 24, and 7 minutes, a total of 45. They were, however, kept covered for 90.5 per cent of the slightly more than eight hours of my watch which fell within the period when the attendants were replacing each other on the nest—that is, during the time not included in Whiteface's long overnight shift.

Each of the three anis twice brought a green leaf when it came to take charge of the nest. Once Whiteface passed the leaf to Whitethroat, whom he had come to relieve. The latter carelessly placed it beside the eggs which she had been covering, then apparently with reluctance left the nest and flew away, calling, while Whiteface settled on the eggs. The other leaves were placed in the nest by the bird that brought them, sometimes carefully tucked beneath the eggs, sometimes negligently dropped down beside them. Once, while Whitethroat incubated, Whiteface and Whitebrow perched side by side in the top of the nest tree, and each in turn stretched up its neck with the feathers erected, while the other preened them. Whitethroat gave no indication of jealousy when Whiteface showed this delicate attention to his other mate. I never noticed a sign of rivalry or disagreement between these three birds.

One of the eggs which had been present when I first saw the nest on 7 February hatched on 21 February. The following day two more eggs hatched, including one which had been laid on 10 February. The incubation period of this last-mentioned egg was not over 15 days. The set had not been completed, however, until 13 February, and probably full-time incubation did not begin until this date, or even later. Unfortunately, the last egg, which would have given the most accurate determination of the incubation period, did not hatch. Only three of the nine eggs in the nest produced nestlings; and when several more days passed and the others gave no sign of life, I opened them. None contained an embryo.

Davis (1940*a*) found the incubation period of the Smooth-billed Ani to be about 13 days. By changing eggs in a nest, he caused a group of three anis to continue incubation for 24 days—almost twice the normal period. Although he had under observation numerous nests containing from 10 to 29 eggs, in no instance did more than eight hatch, apparently because the others were not effectively warmed by the incubating birds, for he never found an infertile egg. Groove-billed Anis do not often lay more than eight eggs in a nest, and at one nest that contained eight, they hatched the entire set (Skutch, 1959).

The nestlings.—The newly hatched anis in the orange tree had tightly closed eyes and perfectly naked black skin; they lacked even the stiff, hair-like down worn by newly hatched cuckoos of the genus *Coccyzus*. Their development was amazingly rapid. On the day after hatching, the sheaths of the remiges and rectrices began to protrude from the skin. Two days after hatching, the sheaths of the contour feathers were also emerging from the skin and the eyes were open. The pinfeathers on wings, tail, and body became very long before they began to release the true feathers which they enclosed. When the young ani was five days old, its body feathers began to emerge from the tips of their sheaths. At this age it could hang by one foot from my finger, and pull itself up by using its feet and bill, which was hooked over the support. When placed on the ground, it tried to crawl away through the grass, and might have escaped if I had not been alert to catch it. When I replaced it in the nest, it would not stay down in the bowl, but persisted in climbing up to perch on the rim. It uttered a little whining note.

The following day, when the surviving nestling was six days old, it hopped from the nest as I came near and began to climb through the thorny branches of the orange tree, but it soon lost its hold and fell to the ground, where it tried to scramble away through the grass. When I took it in hand it struggled to escape, at the same time uttering an infantine version of the usual call of the adults; but I quieted it by stroking its back. Both the body and flight feathers had lengthened considerably since the preceding day and were now expanding rapidly; but much bare skin was still visible between them. I replaced the young ani in its nest and persuaded it to stay, at least until I was out of sight. The other nestlings had vanished within two or three days of hatching and this was the only survivor. The following day it, too, had disappeared from the nest. It was then a week old, fairly well clad in feathers, and sufficiently agile to take care of itself by clambering through dense vegetation. But I looked in vain for it, and at last reluctantly concluded that it no longer lived.

Whiteface, the male parent who had incubated the eggs during the night, also brooded the nestlings through the hours of darkness. When I approached the nest, he became more excited than the two females and once, when the oldest nestling was two days of age, he alighted for a moment in the little nest tree while I was at the nest. He would also fly around quite close to me, voicing an angry *grrr*. Perching on a neighboring tree, he often uttered his high-pitched whining call, which was repeated by the two females, who consistently stayed farther away from me. When the nestling was a few days older, Whiteface did not venture quite so close to scold me, although all three parents still showed much concern whenever I visited the nest. In the more courageous conduct of the male when the nestling appeared to be in peril, these Smooth-billed Anis agreed with a pair of Groove-billed Anis whose sexes I could distinguish. But Whiteface never attempted to strike me when I went to his nest, as the Whiteface with the grooved bill for whom he was named had repeatedly done.

After the disappearance of the last nestling, Whiteface joined the two females at their roosting place, a low bush with dense foliage growing on the shore of the lake, about 100 yards from the nest tree. Here the anis slept in close company with Vermilion-crowned Flycatchers (*Myiozetetes similis*), Cayenne Flycatchers (*M. cayanensis*), and Tropical Kingbirds (*Tyrannus melancholicus*).

At a nest containing nine nestlings hatched from eggs which had apparently been laid by only two females, Davis (1940*a*:194) observed that nine of the 15 birds in the group were bringing food. He found that the fledglings return to the nest for the first two nights after their initial departure. A single parent sleeps with them for several nights after they have left the nest but still linger in the nest tree. After the young can fly, the adults take them out to the feeding area and the whole flock roosts there. The young are fed by the parents for about a month after leaving the nest. In Cuba, a single group of birds may raise three broods in a season. The young of earlier broods remain with the parents while they attend later broods and may feed the nestlings, although less actively than the adults. In one instance, juveniles only 48 days old helped to feed the following brood. The ani's instinct to build is likewise manifested at an early age: in Florida, a hand-reared young bird carried about sticks and straws and arranged them on the ground when only about six weeks old. This foundling Smooth-billed Ani made an attractive, responsive pet (Merritt, 1951).

Laying and the identification of the sexes.—The loss of all their offspring from the orange-tree nest was the first of a long series of misfortunes that befell Whiteface and his two mates. On 15 March, 12 days after the disappearance of the last nestling, I found the trio working on a new nest in a low, dense bush standing on the shore of the lake, between the first nest and their roosting place. Two days later, the new nest contained an egg, which remained alone for two days and then vanished, on 20 March. On 28 March, I noticed their third nest, eight feet up in a small orange tree growing in the grassy clearing, a few yards from the bush that held the abandoned second nest. They apparently built this nest, or at least enough of it to hold an egg, in a single day; for on 24 March I had looked in this little tree and found no nest, but returning in the afternoon of the fourth succeeding day, I saw the completed structure with four fresh eggs which, to judge by the dates of laying of the subsequent eggs, must have been deposited on 25 and 27 March, two on each of these days.

It was at this nest that I succeeded in learning the sexes of these three anis in a manner which left no room for doubt yet left the birds alive for further activities and studies. I already knew that anis lay around midday, so at 1130 on 29 March I entered my blind to watch the laying of the eggs. The paint marks on Whiteface were still unmistakably conspicuous. Of the other two, one still bore a small but distinct white spot on the left wing which revealed her identity as Whitebrow. The third ani had lost all traces of white but was evidently Whitethroat. At 1230, Whitebrow entered the nest, which still contained the four eggs, each with an identifying mark. At 1233, she left as Whitethroat arrived to sit in the nest. The latter remained until 1258, and while she sat Whiteface brought and delivered to her a bit of weed stem, then a green leaf, both of which she arranged in the nest. When Whitethroat flew from the nest at 1258, Whitebrow returned to occupy it, remaining for 55 minutes while Whiteface brought her a green leaf, then a stick, then two more green leaves, all of which were duly added to the structure.

At 1353, Whitebrow ended her long session on the nest. Whiteface promptly flew toward it. But as it was of the utmost importance to see what the nest held before he had a chance to sit, I hurried from the blind and reached the nest ahead of him, finding two fresh, unmarked eggs that had been laid since 1230. Since Whitethroat and Whitebrow both laid eggs, some of which were fertile, Whiteface was undoubtedly the male of the trio. During the night of 30 to 31 March, he incubated the six eggs, and by 1255 next day two more had been laid, completing the set. By 7 April, only three of these eight eggs remained in the nest, and two days later all had vanished.

At the first nest of these anis, in the orange tree, one female had evidently laid seven eggs and the other six. At the nest where I watched the laying, each female produced four eggs. According to Davis (1940*a*:200), in Cuba each female lays from four to seven eggs in a set. At the first nest on Barro Colorado in 1935, an egg was laid between 1140 and 1340, and another was deposited before noon. At this nest, an egg was added daily during four days, and since two females were producing them, each apparently laid at two-day intervals, as at the later nest; but in this case the two alternated with each other instead of both laying on the same day. The Groove-billed Ani also deposits its eggs in the middle of the day, at two- or three-day intervals (Skutch, 1959).

Further history of the colony.—For nearly a month after the loss of their eggs in early April, the three anis on Barro Colorado apparently suspended their efforts to rear a family. But on 6 May I found their fourth nest, already containing a single egg. It was in a clump of the marsh fern, *Acrostichum*, growing in swampy ground at the edge of the cove and about 50 feet from the third nest. On 7 May there were two eggs in the latest nest, but by 9 May it was empty.

During the next five days, the three anis must have been exceedingly busy. They started another nest in the orange tree that had held the first, but abandoned it after placing a few sticks. Next they took some sticks to another orange tree a few yards away, but this project of building was also given up at an early stage. Then they rapidly completed their fifth nest, in the midst of a dense clump of tall grass growing in shallow water along the shore, about 75 feet from the fourth nest. When found on 14 May, it already held three eggs, but three days later it was empty. Possibly a few more eggs had been laid in the interval.

A week later, on 24 May, these anis had a sixth nest in a lemon tree, 15 feet from the site of their first, and it already contained seven eggs. I had never learned what despoiled the anis' nests, but I believed it to be some flightless creature. Accordingly, in an effort to save this latest nest, I surrounded the base of the nest tree with a tall cylinder of sheet iron, setting the bottom firmly against the ground so that, I believed, no snake could force its way beneath it; and I doubted whether serpent, lizard, or small mammal could scale the slippery upright wall. While I was engaged in arranging the protective barrier around the lemon tree, *four* anis perched in a neighboring tree to watch me. The new arrival had apparently come from the mainland, possibly crossing to Barro Colorado at Salud Point, where only a narrow stretch of open water separated the island from Buena Vista Point on the mainland, thence working along the shore of the island to the laboratory clearing. At least, this route seemed more likely than that the new arrival flew across the mile or two of open water of Frijoles Bay, or that it crossed the wide expanse of unbroken forest that enclosed the clearing on the other three sides. The newcomer seemed already to have been accepted as a member of the group; and I hoped that with this increase in force and the protection that I had given them, their efforts to reproduce would at last be crowned with success. But on 28 May three whole eggs and at least three broken ones lay on the ground beneath the empty nest. A few days later, I left the island.

Between 1 February and 24 May, the three anis had built six nests and started several more which they did not complete. The two females (possibly with the help of another at the very end) had laid at least 34 eggs and possibly several more that vanished before I saw them. The intervals between the disappearance of the eggs from one nest and the first laying in the following nest were in some instances surprisingly short: about five days between the second and third nests; only three or four days between the fourth and fifth nests: evidently less between the fifth and sixth. Davis (1940*a*:192) found that laying was resumed in a new nest about five to 14 days after the loss of the eggs from an earlier nest.

The Smooth-billed Ani in Costa Rica.—Although the Pacific side of Central America, as of México, is generally semiarid, with a long and severe dry season that limits the development of the woodland. Costa Rica south of the Gulf of Nicoya is a region of higher rainfall and heavier forest, which over large areas rivaled the rain forest on the Caribbean side of the country in luxuriance. At the beginning of the present century, this southern Pacific quadrant of the country was sparsely inhabited by man, its few scattered settlements separated by long stretches of rough, muddy forest tracks. Colonists from the center of the country slowly trickled in, along the difficult trail that passed over the dreaded Cerro de la Muerte in the Talamancan Cordillera, or else by sea from Puntarenas. The settlement of this region, especially the basin of El General at the head of the valley of the Río Térraba, received a great impetus with the coming of commercial aviation in the early 1930's; while farther south, at about the same period, the development of the port of Golfito and of large banana plantations around Palmar Sur stimulated the settlement of the hinterland. The opening of the Inter-American Highway, from Cartago to San Isidro del General about 1946, and from San Isidro to the Panamanian border around 1963, brought this once remote region into easy communication with the center of Costa Rica and sealed the doom of its wilderness. Except on the higher and less accessible slopes of the Cordillera de Talamanca, the once magnificent forest is now a dwindling remnant that yearly shrinks before expanding farmlands of inferior agricultural value.

With the replacement of the forest by pastures, coffee plantations, and large areas devoted to the shifting cultivation of grains, far-reaching changes in the avifauna have occurred. That which now concerns us is the spread and increase of the Smooth-billed Ani. When I first arrived in El General late in 1935, the Groove-billed Ani (the common species throughout Central America) was sparingly present; but I found no Smooth-billed Ani until 1940, when on 12 March three or four were encountered in a pasture in the valley of the Río Pacuar, near the head of the Térraba Valley. A lone Groove-billed Ani, isolated from others of its kind, tried for six weeks to join the Smooth-bills but was always repelled (Skutch, 1959:307–310).

This was eight years after the Smooth-billed Ani was first reported from Costa Rica by Austin Smith, who on 26 December 1931 found a small colony at the Río Coto, near the Panamanian border (Slud, 1964:126). However, the Smooth-bill may well have been present in this remote region, undetected by ornithologists, for many years before this date. Today, this appears to be the only ani present on the Pacific side of Costa Rica, between the lower reach of the Río Térraba and the Panamanian border, except for an isolated population of the Groove-bill on the Peninsula de Osa. During three months passed in the Palmar-Golfito district in 1947, I noticed only *Crotophaga ani*, and the same was true during a four months' sojourn in the Cañas Gordas–San Vito region in 1964. Slud (1964:126) likewise failed to find the Groove-billed Ani in this frontier zone of Costa Rica, where heavy rain forests are rapidly disappearing before too avid human settlement.

Since I first noticed the Smooth-billed Ani in El General in 1940, it has been increasing far more rapidly than the Groove-billed Ani. In the middle 1950's, the latter still seemed to be the more abundant species. Today, the reverse is certainly true. On several journeys afoot and on horseback early in 1964, I paid particular attention to the anis. Between 2,500 and 4,000 feet above sea level, I found many flocks of the Smooth-bill but only one of the Groove-bill. Why one species is flourishing so much better than the other is an unsolved problem. As far as I know, the two kinds of anis have quite similar requirements, but the Smooth-bill appears to be the more aggressive bird. Both species are sympatric over large areas in Colombia, Venezuela, and western Ecuador. Possibly in these countries they occupy different ecological niches, but the problem appears not to have been investigated.

At Palmar Sur, Costa Rica, on 18 September 1947, I found a nest of the Smooth-billed Ani with one fresh egg. On 30 July 1958, between El Quizarrá and Santa Elena, I found the first nest of the species in El General. By 1 August it contained its full complement of five eggs. When I examined it, five adults protested. Although in Central America anis of both species breed later than the majority of the birds, early nesting sometimes occurs. On 18 May 1964, near Cañas Gordas at 3,700 feet, I found a nest with four nestlings in pinfeathers. Even earlier nesting was indicated by the behavior of a group of about eight Smooth-billed Anis which I watched on our farm at about 2,400 feet on 9 April 1962. They were foraging on a field prepared for planting maize, where the ground was strewn with slender tree trunks, chopped up branches, and dry weeds. They walked rather than hopped along the horizontal trunks and over the ground rough with drying vegetation, rarely hopping from one branch to another. Sometimes an ani flew a short distance in pursuit of a grasshopper that tried to escape by flight, and usually it captured the fugitive. Grasshoppers were evidently their principal prey. After catching a large one, they would beat and bite the life out of it, then carry it eastward across the Río Peña Blanca to a pasture overgrown by a tangle of weeds, bushes, and vines, in the midst of which they evidently had a nest, or fledglings still unable to follow their parents. Their destination was 600 feet or more from the field where they foraged, and they made this considerable journey in characteristic ani fashion, breaking it into several stages, and often pausing to rest in the riverside trees before continuing on their way.

SUMMARY

The Squirrel Cuckoo is found from the lowlands up to 7,000 or 8,000 feet but is more abundant at lower altitudes. Avoiding the interior of the forest, it inhabits open and cultivated country with scattered trees in both wet and semiarid regions. It lives in pairs throughout the year.

Its diet consists of adult and larval insects, including caterpillars covered with stinging hairs.

Its varied calls are described.

Males feed their mates, and both retain their hold on the article of food during coition.

Nests are placed in trees or in low tangled growth. While building, one partner (probably the male) brings material to the other, who stays on the nest and arranges it. One pair tried for over a week to build in an inadequate site from which all their material fell to the ground. They worked most actively after the middle of the morning. The completed nest consists of a loose foundation of coarse sticks supporting a thick mass of leaves, some of which are green when brought.

In southern Costa Rica, the breeding season extends from January to October and appears to be at its height from April to June. The white, chalky eggs, usually two in a set, are soon stained with brown by contact with the leaves on which they rest.

Both parents incubate. After the routine of incubation was well established, one pair kept their eggs constantly covered, changing places only twice a day. One partner sat through the middle of the day, for seven or eight hours continuously, and the other all the rest of each 24-hour period.

The nestlings hatch with hair-like down feathers. At all stages they are fed infrequently—only four or five times in a morning for a single feathered nestling—but from the first the meals are substantial. Each meal consists of a single larval or winged insect, which is usually quite massive, and badly mangled when brought to the nest. Nestlings receive caterpillars with stinging spines.

The parents carry droppings from the nest, which nevertheless becomes somewhat soiled.

Even after they are well feathered, nestlings are brooded through the night, in the early morning and late afternoon, and when rain falls. Their separation from the nest is a gradual process, and they spend several days hopping through, and resting in, the surrounding branches.

The Lesser Ground-Cuckoo, confined to the Arid Tropical Zone of México and Central America, walks over the ground in search of food. Its calls include full, mellow whistles and trilled whistles.

In mid-July, in the Motagua Valley of Guatemala, a nest was found on the ground, beneath a bush. The open bowl of petioles and sticks, lined with fine herbaceous materials, held two white eggs with a chalky surface.

Both parents incubated, sitting for 2½ to 3½ hours continuously. After permitting a very close approach by a man, they gave a variety of distraction displays, although not the "broken-wing" ruse.

An isolated colony of three Smooth-billed Anis on Barro Colorado Island, Panamá Canal Zone, was kept under observation for nearly four months. The group consisted of a male and two females, identified by marking them with paint and watching them lay.

The two females laid in the same nest, depositing their eggs around midday. Each female laid four to seven eggs in a set. The male regularly incubated by night, and by day all three parents (but chiefly the females) took turns on the eggs, sitting from 1 to 127 minutes at a stretch. There were short intervals of neglect, but the eggs were kept covered for 90.5 per cent of the period when the three were taking turns on the nest. While incubation was in progress, fresh green leaves were brought to the nest.

Hatched without a trace of down, the nestlings developed rapidly, and if disturbed crawled from the nest when only five or six days old. The male brooded by night and protested more vehemently than the females when the nest was visited.

During four months, this group of anis built at least six nests, and the two females laid at least 34 eggs, without rearing a single fledgling. The despoiler of their nests was not discovered. The interval between the disappearance of the eggs from one nest and the first laying in the following nest was in several cases only three to five days, and once apparently even less.

The Smooth-billed Ani was first recorded in Costa Rica, near the Panamanian border, in 1931. By 1940 it had reached the upper Térraba Valley, where the Groove-billed Ani was already resident in small numbers. Since that date, the Smooth-bill has become much more numerous than the Groove-bill in this region.

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EL QUIZARRÁ, SAN ISIDRO DEL GENERAL, COSTA RICA, 14 JUNE 1965

SHOREBIRD MIGRATION AT NORMAN, OKLAHOMA: 1961–63

LEWIS W. ORING AND W. MARVIN DAVIS

REPEATED censusing of a limited area provides a valuable source of quantitative migration data despite the many variables involved. Though several such studies of shorebirds have been conducted on or near the Atlantic and Pacific coasts (Urner, 1929; Urner and Storer, 1949; Storer, 1951; Dyke, 1955) no comparable data are available from the central flyway region. This report is a result of observations made from 1 March 1961 to 15 November 1963 at a small impoundment in Norman, Oklahoma.

DESCRIPTION OF AREA

Norman, Oklahoma is adjacent to the floodplain of the Canadian River. The river flows generally from west to east across the state, but follows a northwest to southeast direction for a considerable distance on both sides of Norman. Native woody vegetation near the city is limited to areas along the river and other streams.

Max Westheimer Airfield was developed as a military base in 1942, and is presently operated by the University of Oklahoma. More than 200 acres of asphalt remain, considerable portions of which are not used as runways or taxiways. One such unused area has been the site of a pond since 1949 or 1950. At that time a drainage ditch was dammed in the pasture adjacent to the west edge of the airfield. Except for periods of extreme drought, the pond extends from the pasture onto the airfield as a shallow pool having a maximum depth of about two feet, a length of about 300 yards, a width of about 70 yards, and an area of about three acres. Maximum size is not regularly maintained, however, as an extremely high evaporation rate prevails in Oklahoma from April to October. During these months of 1961–63 the average dimensions of the pond were 150 × 40 yards and the average surface was 1.4 acres. The broad, shallow portion of the impoundment, in contrast to the deeper and narrower section in the pasture, has proved quite attractive to migrant shorebirds despite its small size and lack of sandy or muddy shores.

When first laid, the asphalt that underlies and nearly surrounds the pond constituted a primary bare area. This area has been invaded for some years by a vigorous plant growth distributed linearly along the seams and cracks of unused areas. Such growth invades the pond at a few points. For about 100 yards along the southwest shore of the pond the asphalt was broken up and hauled away several years prior to this study. This section constitutes the major site of both submerged and emergent vegetation and is the only area of the pond in which an automobile cannot be driven.

COVERAGE

Censuses were usually taken at least once daily from 1 March to 31 October of all three years. At times, however, a day was missed and on three occasions (1–8 April 1961; 25–30 August 1962; and 26 August to 3 September 1963) both observers were absent from the study area for about a week. From 1 March 1961 to 31 May 1961 daily visits were made at 0600 and 1800 CST. Throughout the remainder of the study the time of day at which observations were made was variable. Observation periods averaged about an hour, but some lasted from three to six hours in May and September.

INFLUENCE OF WEATHER

During the frequent spring periods of clear skies and strong southerly winds we experienced a rather uniform pattern of migration and found few rare species, whereas at times of heavy cloud cover, fog, or northerly winds, migrants were grounded and we regularly found uncommon species and larger numbers of individuals. It seems likely that a relatively constant flow of shorebirds passes through central Oklahoma during the height of the northbound migration but that many of these birds are seen only when forced to the ground by inclement weather.

Occasionally an extended wet spell occurred in spring. Concurrently there was a reduction in the shorebird population due apparently to two factors: (1) an increase in feeding sites caused by accumulation of water in fields and on the runway, and (2) the reduction of available food at the pond due to the elevated water level.

During very heavy rain or hail only the largest shorebirds remained at the pond—others went to less exposed areas away from the water. Shelter was also sought when the wind velocity reached about 30 mph. At these times we found large flocks of many species running about far from the water feeding voraciously on grounded insects and seeds.

Summer in Oklahoma is characterized by an almost continuous span of variably intense southerly winds and clear skies. During such periods the number of southbound migrants changed little from day to day. But when the first cold snap arrived with strong northerly winds, usually sometime in September, a great variety of shorebirds suddenly appeared; and this phenomenon was repeated to a lesser degree with each ensuing north wind until the supply of migrants was exhausted sometime in November. Our observations of fall migrants are thus consistent with the findings of Brooks (1965) for shorebirds and Hassler et al. (1963) for passerines in that they considered the shift of wind to the north to be the primary weather stimulus for southbound migration.

The paucity of migrants during the days just after an extended stormy period was also notable. In spring this may have been due to the reluctance of birds to leave the Gulf Coast or other areas of concentration during times of weather disturbance. In summer and fall it may have been due to the small number of birds physiologically ready to migrate that still remained at northern "staging points" following a storm front.

RESULTS

Thirty of the 39 species of shorebirds recorded from Oklahoma were seen in the study area. Of the nine unrecorded species (Piping Plover, *Charadrius melodus*; Mountain Plover, *Eupoda montana*; Ruddy Turnstone, *Arenaria interpres*; Woodcock, *Philohela minor*; Eskimo Curlew, *Numenius borealis*; Knot, *Calidris canutus*; Short-billed Dowitcher, *Limnodromus griseus*; Black-necked Stilt, *Himantopus mexicanus*; and Red Phalarope, *Phalaropus fulicarius*), the Knot and Red Phalarope have never been collected in Oklahoma and only the turnstone is of more than accidental occurrence in the central part of the state.

The Whimbrel (*Numenius phaeopus*), White-rumped Sandpiper (*Erolia fuscicollis*), Marbled Godwit (*Limosa fedoa*), Hudsonian Godwit (*L. haemastica*), Sanderling (*Crocethia alba*), and Northern Phalarope (*Lobipes lobatus*) were recorded from only the northward migration whereas the Snowy Plover (*Charadrius alexandrinus*), Dunlin (*Erolia alpina*), and American Avocet (*Recurvirostra americana*) were seen only during the southbound season. Despite increased populations following the reproductive season, the Golden Plover (*Pluvialis dominica*), Spotted Sandpiper (*Actitis macularia*), Greater Yellowlegs (*Totanus melanoleucus*), Pectoral Sandpiper (*Erolia melanotos*), Baird's Sandpiper (*E. bairdii*), Buff-breasted Sandpiper (*Tryngites subruficollis*), and Wilson's Phalarope (*Steganopus tricolor*) were all much less common during southward than northward migration. Our coverage of the study area and its apparent attractiveness to shorebirds were relatively constant throughout the year and thus cannot account for this paradox. Conversely, the Western Sandpiper (*Ereunetes mauri*) was numerous during the southward migration, but recorded on only four dates in spring. The Upland Plover (*Bartramia longicauda*), Solitary Sandpiper (*Tringa solitaria*), Least Sandpiper (*Erolia minutilla*), Long-billed Dowitcher (*Limnodromus scolopaceus*), and Stilt Sandpiper (*Micropalama himantopus*) were also much more common in fall than in spring. Among these, only the Solitary and Western sandpipers showed an increase in numbers greater than

TABLE 1

RANKING OF SHOREBIRDS BY ABUNDANCE IN NORTHWARD MIGRATION, 1961–63

Species	Rank	Total dates	Total individuals	Maximum daily totals
Baird's Sandpiper	1	146	2,553	150
White-rumped Sandpiper	2	86	1,524	105
Semipalmated Sandpiper	3	76	900	145
Buff-breasted Sandpiper	4	46	1,027	215
Wilson's Phalarope	5	56	1,071	140
Pectoral Sandpiper	6	117	857	75
Least Sandpiper	7	73	877	75
Lesser Yellowlegs	8	104	848	64
Greater Yellowlegs	9	64	587	50
Golden Plover	10	36	269	35
Stilt Sandpiper	11	31	88	17
Long-billed Dowitcher	12	31	95	11
Upland Plover	13	23	79	15
Spotted Sandpiper	14	39	68	6
Semipalmated Plover	15	14	29	7
Common Snipe	16	18	22	3
Hudsonian Godwit	17	6	14	5
Willet	18	6	13	6
Sanderling	19	6	13	4
Black-bellied Plover	20	2	13	7
Marbled Godwit	21	4	8	3
Western Sandpiper	22	4	5	2
Solitary Sandpiper	23	5	5	1
Long-billed Curlew	25	1	1	1
Whimbrel	25	1	1	1
Northern Phalarope	25	1	1	1

that explainable by the addition of offspring to the population. The Semipalmated Plover (*Charadrius semipalmatus*), Killdeer (*C. vociferus*), Common Snipe (*Capella gallinago*), Lesser Yellowlegs (*Totanus flavipes*), and Semipalmated Sandpiper (*Ereunetes pusillus*) were about as common during the northward as during the southward migration.

The relative abundances (after Urner and Storer, 1949) of 26 species of shorebirds found in northward migration, and of 23 species seen in southward migration are presented in Tables 1 and 2. The Killdeer is excluded from this comparison because of its year-round presence. Seasonal extreme dates for the three-year span are given below for each species. Migration peaks and dates of maximum counts for both northward and southward seasons are given where data are adequate.

It must be remembered that our area does not provide optimum habitat for all species of shorebirds. Common Snipe and Solitary Sandpipers are more

TABLE 2

RANKING OF SHOREBIRDS BY ABUNDANCE IN SOUTHWARD MIGRATION, 1961–63

Species	Rank	Total dates	Total individuals	Maximum daily totals
Least Sandpiper	1	207	1,892	51
Lesser Yellowlegs	2	123	652	70
Western Sandpiper	3	96	429	30
Semipalmated Sandpiper	4	106	336	23
Pectoral Sandpiper	5	74	300	30
Baird's Sandpiper	6	69	350	21
Buff-breasted Sandpiper	7	30	246	50
Long-billed Dowitcher	8	49	153	29
Stilt Sandpiper	9	57	174	14
Upland Plover	10	49	113	11
Solitary Sandpiper	11.5	44	71	4
Wilson's Phalarope	11.5	16	52	10
Greater Yellowlegs	13	24	38	6
Semipalmated Plover	14	10	16	3
Common Snipe	15	18	26	3
Golden Plover	16	15	21	4
Dunlin	17	4	14	7
American Avocet	18	3	9	7
Spotted Sandpiper	19	9	9	1
Black-bellied Plover	20	6	7	2
Willet	21.5	7	7	1
Long-billed Curlew	21.5	2	5	4
Snowy Plover	23	1	1	1

common along marshy lake edges and streams; Upland Plovers are abundant in alfalfa and plowed fields; and Snowy Plovers are regular along sandy riverbeds. All of the larger forms—Marbled Godwit, Hudsonian Godwit, Long-billed Curlew (*Numenius americanus*), Whimbrel, Willet (*Catoptrophorus semipalmatus*), and American Avocet, as well as Black-bellied Plover (*Squatarola squatarola*), Dunlin, and Sanderling—are more regular at the larger reservoirs. This may be due to the differences in sample sizes. For the remaining species the study pond appears quite suitable and for some, e.g., Buff-breasted Sandpiper, superior.

In the height of spring migration it was obvious that most flocks were restless and little inclined to linger more than a few hours. According to our observations, few birds other than Baird's Sandpipers and Upland Plovers remained longer than a day. During most of the southward migration, however, migrants faced a head wind and under such conditions often lingered several days.

Determination of which birds were new to the census and which had already been counted was complicated by the fact that certain birds circulated back and forth between the study area and another nearby pond. In this regard, we depended upon flock size, direction of departing and arriving groups, and presence of crippled, banded, or otherwise marked individuals.

SPECIES STATUS

Semipalmated Plover.—Extremes: 17 April–6 May and 26 July–25 September. One recorded 11 June 1962. Maximum counts: 25 April 1963 (7) and 22 April 1963 (5). Most common at pond but also noted on runway far from water.

Snowy Plover.—Observed only once, 19 July 1963, despite its breeding three miles south of the study area at the Canadian River. Migrants were often seen at river in April and May.

Killdeer.—Nests commonly, winters sparingly. Peak migration: 2–18 March and 5 August–1 November. Maximum counts: 14 March 1961 (40), 16 March 1961 (11), 16 March 1962 (8), 29 August 1961 (125), 5 August 1961 (45), and 20 August 1961 (40). Seemingly migratory flocks in summer were noticeably larger during midday. One adult banded 13 May 1962 remained at least until 8 September 1962.

Golden Plover.—Extremes: 26 March–22 May and 20 July–11 November. Peak migration: 10–27 April. Maximum counts: 15 April 1961 (41), 10 April 1961 (40), 16 April 1961 (35), and 8 September 1963 (4). In fall larger numbers were seen in plowed fields three miles northwest of study area. In spring it was most common in evening and early morning. They favor a small section of pond shore that has scattered chunks of broken asphalt; also frequent nearby fields and runway. Only two of 269 in spring were in complete breeding plumage—one 18 May 1961, the other 21 May 1961.

Black-bellied Plover.—Extremes: 18 and 19 May; and 2 August–20 October. Maximum counts: 18 May 1961 (7) and 19 May 1961 (6). Both spring flocks were seen at daybreak; all birds were in full breeding plumage.

Common Snipe.—Extremes: 26 March–28 April and 23 September–31 October. Peak migration: 3–20 April and 23 September–31 October. Winters near Norman in favorable habitats.

Long-billed Curlew.—Single birds were observed 25 April and 4 September 1961; flock of four 19 July 1963.

Whimbrel.—A single bird was observed 1 June 1961.

Upland Plover.—Extremes: 11 April–18 May and 6 July–18 October. Four mid-June records of single birds indicate possible local nesting. Peak migration: 12–30 April and 2 August–24 September. Maximum counts: 12 April 1963 (15), 30 April 1962 (7), 24 and 28 April 1961 (6), 9 September 1962 (11), 3 September 1961 (8), 3 August and 7 September 1963 (7). First southward movement, as determined by nocturnal flight calls, 6 July. Usually seen in fields near pond, but occasionally seen feeding or bathing at water. Much more numerous in alfalfa and plowed fields west of Norman.

Spotted Sandpiper.—Extremes: 19 April–31 May and 12 July–12 September. Peak migration: 27 April–23 May. Maximum count: 13 May 1963 (6). Only singles observed in summer. Seen several times resting on the asphalt far from water.

Solitary Sandpiper.—Extremes: 9 April–24 May and 6 July–25 August. Maximum count: 24 August 1963 (4).

Willet.—Extremes: 27 April–6 May and 30 June–4 September. Maximum count: 27 April 1963 (6). Summer observations were all of single birds.

Greater Yellowlegs.—Extremes: 8 March–7 May and 9 July–12 October. Peak migration: 25 March–20 April and 15 July–9 September. Maximum counts: 9 April 1962 (50), 6 April 1962 (49), 7 April 1962 (42), 9 September 1962 (6), 20 July 1962 (4), and 26 July 1961 (3). Most common during April, in unmixed flocks arriving at or after sunset. In contrast to Lesser Yellowlegs it was never seen away from water.

Lesser Yellowlegs.—Extremes: 7 March–3 June and 21 June–28 October. Peak migration: 29 March–12 May and 26 July–6 September. Maximum counts: 24 April 1963 (64), 28 April 1963 (63), 25 April 1963 (41), 3 September 1961 (70), 4 September 1961 (55), and 9 September 1962 (28). Usually observed wading in water but frequently seen in sheltered areas far from water during storms or strong winds.

Pectoral Sandpiper.—Extremes: 2 March–3 June and 9 July–17 October. Peak migration: 10 April–26 May and 26 July–6 September. Maximum counts: 4 May 1961 (75), 30 April 1963 (36), 27 March 1961 (28), 3 September 1961 (31), 5 September 1961 (30), and 25 August 1963 (16). A single bird, apparently male, seen 23 June 1962 was presumed to be an early southward migrant. Usually they favor the pond shore although large numbers land on the runway or in the adjacent pasture. After rain they often visit puddles along the runway. The sexes rarely migrate together in spring. In 1961, Dan R. Harlow collected 124 Oklahoma specimens for parasitological analysis (81 in spring; 43 in summer and fall). His data are as follows: to 5 April—27 males, 0 females; 9 April—11 males, 1 female; 11 April to 25 April—5 females, 4 males; and 27 April to 2 June—33 females, 0 males. Extreme dates for sexes during spring migration in study area (as verified by specimens) are as follows: males 16 March to 6 May; females 9 April to 3 June. Data from 50 fall Oklahoma specimens (including Harlow's 43) yield the following date extremes by sex: males 25 July to 26 October; females 31 July to 26 October. All of Harlow's fall specimens were osteologically immature. This, coupled with the decrease in total Pectorals observed in southward migration, suggests that part or all of the adult population follows a different southward path and that the flocks found here during summer and fall contain juvenile birds of both sexes.

White-rumped Sandpiper.—Extremes: 27 April–21 June. No fall records. Peak migration: 3–26 May. Maximum counts: 16 May 1963 (105), 20 May 1963 (65), and 20 May 1962 (54). Most common at midday. Frequents pond shore most often but also regular on the runway and in the plowed fields. Sexes tend to migrate separately. In Oklahoma, males collected from 2 May to 26 May: females from 17 May to 6 June (data gathered by University of Oklahoma Museum of Zoology).

Baird's Sandpiper.—Extremes: 3 March–31 May and 20 July–13 October. Peak Migration: 12 April–24 May and 20 July–24 September. Maximum counts: 10 May 1963 (150), 9 May 1963 (145), 17 May 1963 (135), 4 September 1961 (21), 3 September 1961 (20), and 25 July 1962 (20). This species often remains several days and in spring some may remain a week or longer. Often seen on runway or in adjacent fields, especially when standing water is widespread or when winds are exceptionally strong.

Least Sandpiper.—Extremes: 27 March–24 May and 4 July–1 November. Peak migration: 22 April–18 May and 8 July–22 October. Maximum counts: 1 May 1961 (75), 8 May 1961 (65), 8 May 1963 (58), 6 October 1961 (51), 4 September 1961 (50), and 8 October 1961 (41). Most common during midday. Usually found at pond's edge but seek sheltered areas in heavy winds.

Dunlin.—Extremes: 9–29 October. Four records only: 9 October 1961 (7), 10 October 1961 (5), 11 October 1961 (1), and 29 October 1961 (1).

Long-billed Dowitcher.—Extremes: 16 March–18 May and 10 July–20 October. Peak migration: 6 April–8 May and 26 July–18 October. Maximum counts: 29 April 1962

(11), 27 April 1962 (7), 22 April 1963 (6), 6 October 1961 (29), 18 October 1961 (11), and 23 September 1961 (10). On a few occasions the presence of Short-billed Dowitchers was suspected

Stilt Sandpiper.—Extremes: 20 April–25 May and 6 July–25 September. Peak migration: 25 April–16 May and 2 August–25 September. Maximum counts: 10 May 1963 (6), 9 May 1963 (6), 11 May 1962 (5), 5 September 1962 (14), 3 September 1961 (10), and 12 August 1961 (10).

Semipalmated Sandpiper.—Extremes: 8 April–30 May and 24 June–13 October. Singles observed 11 and 16 June 1963. Peak migration: 18 April–26 May and 12 July–3 September. Maximum counts: 25 April 1961 (145), 26 May 1961 (68), 4 May 1962 (57), 30 August 1961 (23), 1 September 1961 (18), and 3 September 1961 (15). Most common at midday. Occasionally seen on the runway and in plowed fields.

Western Sandpiper.—Extremes: 16 April–27 April and 30 June–9 October. Peak migration: 2 July–3 September. Maximum counts: 29 August 1961 (30), 27 August 1961 (25), and 17 July 1963 (20).

Buff-breasted Sandpiper.—Extremes: 17 April–3 June and 23 July–4 October. Peak migration: 4–19 May and 9 August–8 September. Maximum counts: 9 May 1962 (215), 10 May 1962 (117), 12 May 1962 (98), 9 August 1963 (43), 5 September 1962 (29), and 8 September 1963 (26). Most common at midday. They feed mainly in nearby fields and on the runway, but bathe and display at the pond. Flocks in April and early May contained a preponderance of males while those after the middle of May often were composed solely of females.

Marbled Godwit.—Extremes: 26 March–1 May. Four records only: 26 March 1961 (3), 9 April 1961 (1), 24 April 1963 (3), and 1 May 1963 (1).

Hudsonian Godwit.—Extremes: 15 April–20 May. Maximum counts: 15 April 1961 (5), and 17 May 1963 (4). All birds were in breeding plumage

Sanderling.—Extremes: 7–26 May. Maximum counts: 14 May 1961 (4), 11 May 1961 (3), and 8 May 1961 (3). No fall records despite their being regular at a large reservoir 30 miles north of Norman.

American Avocet.—Extremes: 5 July–4 October. Four records only: 5 July 1962 (1), 29 July 1961 (7), 24 September 1961 (1), and 4 October 1961 (1). No spring records despite several occurrences near Norman. Nine of ten southbound birds lacked breeding dress.

Wilson's Phalarope.— Extremes: 10 April–28 May and 16 July–24 September. Peak migration: 22 April–17 May and 12 August–4 September. Maximum counts: 28 April 1962 (140), 22 April 1963 (125), 29 April 1962 (111), 13 August 1961 (10), 12 August 1961 (8), and 4 September 1961 and 1962 (8). Most numerous at midday. In spring, very common for only a few days. Flocks usually are seen at the pond's edge, but sometimes they swim in deep water and, at times, feed on dry land. Both sexes migrate together but flocks during April contain a great preponderance of females, while those in early May often contain pairs, and flocks in mid- and late May contain more males than females.

Northern Phalarope.—Single female in breeding plumage seen on 17 May 1963.

SUMMARY

A study of shorebird migration was conducted at Norman, Oklahoma, from 1 March 1961 to 15 November 1963. A total of 30 species was observed including 27 during the northward and 24 in southward migration. Baird's Sandpiper was by far the most abun-

dant species during the northward migration; Least Sandpiper was the most abundant during the southbound season. White-rumped Sandpipers were common in spring but unrecorded after 21 June. Likewise, all six Sanderling records were in the spring. Species that were definitely more common in spring than in fall included the Golden Plover, Spotted Sandpiper, Greater Yellowlegs, Pectoral Sandpiper, Baird's Sandpiper, Buff-breasted Sandpiper, and Wilson's Phalarope. The Western Sandpiper was numerous during the southward migration but only five individuals were recorded during spring. The Dunlin was seen only four times, all in fall. The following species were also much more common in fall than in spring: Upland Plover, Solitary Sandpiper, Least Sandpiper, Long-billed Dowitcher, and Stilt Sandpiper. Only the Solitary and Western sandpipers, however, showed an increase in numbers greater than that explainable by the summer's reproduction.

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FEEDING BEHAVIOR OF THE GLAUCOUS-WINGED GULL ON AN ALASKAN SALMON STREAM

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Every year during the months of June through September millions of salmon (*Oncorhynchus* spp.) enter Prince William Sound, Alaska. Those that are not caught by commercial fishermen go up the numerous short streams that flow into the sound, where they spawn and die. These salmon, living and dead, are a superabundant food source that attracts to the spawning streams large numbers of predators and scavengers, among them bears, eagles, crows, ravens, gulls, and countless invertebrates. Despite their abundance and accessibility, the behavior of these animals has not been studied intensively on salmon streams. Perhaps the most conspicuous of the salmon stream scavengers are the gulls. On Olsen Creek, Prince William Sound, Alaska, the principal gull species were the Glaucous-winged Gull (*Larus glaucescens*), the Mew Gull (*Larus canus*), and the Bonaparte's Gull (*Larus philadelphia*). Because these gulls occurred in large numbers and remained in one area for several months, they could be studied using a blind and other methods normally reserved for breeding colonies. With the exception of Mossman (1958), however, virtually no systematic studies have been made of gulls on salmon streams, although the literature abounds with nonsystematic observations, as in Bent (1921) and Murie (1959). The nonbreeding behavior of gulls has received little attention compared to the intensively studied breeding behavior, with the exception of studies by Tinbergen (1956, 1960) and the Frings et al. (1957).

Since the Glaucous-winged Gull was the dominant gull on Olsen Creek, both in size and in numbers, this paper is concerned primarily with the behavior patterns of this species. Unfortunately, even the breeding behavior of the Glaucous-winged Gull is not well known. The only substantial paper on the subject, by James-Veitch and Booth (1954), was done without the benefit of Tinbergen's classical studies on gull behavior. The Glaucous-winged Gull, however, does belong to the Herring Gull group of Tinbergen (1959) and the behavior patterns observed on Olsen Creek fit nicely into the general patterns described for the group as a whole. Most of the behavior patterns observed on Olsen Creek appear to be closely related to those of the breeding season in form, although not necessarily in significance.

THE STUDY AREA

Olsen Creek is one of the principal spawning streams on Prince William Sound of the pink salmon (*Oncorhynchus gorbuscha*) and the chum salmon

(*O. keta*) and is the site of a U.S. Bureau of Commercial Fisheries research station, at which the author was employed. The study was carried out on free hours during the summers of 1963 and 1964, with most of the quantitative work using a blind accomplished during 1964.

The gulls were concentrated on the tidal flats, in areas along the stream where the largest numbers of salmon carcasses accumulated. These areas were different for the two summers, because the great Alaska earthquake of 27 March 1964 uplifted the entire region about five feet, moving the feeding areas downstream. The gulls were also affected by the lateness of the 1964 spring, as appreciable numbers of pink salmon did not appear in the creek until 11 July, nearly 10 days later than the previous year. (A few chum salmon were in the stream, however, on 16 June.) Thus, the number of Glaucous-winged Gulls during the first two weeks in July was lower in 1964, although the estimated maximum of 250 birds was reached in mid-August in both seasons. Large flocks of Bonaparte's Gulls appeared on 15 July in 1963 and on 22 July in 1964, reaching an estimated maximum of 100 birds during the first week of August. In both seasons Mew Gulls did not appear in any numbers until the third week of July and their maximum population never exceeded 40 birds. The lateness of the gulls' arrival on the stream in 1964 was probably due also to the lateness of the breeding season. Although there were no gulls breeding in the immediate vicinity of Olsen Creek, a colony of Arctic Terns (*Sterna paradisea*) nearby was still incubating on 21 June 1964, nearly 10 days later than noted in previous years. However, Gabrielson and Lincoln (1959) observed hundreds of fuzzy young Glaucous-winged Gulls in a Prince William Sound colony on 29 July 1945. Although this date seems exceptionally late, Bent (1921) gives egg dates for Alaska, south of peninsula, as ranging between 3 June and 16 July.

SPECIES DIFFERENCES

The different feeding habits of the three species resulted in a minimum of interspecific conflict. The dominant Glaucous-winged Gull either fed on carcasses pulled up on the stream bank or bobbed for drifting salmon eggs while swimming with the current. The Bonaparte's Gull generally flew up and down the spawning areas in flocks of 10 to 20 birds, lighting briefly on the water to dive for drift eggs. The Mew Gull occupied an intermediate position. Like the Bonaparte's Gull, they often fed on drift eggs by flying up and down over the spawning area. When no Glaucous-winged Gulls were nearby they tended to swim with the current to bob for eggs. They also would defend a riffle area or salmon carcass for short periods against all other Mew and Bonaparte's Gulls, if no Glaucous-winged Gulls were near enough to chase them off.

DISPLAYS AT SALMON CARCASSES

Most of the feeding behavior of the Glaucous-winged Gull at Olsen Creek occurred in the two distinct situations mentioned above. The displays centering around salmon carcasses were studied most intensively because of their close relationship to breeding season territorial displays described by Tinbergen (1959, 1960) and James-Veitch and Booth (1954). General descriptions of the Upright Display, the Oblique-cum-Long-Call Display, the Mew Call Display, and other displays mentioned can be found in Tinbergen (1959).

Upright Display.—This was the most common display observed. When assumed by an attacking or defending bird it was often sufficient to decide the issue by itself, the loser walking off, usually only a few paces, in the Hunched Posture. An Aggressive Upright Display was turned into an overt attack when the attacking gull began running towards the defending bird, neck stretched forward and wings partially out. In such an attack, an element of surprise was frequently the deciding factor, for, if the defending gull was not expecting the charge, it had little chance to do anything but jump out of the way.

The Upright Displays varied greatly in appearance. A gull feeding on a salmon carcass often stretched its neck only half as far as it would when extremely provoked, as a warning to another gull walking or flying by. Such a semi-upright posture could also be assumed by a defender towards a gull approaching in a "full" Aggressive Upright Display. In such a case, the defending gull almost always yielded to the aggressor.

When an attacking bird assumed such a semi-upright posture, the dispute usually ended in its favor. The attack was signaled as much by the aggressor's approach in a rapid walk as by its posture, which was often indistinguishable, at the beginning of the attack, from normal walking posture. The defender almost always walked off at the first sign of such an attack, most likely because it was familiar with the aggressor, and had lost a more vigorous dispute with it earlier. Thus, when a row of fish five feet apart was placed in front of the blind, it was common to observe the following:

> Two adult gulls begin feeding, gull 1 on fish A, gull 2 on fish B. Gull 2 assumes a semi-upright posture and charges gull 1. Gull 1 immediately jumps back and stands by with hunched shoulders a few paces off. Gull 2 feeds at A. Gull 1 now circles around and begins feeding at B. Gull 2 stops feeding and looks at gull 1, which also stops feeding. Both gulls resume feeding. Gull 2 suddenly begins walking in a semi-upright posture towards gull 1, which quickly steps a few feet away. Gull 2 begins feeding at B, while gull 1 circles around and begins feeding at A.

The whole performance may be repeated several times, ending only when one of the two gulls leaves the area. Occasionally an attack by one gull on its immediate neighbor resulted in a chain reaction with four or five gulls switch-

FIG. 1. Typical Oblique-cum-Long-Call Display, gull on left defending.

ing fish. The stimulus for the attack was the presence of another gull feeding nearby. Gulls not feeding were seldom disturbed, as long as they were behaving in a nonaggressive manner.

Although the above behavior seems, in many respects, like the pecking order behavior described for other bird species, any order established in the study area was only temporary, because the individual gulls in one area changed constantly. Not only did individual birds leave the feeding area to roost and preen when their hunger had been satisfied, but they often left to feed someplace else on the stream. Furthermore, the number of gulls in the study area (which was above the reach of most high tides), varied with the height of the tide and the time of day. When the tide was high or the hour early, there tended to be more gulls in the area than at other times. Also, individual gulls with conspicuous identifying plumage characteristics were never observed feeding continuously in one area for longer than two weeks. Thus, the feeding rights to fish were constantly being established and reestablished as new gulls came in and others left. This instability of local social orders resulted in numerous Oblique-cum-Long-Call and Mew Call Displays, as well as outright fights.

Oblique-cum-Long-Call Displays.—The Oblique-cum-Long-Call (Fig. 1) occurred primarily in three situations: (1) when a gull was highly motivated (i.e., hungry) in the defense of a salmon carcass or in an attack on a feeding bird; (2) when a gull was issuing a general challenge; and (3) when a gull was extremely frustrated or excited. Unfortunately, the exact nature of a Long Call was often very difficult to determine. This was particularly true of the second category, for even though a general challenge appeared to be directed towards any individual gull that happened to be nearby, it was really a challenge to all the gulls in the vicinity. Such a Long Call was seldom followed by an attack. Thus, with the exception of Long Calls given after a victory (which were apparently not aimed at individual gulls), all category two Long Calls were also analyzed as part of category one. Analysis for all categories was made in terms of Long Call performances, i.e., any display that included Long Calls was considered as one performance no matter how many single vocalizations were given (32 per cent of the performances involved more than one Long Call). Out of 100 such performances, 51 were begun by the attacking bird, 37 by the defending bird; nine were challenges given by adults to juveniles, and three were given by victorious birds after a conflict.

The temporary social superiority of a gull giving an Oblique-cum-Long-Call Display is indicated by the fact that, overall, a gull initiating a conflict by giving a Long Call came out ahead 65 per cent of the time. If the initiating gull was defending a carcass, however, it won 80 per cent of the time; if attacking, only 50 per cent of the time. These figures are striking when compared to the combined win–lose percentages for all the carcass conflicts on the creek. Normally, a carcass was defended successfully only 33 per cent of the time. The reason for this difference is probably that any defending gull that had to be attacked with a Long Call had already been sized up by the attacking bird as a formidable opponent. Otherwise an Aggressive Upright posture would have been sufficient. If the defending gull responded to the intruder with another Long Call, the two birds were probably equal in most respects, for a fight (Fig. 2), or a Mew performance, ensued, from which either bird could emerge the winner. Occasionally, the defending bird simply delivered a quick jab at the Long Calling intruder, which hastily retreated.

General challenge Long Calls were given either by gulls in possession of a carcass as a severe warning to any nearby or approaching gulls or by gulls landing in a new feeding area, presumably to test the aggressiveness of the birds already feeding. Long Calls given by a victorious bird after a conflict were also of the general challenge type. A defending bird that gave a general challenge Long Call was usually exceptionally aggressive and would often leave its fish temporarily to attack other gulls feeding nearby.

FIG. 2. A fight over a salmon carcass, gull on right trying to flee. Such fights usually last only a few seconds.

Long Calls that occurred under stress are discussed under encounters with juveniles and under gull–bear relationships.

Mew Call Displays.—The Mew Call Display (Fig. 3) was one of the most noticeable displays on the salmon stream, both because of its comparatively long duration and because of the long, monotonous cries that accompanied it. Three general types of Mew Call Displays were observed: conflict, sexual, and threat. In the conflict Mew Call Displays Glaucous-winged Gulls walked side by side in a deliberate manner, necks arched, with one or both gulls Mewing continuously. A Mew walk began when one gull, giving Mew cries, approached another feeding. If the dispute did not end immediately with a sudden jab by one of the birds, the defending gull would join the intruder in a Mew walk. Frequently, one of the gulls climbed up on the disputed fish and then ate and vocalized (in a muffled sort of way) simultaneously. The other gull slowly paced around the fish and its owner, Mewing constantly, until the dispute was settled, either by a jab, a fight, or by one gull walking away.

FIG. 3. A Mew walk. Gull on left is losing interest and walked away from other gull immediately after picture taken.

The sexual displays were similar in form to the conflict displays, except they did not center around a salmon carcass and they seldom ended with a jab or fight. They occurred primarily in areas where feeding was not taking place and their only obvious cause was the mutual attraction of two gulls. In seven sexual displays that occurred near the study area (which was almost exclusively a feeding area), three were accompanied by Choking, one by Head Tossing, and one was preceded by Long Calling by both birds. During the breeding season, Mewing, Choking, Long Calling, and Head Tossing are all part of pair formation or territory defense (Tinbergen, 1959).

Conflict Mew Call Displays always occurred in the vicinity of a fish on which one of the disputants was feeding. One of the gulls usually retained possession of the fish at the end of the display (in 27 of 32 displays analyzed). There was no sharp separation, however, between conflict and sexual displays and sexual motivation was probably at least partially responsible for many conflict displays. Choking occurred in six of the 32 cases analyzed. In one instance, when one of a pair of Mewing gulls began Choking, the other bird, which had climbed on top of the disputed fish, reached down and grabbed the Choking bird by the tail. In other cases, Choking occurred only as a short interruption of a Mew walk, with both birds Choking. Five of the 32 Mew Call conflicts began with the intruding bird giving a Long Call to which the defender immediately responded with a similar Long Call. Half (16) of the Mew Call conflicts ended with a fight; 10 of these were won by the attacker, six by the defending bird.

Although the number of conflict displays subjected to detailed analysis was small, tentative conclusions about them have been made from these and other more general observations. In a conflict Mew Call Display the two contenders are strangers, but recognize, from each other's size and actions, that they are approximately equal in strength and aggressiveness. During the Mew walk they discover more exactly the extent of their equality. If one gull then discovers its superiority to its opponent, it jabs out abruptly and the other bird flees without further ado. If, on the other hand, the Mew walk is unsuccessful in establishing the stronger bird, a breast-to-breast, or bill-pulling, fight results, winner take all. Such a fight usually lasts only a few seconds, although if one birds gets a good grip on another's bill it may last over two minutes. In 11 disputes (out of 32) in which the attacker gained the fish, 10 were won only after a fight, indicating that the defending bird had a slight advantage in being the possessor. This is further indicated by the fact that 16 of the Mew conflicts were won by the defending bird and only six of these by combat. The remaining five conflicts ended indecisively, with neither gull going back to the original fish, possibly because the Mew Call Display was partially sexual in origin. There is the distinct possibility that most conflict Mew Call Displays occur between birds of the opposite sex, and that the display itself results from a conflict between sex and hunger drives.

The third category of Mew Call Display, threat, perhaps better belongs under Upright Displays. Its exact origin is still uncertain, although it appears to be an intermediate threat display, i.e., stronger than an Upright Display but less intense than a Mew or Long Call Display. During a threat Mew Call Display, the neck is in a Mew or Semi-oblique position and the attacking bird walks towards its opponent giving one or two short Mew cries. The defending gull immediately either yields or jabs at the threatening gull, which then retreats. In nine of the 32 such threats analyzed, the defending bird responded first with another threat Mew Call Display and in four it responded first with a Long Call. The conflict, however, was decided immediately after that with a jab or a yield. Twenty-eight of the threats were given first by attacking birds, yet they succeeded in gaining the fish only 44 per cent of the time.

TABLE 1

FEEDING PERIODS OF THE GLAUCOUS-WINGED GULL, OLSEN CREEK

Time interval (sec)	Number of feeding periods
15–60	34
61–120	12
121–180	7
181–240	6
241–300	4
301–360	2
361–420	4
421–480	4
481–540	2
541–600	1
601–660	2
661–720	1
721–780	1

RELATIONSHIP TO BREEDING BEHAVIOR

With the possible exception of a few Mew Call Displays, all displays centering around the salmon carcasses were what Tinbergen (1959) terms "distance increasing displays," displays that, during the breeding season, permit the existence of territories by keeping rival birds apart with a minimum of physical encounter. On the salmon stream, however, these displays existed in the absence of true territories. Instead, individual carcasses or small groups of carcasses were defended. Furthermore, the carcasses were defended only for very short periods of time and attacking gulls seemed to have an overall advantage over those defending.

One of the main characteristics of a breeding territory is that it is defended for most of the breeding season. In contrast, a salmon carcass at Olsen Creek was held by an individual gull only for an average of three and one-half minutes. This figure was determined by timing 70 feeding periods to the nearest five seconds. A feeding period was considered the time between a gull's arrival on a carcass to the time it left, usually as the result of an encounter with another gull. The period was not necessarily one of continuous feeding but might have been interrupted by fights and threats. Even though periods under 15 seconds were arbitrarily discarded as exploratory, 43 per cent of the periods were still under one minute (Table 1). These were balanced by a few long periods, ranging up to 12.1 minutes. The shortness of the average feeding period is not surprising, because a hungry gull can eat an extraordinary amount of food in a very short period. Furthermore, when salmon carcasses were very abundant, a gull would often defend one only long enough to devour the eyes and viscera.

Another characteristic of a breeding territory is that the defending gull has the odds for winning in its favor. Out of 218 disputes over salmon carcasses, however, the attacking bird gained possession 145 times, 67 per cent of the total. (A dispute is defined as any encounter between two adult birds in which one, or both, of the gulls shows definite hostile intentions to the other by an Upright, Mew, or Long Call Display.) The intruding gull's advantage, in part, can be explained by the feeding gull's steadily decreasing motivation to defend a carcass as its hunger is satisfied. Similarly, the aggressiveness of an attacking gull was most likely to be stronger the hungrier it was. The attacker's advantage appeared mainly in the form of Aggressive Upright Displays to which the defending gull yielded with little protest, either because its hunger had been satisfied or because it had been defeated by the attacker in a previous fight. When a hungry gull had just begun feeding, the odds for winning an encounter were in its favor. Thus, in an analysis of 151 Mew Call and Long Call Displays, which indicate one or both gulls was highly motivated, 57 per cent were won by the defender, and 40 per cent by the intruder, leaving 3 per cent inconclusive. A feeding bird generally had to have an aggressive appearance in order to provoke a Mew Call or Long Call Display by an attacker. In extreme cases, such a bird attacked or threatened every gull in its immediate neighborhood, actually spending more time displaying than feeding. If one of its opponents also happened to be highly motivated, a wing-flapping, bill-pulling fight ensued, from which either bird could emerge the winner. When exceptions to the preceding occurred, they were often spectacular. A gull occasionally finished feeding and then walked for a few minutes among the other feeding birds, challenging, chasing, and fighting every gull it met, before finally settling down to preen and roost. Other gulls were chased from one carcass to another by more aggressive neighbors and never protested, no matter how eager to feed they appeared.

Despite these differences the relationship between breeding behavior and that observed on the salmon streams is undoubtedly very close. In many cases the motivation for a salmon stream display may have been purely sexual, as in the Head Tossing Displays that were occasionally seen on the tide flats. This also applies to many Mew Call Displays, particularly those preceded by Long Call performances or interrupted by Choking or Head Tossing. Any sexual displays on the salmon stream during June and July could be the result of feeding gulls still being in breeding condition, such as unmated birds, mated birds that had lost their brood, second- and third-year juveniles, or birds coming from nearby breeding colonies to get food for themselves and their young. Once the breeding season is over any sexual behavior could be the result of sexual recrudescence, similar to that of the Herring Gull (Tin-

FIG. 4. Gull waiting for black bear to finish feeding on female pink salmon. Note Long-Calling gull at center.

bergen, 1960). There is, however, no direct evidence for this in the Glaucous-winged Gull.

BEARS

Most of the described displays, except the Long Calls of the Glaucous-winged Gull, were of little value when the carcass involved was that of a freshly caught salmon, left behind by a fishing black bear (*Ursus americanus*). The desirability of such salmon to the gulls arose from the sloppy but selective eating habits of the bears. They seldom devoured a salmon completely, leaving the scraps for the gulls. When the salmon became abundant in the stream, the bears often captured unspawned females. With these, the bears squeezed, sucked, or tore out the eggs, spilling many in the process. Those eggs that the bears failed to lick up were left for the gulls, along with the remains of the salmon. Thus, any bear that dragged a freshly caught salmon up on the bank was quickly surrounded by Long Calling gulls (Fig. 4). When the bear left, there was a general rush for the remains of the fish. If the salmon was left in pieces, those gulls that could each grabbed one and tried to carry it away. The other gulls gave Long Calls and tried to snatch the pieces away. Fights were frequent and a gull often dropped a hard-won piece of fish when it tried to give a Long Call in response to a challenger. If the salmon was still whole, five to 10 birds could end up grouped around it, alternately feeding, challenging, and fighting. If the bear had spilled large numbers of eggs, the gulls present pecked frantically, generally ignoring the challenges of latecomers, until the eggs were gone. The gulls reacted in the same manner with Long Calls and fights when a bear fed on an old carcass that the gulls had rejected previously. The remains of such a carcass, however, were quickly deserted by the gulls after a few initial squabbles.

CARCASS SELECTION

Most of the salmon carcasses defended by the Glaucous-winged Gulls of Olsen Creek were originally dragged out of the water by the gulls themselves. When large numbers of salmon were spawning and dying, the gulls tended to feed more extensively on female carcasses. The Glaucous-winged Gull's preference for female salmon was also noted by Mossman (1958) on red salmon (*O. nerka*) streams of Bristol Bay, Alaska, where gulls preyed on live fish splashing through shallow water. Mossman found that nearly four times as many female salmon were killed as males. On Olsen Creek, there was no significant predation on live salmon, but nearly twice as many female carcasses were dragged up on the bank as males. Out of a total of 387 pink and chum salmon carcasses examined on two separate days, 133 were male and 254 were female. All the carcasses were in areas above the mean high tide mark where large numbers of gulls had been observed feeding. It was assumed that any carcass on the stream bank had been dragged there by the gulls.

On the first examination date (29 July 1964) the number of dead pink salmon was small, so only chum salmon carcasses were examined. The carcasses were arbitrarily divided into three categories to determine if the gulls also ate larger portions of individual female carcasses: (1) carcass in good shape, usually just eyes eaten; (2) carcass partially eaten, viscera gone; (3) carcass with only head, bones, skin, and fins; most of edible parts gone. It was found that 96 per cent of the female carcasses belonged to classes 2 and 3 (87 per cent to class 3 alone), contrasting with 61 per cent for the males (36 per cent to class 3). Thus, an apparent preference for female carcasses is shown, despite the fact that only 53 per cent of the 159 carcasses examined were female. The tendency to eat more of a female carcass was probably caused by the gulls' preference for salmon eggs, small numbers of which were usually retained in the visceral cavity of the female salmon after spawning.

Once a gull had torn into a fish to get the viscera, it would be easier for it to continue to feed on the same fish than it would be to tear open a new one, particularly if the number of carcasses was small. A preference for eggs is also given by Mossman (1958) as the principal reason for selective predation by Glaucous-winged Gulls on female red salmon.

On the second examination day (3 September 1964) both chum (45 fish total, 65 per cent female) and pink salmon (183 total, 77 per cent female) were examined. However, it is not known if the high percentages of female pink salmon carcasses were caused by a high percentage of females in the run itself, as indicated by Helle, Williamson, and Bailey (1964), by selection by the gulls, or by a combination of both. Among the chum salmon censused 55 per cent of the females were in classes 2 and 3 (10 per cent in class 3) as opposed to 25 per cent for the males (6 per cent in class 3), indicating, despite the small number of carcasses, the gull's preference for females. This is not so clear among the pink salmon because 36 per cent of the females and 30 per cent of the males belonged to classes 2 and 3. The low number of chum salmon in the sample is due to the small number spawning in the stream at this time and not to a preference by the gulls for pink salmon.

ROLE OF JUVENILE GULLS

Gulls in immature plumage were generally forced by adult birds to feed in the less desirable areas, either upstream from the prime areas or on the tideflats away from the stream, where occasional fish were left by the tide. Consequently, certain areas along Olsen Creek were characterized by the constant presence of groups of 20 to 30 juvenile birds. These birds, however, also spent much time patrolling the adult areas in the submissive Hunched Posture, feeding momentarily on unguarded fish or on carcasses rejected by the adults. Usually an adult gull had no trouble driving a second- or third-year juvenile from a fish, for they seemed to react to all the adult threat displays and even used them in juvenile-to-juvenile conflicts. Although vocalizations of the juvenile Long Call Displays were just a series of hoarse squeaks, adults and other immature birds reacted to them or, at least, to the posture. In rare cases an aggressive juvenile could actually drive an adult off a fish with a threat display.

The first-year juveniles occupied a more ambiguous position, for they usually didn't react to adult threat displays. Furthermore, their Hunched Posture tended to inhibit any direct attacks by the adults except under extreme provocation. As a result, feeding adult gulls became noticeably uneasy in the presence of persistent juveniles and often left a fish previously defended against other adults. In one case, three juveniles were observed feeding on a carcass claimed by an adult. The adult gave repeated Long Call

Displays and was completely ignored by the feeding juveniles. If the adult charged, the juveniles only scattered briefly. As soon as it began feeding again the juveniles would return and begin feeding also. The adult finally walked off, giving a Long Call to another adult feeding over 30 feet away.

The Head Tossing Display used by begging first-year juveniles was also observed frequently, although regurgitation feeding of a juvenile by an adult was observed only once.

DRIFT EGG FEEDING

Much of the Glaucous-winged Gull's time on Olsen Creek was spent bobbing for loose salmon eggs that rolled along the stream bottom, carried by the current. These eggs were primarily those which were dug up by salmon spawning at a site where other salmon had spawned previously. When drift egg feeding, a gull swam with the current until it spotted an egg. If the egg had been forced to the surface by an eddy or a digging salmon, the gull simply ducked its head and grabbed it. If the egg was deeper, the gull jumped up from the surface of the water and dived headfirst after the egg, often completely submerging. The gulls would also stand in shallow riffles and catch eggs rolling by. A gull intercepting eggs on a riffle appeared to have interactions with other gulls very similar to those centering around carcasses. A swimming gull, however, was exceptionally vulnerable to an attacking bird. When the attack came from the air, the swimming bird was helpless. It either had to fly up at the low-flying approach of an attacker or be bowled over, for the attacker always tried to land on top of the swimmer, throwing it off balance in the water and making it practically helpless before further onslaught. Thus, in all of 58 such attacks, the swimming gull either flew up at the approach of another gull coming in low over the water or, if caught by surprise, was knocked off balance, fleeing as soon as it could.

Another behavior pattern associated with riffle egg feeding was paddling (reviewed by Tinbergen (1960)) in which the gull stood in one place and trod rapidly in shallow water. Tinbergen concluded that for Black-headed Gulls (*Larus ridibundus*) feeding in shallow pools, the primary purpose of paddling was to stir up invertebrates, which then revealed themselves by moving. In Olsen Creek, paddling usually occurred when a Glaucous-winged Gull was standing in a shallow riffle. Its apparent purpose was to loosen salmon eggs from the surface gravel, although it was observed both before and after a gull had bobbed for an egg.

SUMMARY

The feeding behavior of the Glaucous-winged Gull was studied on Olsen Creek, a salmon stream flowing into Prince William Sound, Alaska. It was found that feeding

took place in two distinct situations: (1) on the banks of the stream on salmon carcasses pulled up by gulls or bears and (2) in the stream itself, on salmon eggs drifting with the current. The behavior patterns centering around the defense of salmon carcasses appeared to be very similar to the territorial displays of the breeding season with these exceptions: actual territories did not exist, the carcasses were defended only by hungry birds, and the attacking gull won more often than the defender in disputes over a carcass. Upright Displays, Oblique-cum-Long-Call Displays, and Mew Call Displays were all observed frequently during carcass defense. The effectiveness of such behavior, however, tended to break down in the presence of bears feeding on freshly caught salmon, particularly when the salmon were females. The gulls also seemed to exhibit preference for female over male carcasses of spawned out salmon. Birds in immature plumage usually could not defend a salmon carcass against adult gulls, although first-year juveniles had a certain immunity to attack by their unresponsiveness to adult threat displays. Apparently, even adults cannot defend themselves against other adult gulls while diving for drift eggs in the stream. At the approach of a low-flying attacker, the swimming gull must either fly up or be bowled over. If drift egg feeding occurs in a riffle, however, the riffle can be defended like a salmon carcass. Paddling, probably to stir up salmon eggs caught in the surface gravel, also occurred in the riffles.

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THE SELECTION OF SEED SIZE BY FINCHES

Henry A. Hespenheide

Theories dealing with ecological aspects of species formation in birds and diversity within avian communities have used ratios of culmen lengths as indices of the disparity between the niches of sympatric congeneric species (Klopfer and MacArthur, 1961). The use of such indices assumes, in most cases, a relation between the size or shape of a bird's bill and the size and shape of the food it eats; Snow (1954) has even gone so far as to correlate particular bill types with particular habitat types. This assumption, although frequently made, has never been satisfactorily demonstrated experimentally. Two recent studies have shown that different bird species feed on different sizes of food in the wild: Bowman's study of congeneric species (1963) is discussed below; Gibb (1956) has shown that unrelated species will feed on different sizes of the same food, but did not discuss the role of bill size and shape which is complex in his case.

The present study was undertaken with the idea of investigating the morphological determinants of feeding from a simple experimental standpoint. In general, one may visualize a bird's feeding as involving four steps: the psychological choice of food, its acquisition, preparation for swallowing, and digestion. Experiments were designed to test the first and third of these—that is, to show that birds of two different species with different bill sizes would not only choose different sizes of the same food, but also feed more efficiently on them. Kear (1962) has already shown that different bird species of the same family will choose and feed more efficiently on different sorts of food; Bowman (op. cit.) has shown that congeners will feed on different sizes of different foods. The role of the factors of taste or nutritional preferences, as well as of differences in the degree of difficulty in husking different seed types, could not be readily assessed in either study. Consequently, the study below used only different sizes of the same food, thus allowing analysis of the mechanical aspects of feeding alone.

MATERIALS

The species used were the White-throated Sparrow (*Zonotrichia albicollis*) and the Slate-colored Junco (*Junco hyemalis*), individual subjects being trapped from populations wintering in North Carolina. Drawings of the bills of the two species are given in Figure 1. The shapes are basically the same, although the culmen of the junco is somewhat more convex at the tip (see Bowman, 1961:141ff., for a discussion of bill shape). The differences in the size of the bills are given in Table 1. The ratio of the larger culmen measure-

FIG. 1. Drawings of bills of test species (not to scale).

ment to the smaller is small, that of the larger depth to the smaller being somewhat greater. The unequal difference in bill depth as compared to length is probably more important than the length itself in determining the demonstrated differences in feeding; the advantage of a relatively deeper bill of the same shape has been summarized by Bowman (1961:153f.). No single dimension can be used, a priori, as an index of differences in feeding.

TABLE 1
MEASUREMENTS OF TEST SPECIES

Measurements*		Junco	Whitethroat	Ratio: Whitethroat/Junco
Net length (without tail)	mm	79.7 (56)	85.8 (14)	1.08
Bill: Exposed culmen	mm	11.0 (56)	11.4 (14)	1.04
Depth at base	mm	6.3 (39)	7.7 (14)	1.22
Weight	g	21.1 (856)	27.1 (347)	1.28
Ratios—				
Culmen/length		0.138	0.133	0.96
Depth/length		0.079	0.090	1.14

* Linear measurements taken from Ridgway (1901); all are averages of male and female averages, those of the junco for all subspecies. Sample size given in parentheses; Ridgway seems not to have measured all junco specimens for depth of bill. Weights from Helms (1963); the mean fat class of the species differed by only 5 per cent. The ratio of the cube roots of the weights was 1.078, negligibly different from the ratios of the adjusted lengths.

TABLE 2

WEIGHTS OF SUNFLOWER SEEDS*

Size class (mm)	Sample 1			Sample 2 total (g)	Difference (per cent)
	Shell (g)	Kernel (g)	Total (g)		
9–11	0.957	1.184	2.141	2.085	–3
11–13	1.015	1.311	2.326	2.235	–4
13–15	1.313	1.744	3.057	2.957	–3
15–17	1.682	1.988	3.663	3.774	+3

* Each measurement is the total weight of 25 seeds; only the total weights were measured in the second sample.

In the tests only sunflower seeds were used, because they were the only seed type readily available that both had a husk and was large enough to exhibit measurable size differences. The seeds were individually measured and assigned to one of four size (length) classes: 9 to 11, 11 to 13, 13 to 15, and 15 to 17 mm, seeds of exactly 11, 13, or 15 mm being discarded. Table 2 gives the average weight of kernel and husk for 25 seeds of each class; the totals of this sample compared with those of a second such sample differ regularly by a factor of only 3 per cent and not always in the same direction. The way both species open the seeds suggests that the thickness of the seed is, in fact, the most important dimension to the birds. The seed is held crosswise in the bill at the thickest portion of the seed and billed vigorously, being rotated occasionally so that the longer end of the achene sticks out of first one side of the bill and then the other. Both species opened the seeds in this way.

As noted, the midrange values were assigned to the seed size classes: none of the measurements were recorded nor averages made. It can be shown that the mean lengths of the seeds in the longest and shortest size classes were shorter and longer, respectively, than the midrange values expected. This result might have been predicted in view of the difficulty in obtaining seeds from these classes; this means that in the graphs (Fig. 2) the spacing of the seed classes on the abcissa is not equal, and the two extreme classes are closer to the middle two than shown.

CHOICE EXPERIMENT—PROCEDURE AND RESULTS

Three birds of each species were used. These were placed all at once in a small room roughly 8 by 12 feet in size. The two species were kept separate by a net partition along the long axis of the room. The birds had prior experience with the four seed sizes, both separately as their only food for some periods and mixed with their regular seed mixture at others (cf. Kear, op. cit.). The birds were then presented with a choice situation in which 200 seeds, 50 of each of the four sizes, were offered as the only food for six-hour

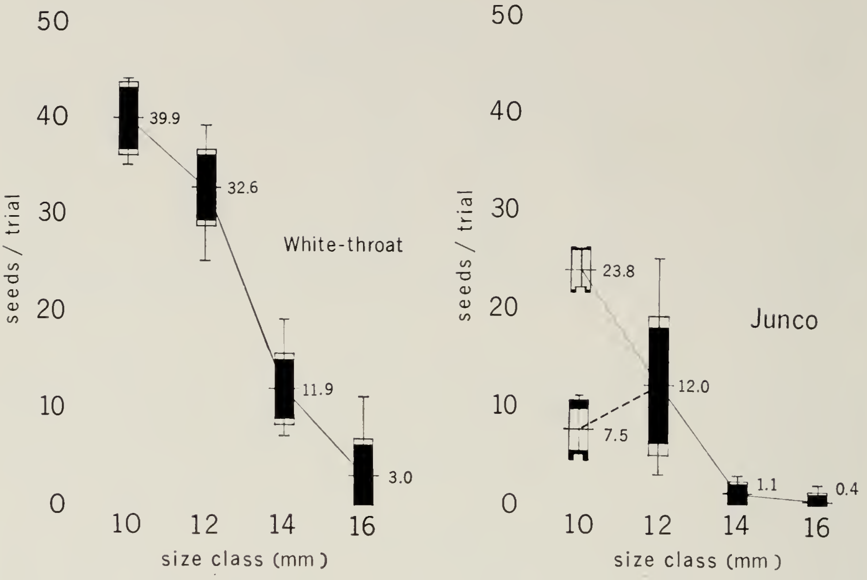

FIG. 2. Average seed consumptions, out of 50 seeds offered, for eight tests. The vertical line gives the range; the open vertical band, the standard deviation; the closed vertical band the 95 per cent confidence interval of the mean; the horizontal line, the mean. The upper figure of the smallest junco seed class is for the first four tests; the lower, for the second four tests.

periods. The seeds were placed in four separate cups on the inside of a special feeding dish that allowed only one bird to feed at a time; thereby peck-order relationships were prevented from affecting preference. At the ends of these periods all shells and uneaten seeds were removed and the number eaten calculated. A mixture of different sorts of seeds was used as food between tests. Two series of four tests were run; the results are given in Figure 2. The results require a qualification with respect to the drop in consumption of the smallest seeds by the juncos in the second series of tests. The smallest seeds used in this series of tests had been taken from a newly bought batch of seeds because of the scarcity of seeds of this size class in the original material. The new seeds were noticeably different in shell markings from the original material and showed no air space, present in the first seeds between the seed coat and the kernel. Apparently this closeness made the shells too difficult to open. This interpretation is supported by the fact that the drop occurred in this class alone and, surprisingly, was not balanced by an increase in consumption of larger seed types: the Whitethroats were not affected.

TABLE 3
KERNEL EXTRACTION TIMES OF WHITE-THROATED SPARROWS

Size class (mm)	Number observations	Mean (min)	Range (min)	Standard error (min)
9–11	20	1.22	0.23–4.85	0.255
11–13	20	1.43	0.37–3.50	0.205
13–15	14	2.01	0.33–3.88	0.288
15–17	13	2.38	0.58–5.02	0.383

EFFICIENCY EXPERIMENT—PROCEDURE AND RESULTS

The birds' efficiency in extracting the seed for swallowing was measured by observing the time taken by two White-throated Sparrows to husk individual seeds of each of the four size classes. A single bird was isolated on one side of the experimental room and fed with seeds of a single size class. The bird was observed through one-way glass and timed from when he picked up and began billing the seed to the time he hopped away from, or stopped paying attention to, the empty shells. The time the bird is occupied in extracting the seed—and thus prevented from any other feeding—is considered more significant than just the time taken to break the shell (cf. Kear, op. cit.). The extraction times, measured in minutes, are given in Table 3. One bird was observed for 10 scores in each of the four size classes; the other bird was used for the rest of the scores, escaping before the full 40 scores could be obtained. Although over 12 hours of observations were made, only six scores could be obtained for juncos so that conclusions on efficiency must be drawn from the Whitethroat scores alone. (The junco scores were, for 9–11 mm seeds, 0.92, 3.37, and 7.13 minutes; for 11–13 mm seeds, 0.77, 2.97, and 4.55 minutes. These scores are higher, on the average, than those of the Whitethroats.)

Because of the large variance in the Whitethroat scores, a linear regression was run on the data to determine whether or not the observed increase in extraction scores with seed size was significant. A slope of $b_{yx} = 0.36$ was obtained with 95 per cent confidence intervals of ± 0.22. This value of the slope may be low since the midrange value assigned as the value of x was too high and low for the largest and smallest seed classes as discussed above.

DISCUSSION

The major structural difference of the Whitethroat bill from that of the junco is that it is relatively deeper. The data from the choice experiment and the few junco husking scores indicate that the Whitethroat feeds more easily on sunflower seeds than does the junco. The Whitethroat test individuals on the average ate 2½ times as many seeds of all classes in a six-hour period as the junco. The junco took 64 per cent of its seeds from the smallest class and only 4 per cent from the largest two, whereas the Whitethroat ate 45 per cent from the smallest and 17 per cent from the largest two. For the Whitethroat the sharp decrease in seeds chosen and sharp increase in husking times came between the 12- and 14-mm seeds, although, as noted previously, the difference in average seed size between these intermediate classes was probably greater than that between either the 10- and 12-mm or 14- and 16-mm classes. The possibility does exist that the choice curve is somewhat higher in the relative proportion of the second seed size taken by the Whitethroat because of the limiting of the amount of seed in the tests to only 50 per class; that is, the birds may have been forced to eat the larger seed when the supply of the smaller was exhausted. For the junco the inflection seems to lie within the 12-mm class, hence the wide variance in that class in the choice trials.

Kernel intake efficiencies were obtained by dividing the kernel weights of the seed classes (Table 2) by the husking scores (Table 3). When a linear regression is run on the resulting values, however, the slope is not significant, having a value of b_{yx} on the order of -10^{-6}. Although the slope of the husking scores was significant, because both they and the kernel weights were increasing with the length of the seed, the resulting quotient is not. A greater number of observations might show a significant slope.

The working hypothesis is that each species is adapted to feed most efficiently on an optimal seed size that is in some way related to the size and shape of its bill. That there is no obvious increase in efficiency of kernel intake with decreasing seed size for the Whitethroat is somewhat surprising, although all the seeds used in the experiment are larger than the normal seeds in the diet of the Whitethroat, and an increase in efficiency could well occur in a smaller size class than any tested in these experiments. Studies in progress on the food size of flycatchers, swallows, and vireos indicate that such optima do exist. It has been suggested by Dr. John Smith (pers. comm.) that differences in feeding technique, and, of course, habitat, not investigated here, are the primary means for niche separation in the case of the Whitethroat and junco.

SUMMARY

The frequent assumption that the size of a bird's food is correlated with the size and shape of its bill is supported by experiments on food choice and feeding time. In the first experiment White-throated Sparrows (large-billed species) and Slate-colored Juncos (small-billed species) were fed different sizes of the same food in a choice situation; in the second experiment the time taken to extract the kernel of each of the seed size types was measured for White-throated Sparrows. Two aspects of the feeding are shown: (1) that the relative choice of different sizes of the same seed is different for the two

bird species of different bill size, in a way predictable by the bill size; and (2) that choice of seed types by one of these species is generally correlated with the bird's speed in opening these types.

ACKNOWLEDGMENTS

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COLLECTIVE TERRITORIES IN GALÁPAGOS MOCKINGBIRDS, WITH NOTES ON OTHER BEHAVIOR[1]

JEREMY J. HATCH

COLLECTIVE territories do not fit easily into the more usual categories of territoriality (e.g., Hinde, 1956) and the few cases described for birds demonstrate a variety of forms. In the evolution of social behavior in the Crotophaginae, one of the six subfamilies of cuckoos, the defense of colonial territories coincides with the reduction or disappearance of territorial defense by the pair, which has permitted communal nesting (Davis, 1942). In contrast, the Jackdaw (*Corvus monedula*) and Rook (*C. frugilegus*) both defend, albeit not very rigorously, colonial territories within which they feed, but also maintain pair territories around the nest. Coveys of quail (*Lophortyx californica*) outside the breeding season do not defend a particular area but familiarity with the area is important in determining the initial dominance of aliens by resident birds (Howard and Emlen, 1942). Carrick (1963) describes a particularly interesting situation in the Australian Magpie (*Gymnorhina tibicen*) in which territorialism and associated social and sexual interactions limit breeding to about one-quarter of the adult population, these breeding birds being among those in small social groups (each of two to ten birds) that live permanently within territories of five to 20 acres. In no other species has the nature of the reserve of nonbreeding birds been distinguished so clearly (cf. Hensley and Cope, 1951, who found a large but usually invisible reserve). The mockingbirds described below defend collective territories within which they feed and roost but intensive observations were not made during the breeding season.

Apart from the ubiquitous finches the mockingbirds are among the most obvious of the small land birds of the impoverished Galápagos avifauna. They have been considered sufficiently distinct from other mockingbirds (*Mimus*, spp.) to be placed in a separate genus, *Nesomimus*. Within the archipelago this genus shows considerable variation: no island has more than one form but the forms on Chatham (San Cristóbal), Hood, and the islets near Charles (Floreana) are so different from each other that they are described as separate species, and Swarth (1932) divides the fourth species into seven races that occur on most of the other islands.

The behavior of the Galápagos mockingbirds was first studied by Venables (1940) who found *N. melanotis* on Chatham Island to be strongly territorial while breeding. In particular he describes a form of aggressive territorial

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display which he calls "posture dancing" and a "branch chase" which may be sexually motivated. Both of these displays are considered again below.

METHODS

During 1962–63 I spent about three months on the Galápagos Islands and had occasion to watch the mockingbirds on several islands. Most of the observations reported here were made from 12–28 December 1962, on Hood Island where *N. macdonaldi* is numerous and particularly tame. Shorter visits were made to Tower Island (22–24 November, 4–8 January) and Champion Islet (near Charles) 11–15 January. Intervening periods were spent at Indefatigable Island (Santa Cruz). In many cases the birds were caught, usually in mist nets, and marked with colored plastic legbands. On some occasions identifications were based on plumage characters.

On Hood Island our camp was about two miles east of Punta Cevallos on the north shore at the eastern end of the island on a small triangular patch of sand between the bank of rounded lava boulders that fringes the sea and the thorny shrub characteristic of the island. Immediately upon our arrival we were "taken over" by the resident "band" of mockingbirds that were a constant source of delight to us with their boundless curiosity. Their tameness meant that it was little trouble to catch them in mist nets (or by hand in the cooking pots) and I marked a total of 21 birds at various places near the camp. Most of the observations were made on these birds, in the course of other work. In addition I watched some of the mockingbirds on the south coast for short periods and marked four of these.

RESULTS OF MARKING

On Hood Island the mockingbirds on the north shore characteristically occurred in groups that I have called "bands." Of the 21 birds marked near our camp, six comprised the band that occupied the campsite (called RW's band after the color combination of the dominant member). Eight formed RR's band to the east of the camp. Of seven marked birds in these two bands, three were rarely or never seen again, two were in a band of seven to the west and two formed the band to the south of the campsite.

None of these mockingbirds showed the spotted breast characteristic of young ones (Swarth, 1931), nor did they have the yellow gape and buff-colored rump that I saw on young *N. parvulus* on Indefatigable Island. Every bird was in worn plumage; the tails were so worn that measurements were difficult to evaluate but the 20 wing measurements fall clearly into two groups which fit well with Swarth's (op. cit.) nonoverlapping measurements for males and females. In the two bands there were eight males (of which six were heard to sing) and six females.

OBSERVATIONS OF BEHAVIOR

Each of the two bands of mockingbirds (RW, RR) studied closely occupied a restricted area within which they fed and roosted; this situation seemed to apply elsewhere near the coast, but in the more arid interior of the island the mockingbirds occurred in twos, or less often threes or fours, and during my brief visits I saw little territorial behavior. On the windswept treeless southern coast of the island amongst the nests of boobies (*Sula nebouxii* and *S. dactylatra*), frigatebirds (*Fregata minor*), and albatrosses (*Diomedea irrorata*) the mockingbirds appeared not to form discrete bands and to lack the obvious dominance hierarchy of RW's band. For much of the time the members of a band moved around together in a widely scattered group. Occasionally (six or more observations) a single alien bird furtively crossed a territorial boundary only to be driven off by one or more of the residents (nos. 1, 2, 4, and 6 were observed chasing intruders). The structure of these bands and the relations between bands are described below.

Intragroup behavior.—On Hood Island the mockingbirds are particularly noisy and the most noticeable behavior within the band is a display which resembles the begging of young birds. It is given by both males and females to dominant members of either sex. The crouched posture is accompanied by a raucous squeak (Fig. 1) and is apparently a sign of submission. Very frequently the submissive bird turns its back on the dominant individual. Occasionally this submissive posture is given in response to the call of a dominant bird up to 20 yards away. In feeding situations there was a linear dominance hierarchy, demonstrated by "Begging" to all higher birds, except that in RW's band (at least) no. 2 did not beg to RW (no. 1) but gave a faint rattle call instead; between nos. 2 and 3 there was no begging and it was as if they were equal. I never saw a Begging bird being fed, but at least twice the dominant bird pecked in a slow, hesitant manner at the open beak. Bryan Nelson writes (in litt.), ". . . if a dominant individual is trying to dispel another bird from, say, a source of food it uses (or may use) a *quite distinct* form of pecking, which is essentially that used to hoist heavy twigs or stones aside, when feeding." I never recorded this kind of pecking possibly because it only occurs commonly amongst larger, probably unstable, groups of mockingbirds. A silent running chase in which the wings were slightly drooped occurred frequently, and occasionally ended with the chaser (male) attempting to peck the nape of the chased (female?). This is Venables's "branch chase" except that I usually saw it on the ground. This type of chasing was

FIG. 1. Begging Display. The bird on the right has just arrived and is dominant to the bird on the left. (Photo by R. W. Risebrough.)

mostly seen between 1, 3 and 5, 6, suggesting that they were pairs, but I saw no copulation. Dominant birds also chase squawking subordinates. I could detect no differences in the dominance of individuals in different parts of the group territory, but I did not set up feeding stations or watch extensively at distant sites. Some of the interactions within RW's band during 0600–1200 hours on 15 December 1962 are recorded in Table 1.

Of the members of RW's band, RW and no. 3 sang each day in occasional short bursts, preferring different song posts. Song was twice heard briefly from no. 5, the only other male in the band. On five occasions mockers (two then unmarked, once RW, twice no. 5) were seen to carry a twig to two uncompleted nests in bushes. Three of RR's band sang (two birds with the measurements of males were not heard to sing).

J. B. Nelson (in litt.) considers that the mockingbirds at Punta Suarez recognized each other by their facial patterns; frequently "before attacking, a bird would run round or stretch round and peer into the face of the other as though it was uncertain of the other's identity." In this region the bands apparently number up to 40 individuals which may account for this un-

TABLE 1

INTERACTIONS OF MEMBERS OF RW BAND

Subordinate individual	Sex	Dominant individual					
		RW	RBk	PM	OB	BY	OG
RW	♂	—					
RBk	♂	B, (C)	—				
PM	♀	(R)	(R?)	—			
OB	♀	—	B, C	B, C	—		
BY	♂	B	4B, C	2B, 2C	2B, (C)	—	
OG	♀	B	B	C	(C)	C, 2R	—

The majority of interactions that occurred between dawn and 1200 h on 15 December 1962 are included. Parentheses indicate interactions observed on other days. B = Begging-squawk. C = Chase and squawk. R = Silent running-chase.

certainty, for I saw little behavior that could be explained in this way amongst the bands of six and eight that I watched closely near Punta Cevallos.

Intergroup behavior.—On Hood Island Dancing occurred whenever two bands met, but this was infrequent. Usually it was initiated by the dominant members of the bands and often spread to all the others nearby so that ten birds might be posturing at each other. I never saw two lone individuals Dancing (except once on Tower Island). It seemed to me that one band was opposing the other and it was not merely "other birds attracted by the spreading excitement and by their natural curiosity," as suggested by Venables (1940) for *N. melanotis.* The Dancing occurred at the boundary of the collective territory (Fig. 2) and presumably the display serves to delimit this boundary. The form of the dance is rather similar to the Dancing of *Mimus polyglottos* which is described in detail by Hailman (1960) except that flicks of the tail and wings are more pronounced. Ranged on either side of an imaginary line the birds make a series of forward, backward, or lateral steps following and keeping within about three feet of each other and often almost touching. Each jerky step is accompanied by a flick of the wings and followed by an exaggerated upward flip of the unspread tail. The tail-flip sometimes included some lateral movement also. The characteristic posture during this display is an upright one with the body tall and thin, but this is usually alternated with a head-forward position sometimes with feathers fluffed (presumably betokening a more aggressive tendency). The head-up posture is more often accompanied by a step back or sideways and the head-forward posture by a step forward. Dancing is often accompanied by various calls, some are squawks probably given by non-dancers in response to the other calls. On the few occasions I saw single birds chased from a territory, these were never the dominant members of a foreign band.

The mockingbirds in the seabird colonies on the south coast were often in groups but I found no evidence of territorial behavior and I never saw a

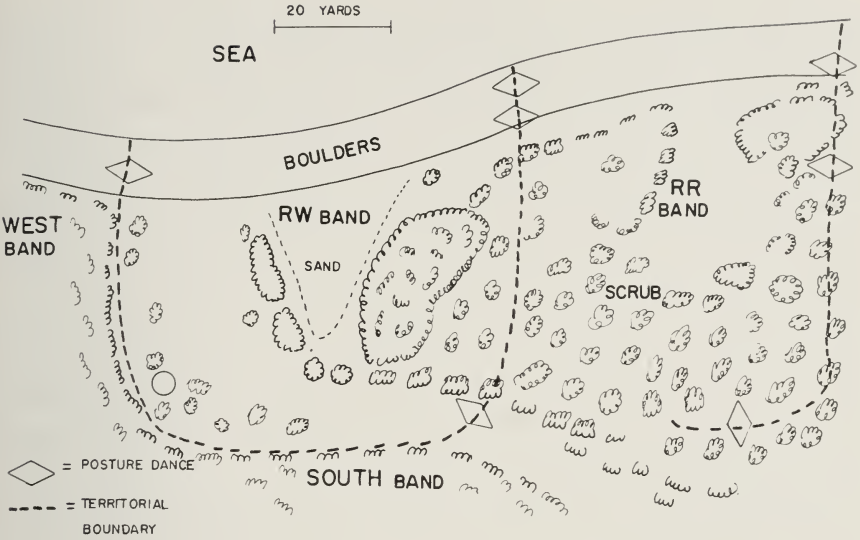

FIG. 2. Sketch map of territories of mockingbirds on the north coast of Hood Island, showing approximate boundaries (from observations of feeding, chasing, etc.) and sites of observed Dances.

Dance. However, the Nelsons saw two Dances and other territorial behavior in the seabird colonies on Punta Suarez. Of about 20 mockingbirds that clustered at my feet to drink from a small can of water, I marked four and subsequently saw some of these up to half a mile from the marking site.

On Tower Island Dancing by *N. parvulus* was seen on several occasions, once between two birds (one, at least, a songster) immediately following a fight (the only fight that I saw). Four bands, of two to four individuals each, could be distinguished in the area near our camp at Darwin Bay.

On Indefatigable Island the mockingbirds (*N. parvulus*) are less numerous and less tame than on Hood; some of them were nesting during the period November 1962–April 1963. Dances were apparently limited to pairs and I never saw other birds attracted to the dancers as described by Venables for breeding mockingbirds on Chatham Island. Once I saw a recently fledged bird beg (unrewarded), sing briefly, and feed the next brood of its parents in the nest.

On Champion Islet there were few *N. trifasciatus*; I saw Dances on four occasions, but noted no clear differences from the Dances of *macdonaldi*.

Other behavior.—Not only are the mockingbirds of Hood fearless of man but they also showed no fear of a hawk (*Buteo galapagoensis*) while it perched in the camp. They neither mobbed the hawk nor fled from it, but did show interest in it and approached within about ten yards while it fed on a lizard (*Tropidurus*). At first sight this lack of fear seems remarkable since D. W. Snow found a hawk's nest with young near Punta Suarez (Hood) at which the food remains were mainly mockingbirds. J. B. Nelson (in litt.) observed that the mockingbirds "have a special 'chirrup' alarm call which immediately elicits a striking fleeing response from every mockingbird within hearing. We saw it several times *when a hawk flew over*." (Italics added.) I heard a few "chirrups" when the hawk flew short distances but saw no directed fleeing. At no time did the hawk fly overhead. Finches (*Geospiza conirostris* and *G. fuliginosa*) watched the perched hawk intently and made "tink" calls when it was on the ground amongst bushes. The doves (*Nesopelia*) appeared more alarmed. Several snakes (*Dromicus*) appeared in the camp and elicited immediate interest from the mockingbirds, which followed them and usually made a characteristic churring, chattering note.

Sunbathing occurred quite frequently, especially among the lower members of the band. Sometimes the bird would bend forward and fluff its back feathers but more usually it would lean to one side, raise the upper wing, and fluff the flank and back feathers while twisting the head and closing the nictitating membrane. Apparently identical movements were seen during three light misty showers.

DISCUSSION

Territory and dancing in two other mockingbird species.—*Mimus polyglottos* of North America defends a pair territory in the spring and summer and both sexes may defend individual or joint winter territories (Laskey, 1962) but the pattern of exclusive breeding territories is distorted by the presence of a rich source of food (e.g., a feeding station at a house) to which territorial birds come from up to ¼ mile but show no lasting territorial behavior near the feeding place (Michener, 1951). Dancing usually involves only two birds but Michener and Michener (1935) watched pairs opposing a new bird on several occasions. The Micheners' observations suggest that Dancing occurs during the establishment of the territories: my limited observations support this. Even when territories are being established, Dancing is a rarer display than the Dancing of *Nesomimus*, which occurs through a longer period.

In the arid coastal region of Ecuador the mockingbird, *Mimus longicaudatus*, is locally numerous and was breeding during my stay at Palmar during February and March 1963. They are markedly less aggressively territorial than *M. polyglottos* and respond less noisily to humans approaching nests with eggs or young. Marchant (1960) agrees that the territories may be less strongly held than *M. polyglottos*, and suggests that there may be a tendency to polygamy. "Amicable associations of more than two birds were often noted in the breeding season, apart from the normal dry-season parties, and pairs forage for food for the young or building material far from their own territories, across intervening ones." I saw a few groups of three or four adult individuals but did not elucidate their breeding status; on one occasion I had a distant view of a Dance in which four of seven birds were involved.

The significance of collective territories in Nesomimus.—It is difficult to evaluate the ecological significance of the collective territories without a series of observations of marked birds extending through the breeding season. The clutch size of *parvulus* and *melanotis* is two or three (Venables, 1940), and *macdonaldi* is unlikely to differ markedly from this, so if the bands represent family parties they must be derived from several broods and have existed since the previous breeding season and subsequent postjuvenal molt. Breeding and molting may be dependent upon increased food, and thus upon rainfall, which occurs irregularly from December to March. The peak of breeding is probably about February; two broods per season are well known (Venables, 1940) and there might be more. Swarth (1931) suggests on the basis of 78 specimens, that the annual and postjuvenal molts are "accomplished by different individuals over a long period of time." But to explain the smaller bands inland it would be necessary to postulate a lower breeding success there. Alternatively the young birds from inland might move to the coast and form the large southern groups. Perhaps these southern birds are nonterritorial nonbreeders (with no nest-sites nearby) taking advantage of the rich food supply in the littoral zone or from the seabirds (cracked eggs, food scraps, etc.; Hatch, 1965), and are thus akin to Carrick's nonbreeding magpies (Carrick, 1963). If this is true, then the holding of collective territories may be linked with the control of population in the absence of many predators. It would be interesting to discover the fate of the different birds during the breeding season: do the bands split to form exclusive breeding territories and do the birds at the south coast move inland to breed although continuing to feed among the seabirds? These observations, admittedly scant, are reported in the hope of encouraging others to take advantage of the avifauna peculiar to the Galápagos Islands.

SUMMARY

Mockingbirds (*Nesomimus macdonaldi*) on part of Hood Island in the Galápagos were found in December 1962 to occupy collective territories within which they fed and roosted, which they defended against neighboring bands with a characteristic "Dance" similar to that of *Mimus polyglottos*. Within the band of four to ten birds there is an approximately linear hierarchy and up to three individuals were heard to sing. Elsewhere on the island, amongst seabird colonies where there were no nesting sites, the band structure was apparently absent and it is suggested that these may be nonbreeding birds. Behavior of mockingbirds on other islands was not markedly different. Some observations are presented of other behavior patterns including responses to potential predators, and recognition of individual mockingbirds.

ACKNOWLEDGMENTS

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DEPARTMENT OF ZOOLOGY, DUKE UNIVERSITY, DURHAM, NORTH CAROLINA, 11 JUNE 1965

NEW LIFE MEMBERS

Two new additions to the list of Life Members of the Wilson Ornithological Society are Mr. and Mrs. Stanley S. Dickerson of Somerville, New Jersey. The Dickerson's are well known among eastern ornithologists as enthusiastic bird-banders. Since 1953 they have banded over 43,000 birds of more than 170 species. For a number of years Mrs. Dickerson was the leader of the Island Beach, New Jersey, Operation Recovery Station, and more recently they have operated an OR station on Block Island, Rhode Island. Mrs. Dickerson has been the long-time treasurer of the Eastern Bird Banding Association. Mr. Dickerson is a graduate of Rutgers University and Newark Law School, and is a practicing attorney. Mrs. Dickerson attended Duke University and Combs Conservatory. They are parents of four children, and include among their many activities membership in most of the ornithological and conservation organizations in this country, and a few abroad as well.

AGONISTIC BEHAVIOR IN THE MALE STARLING[1]

CHARLES R. ELLIS, JR.

THE Starling (*Sturnus vulgaris*) has been the subject of much biological research and the important details of its life history in North America are known (Kessel, 1957). Nearly all of the literature on behavior of Starlings is anecdotal or fragmentary. However, Davis (1959) has named and described certain patterns used in courtship and also certain vocalizations. This report is restricted to the ethological description of agonistic behavior. The purposes were: (1) to identify and describe specific behavior patterns of male Starlings in aggressive situations, and (2) to analyze some relations of agonistic behavior to social organization.

MATERIALS AND METHODS

Caged birds.—The Starlings were housed in 6 × 6 × 6-feet cages. A special observation cage was 6 × 6 × 12 feet long. The birds were fed ordinary dog mash in standard poultry-chick feeders. Water was provided ad lib. in standard poultry water dishes. Perching bars were installed: some were adjustable as to length and location. Natural daylight was supplemented by 150-watt bulbs overhead. No attempt was made to control the length of day to conform with natural conditions; the lights were often on for several hours after sunset. The building was imperfectly heated: thus, the temperature varied but never reached freezing.

The caged birds were color-banded and their symbols were derived from the color combination (BY = Blue–yellow, e.g.).

Wild birds.—The wild birds observed were members of local populations breeding in the area. Many observations were obtained in a certain woodlot that contained a high density of territorial males. Identification of sex in spring was accomplished by use of the bill-color character (Witschi and Miller, 1938), namely, blue base in males and pink base in females.

Observational methods.—Observations of the caged birds were made through a one-way mirror and reported on a tape recorder. Data gathered on wild birds were necessarily qualitative since the availability of individuals could not be controlled. Also, a given individual was frequently inactive, absent, or doing the same thing for long periods of time.

Most of the results of the study of the caged birds apply to birds in nonbreeding condition, but there was some indication of sexual behavior in the latter part of January 1964. This restriction was justified because the emphasis was directed to the role of agonistic behavior in flock organization.

Quantitative aspects.—Observations of dominance relations were made on

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a captive flock of 12 male Starlings. The dominance of one bird over another was regarded as demonstrated if on an encounter the opponent was physically displaced from its perch, regardless of the particular display causing displacement. No judgment of "win" or "loss" was made if neither bird was displaced. The observations were summarized in win–loss diagrams; the judgment of relative rank was based on how many encounters a bird won and with which bird it fought. When two birds appeared to be tied for a particular rank, the decision was made by qualitative remarks in the notes.

The data on the dominance hierarchy were gathered during two main periods: one beginning in the second half of July 1963 and another beginning at the end of December 1963. The second sample was larger in terms of hours of observation time.

A manipulation of the flock on 21 February 1964 consisted of the removal of six of the birds. Their symbols and rank in the hierarchy were as follows: WY-3, BW-4, YY-5, YW-9, WW-10, and W-11. On 22 February five new birds were color-banded and introduced into the cage. Observations of encounters were made and in this sample the initiator of all but one encounter was known. The dominance hierarchy was assessed as before.

RESULTS

General patterns of agonistic behavior.—Agonistic behavior was observed in wild birds much less frequently than in the caged birds, a natural corollary of the ease with which a bird can escape an aggressor. Severe fighting in the wild was rare but spectacular when it did occur. Early in the breeding season males sometimes fought to exhaustion at nest-holes. Pursuit without contact, in both males and females, was much more common than fighting. In the caged birds severe encounters followed intense dominance rivalry and were easily elicited by depriving the birds of food. After the return of food, the incidence of contact aggression was high. Undeprived birds showed relatively more threatening behavior; half the displays identified were at least partially threatening in appearance.

Specific display patterns of male Starlings.—*Wing-flick* (Fig. 1). An important display consists of rapid flicking of the wings. The birds do not open and flap the wings but extend the wings from the wrist with the humerus remaining essentially folded to the body. The most common eliciting situation was the approach of a bird to another who was feeding; the latter displayed to the oncoming intruder, often continuing to feed while doing so. Subordinate birds displayed towards dominant ones as well as vice versa. The effect of the display on the intruder was variable, but a frequent characteristic was a pause, either momentary or prolonged. In 19 of 38 cases the display resulted in failure of the intruder to approach close enough to feed. In many cases

Fig. 1. *Wing-flick.* Assuming no previous encounters between these two birds, height may give the upper bird the decisive advantage.

the intruder responded with the same display before leaving or stopping. In a few cases both birds continued to display while the intruder continued to advance: when the intruder had cautiously approached, display ceased and both birds fed. In still fewer cases the display evoked outright attack by the intruder, who drove away the defending bird.

In wild birds the Wing-flick was common in birds feeding at a limited food source in winter. On a snowy morning in December 1963 about 20 Starlings were observed feeding on a pile of offal left by a deer hunter. Individuals, constantly repelled at one place, went around to the other side and tried to get to the food again. Wing-flick displays kept almost all birds nervously flicking their wings as they fed.

Vocalizations. usually high-pitched. segmented squeals, accompanied one-third of all such displays.

Fluffing (Fig. 2, right). The bird faces the opponent directly. the body feathers expanded and the crown feathers raised. A harsh vocalization accompanies the display and as the bird squeals the wings are flapped (not "flicked" as in Wing-flick). Mutual Fluffing between two antagonists was common and was sometimes prolonged if the birds reached an impasse in the en-

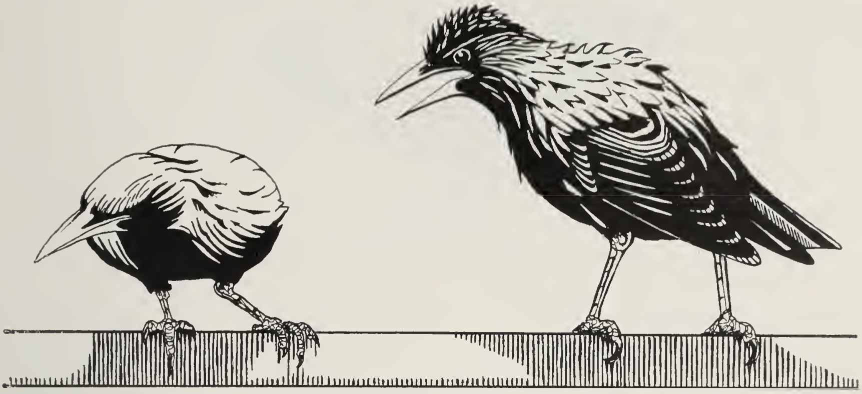

FIG. 2. (left) *Depressed Posture.* Intense form; in mild submission the bird may not bend low but merely leans away from the aggressor. (right) *Fluffing.* The feathers of the scapular area are often raised, as in this bird.

counter. The response behavior to Fluffing was highly variable (Tables 1 and 2). The usual stimulus evoking ordinary Fluffing was the approach of another bird. At times "approach" could mean even a very slight postural change in a bird 2 feet away. There seemed to be a difference in response to approach according to whether the intruder represented competition for a perching place, or whether he represented potential competition for food and water. The Wing-flick display was seldom given to an approaching bird unless the displayer was engaged in feeding, drinking, or bathing: on the other hand, fluffing was the response to random approach.

The Charge. A Starling charging an opponent exhibits all the postural components of Fluffing, the difference being the advance on the opponent. Charging may be slow or fast; in the fast form the bird moves swiftly, while in the slow form the bird simply walks. As with ordinary Fluffing a harsh vocalization is given. The result of Charging is usually the escape of the bird being charged; but sometimes the opponent responds with a Charge of his own or with the Tall Posture (see below). If the Tall Posture was given. the bird was able to resist displacement in many cases, regardless of his position in the dominance hierarchy. In one case the adversary responded with a Charge of his own and by Dance-fighting (see below) won the encounter.

Sidling. Sidling occurs when an intruder comes near a nest-hole which belongs to a bird. This bird attacks the intruder. The behavior which was seen exclusively in the wild consists of walking or "sidling" toward the intruder along a limb. Sometimes short, sidewise hops were used, and often it was clear that the aggressor was not facing the intruder. There were fre-

TABLE 1
RESPONSE OF THE OPPONENT TO 71 THREAT DISPLAYS

Behavior	Per cent
Escape	19.7
Tall Posture	19.7
Charge	11.5
Dance-fight	6.6
Bill-fence	6.6
Avoidance (in-flight)	1.6
Depressed	1.6
Not identified	32.8

quently long pauses between steps or hops, during which the bird might give the Wing-waving or Crowing displays (see below). In the usual case the intruder seemed to be oblivious until the owner was quite close. Davis (1959) described the behavior in reference to the defense of a nest-hole; in one case a defending male gradually forced an intruder 50 feet along a wire away from the hole. My observations tend to confirm that the behavior is associated exclusively with territorial conflict. Sidling did not always result in departure of the intruder; once the owner approached to within one foot of the intruder, who then attacked and drove the defending male away. In another type of situation, seen several times, the defending bird sidled toward the intruder but stopped and went into the Wing-waving display before attacking and routing the intruder. The intruder on one of these occasions had been Wing-waving also. Finally, on several occasions the owner stopped the display without apparent cue or cause.

Twitching. During the 1964 spring season of vigorous nest-hole defense, a striking behavior was seen in wild males. One male was defending a hole in the eave of a building, and at the time was perched in the top of a nearby poplar tree. An intruder landed in the tree about 10 feet from the defender. The latter, who had been Crowing vigorously (see below), ceased suddenly on the appearance of the intruder. Both sat quietly for some minutes. Then the defending male began Crowing softly and continued for about 2 minutes. Suddenly he stopped, assumed an alert pose, and began twitching his wings

TABLE 2
EFFECT OF 61 THREAT DISPLAYS ON THE THREATENED BIRD

Result on threatened bird	Per cent
He was displaced	29.5
He adjusted without displacement	29.5
He dominated his threatener	41.0

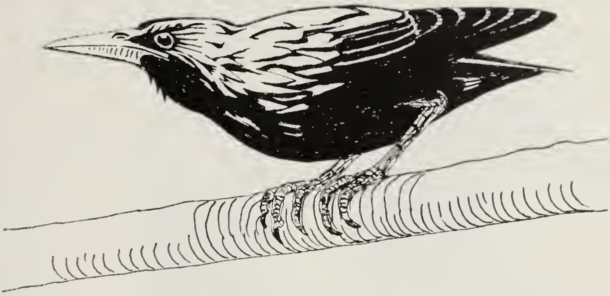

Fig. 3. *Horizontal Posture.* The basic pose is clearly an intention movement to launch flight.

and tail. The wings were not opened but rather "clutched" closer to the body (the reverse of the "flicking" seen in the Wing-flick). The tail jerked through a vertical arc and there was some lateral spreading as well. Each twitching session consisted of three or four movements. The first time the defending male twitched the intruder moved away about one foot; the second time, about 6 inches, and on the third display the intruder flew away, whereupon the defender pursued him out of sight. In another incident about the same time (April 1964), the two birds displayed in more or less continuous fashions; both flew away together. This behavior was observed by Davis (1959) on several occasions of prolonged fighting for a nest-hole. In one case the Twitching occurred intermittently for 3 days.

Depressed Posture (Fig. 2, left). When Starlings yield to another in an encounter, they display their subordination by a depressed posture which is variable but which has three constant characteristics: (1) the head is turned away from the opponent; (2) the plumage is tightly sleeked; and (3) the bird bends in a low crouch on the perch. In the caged birds the display was commonplace. A bird displaying submission seemed to be reluctant to give up his perching place. In many cases the depressed posture was followed by cessation of the aggression. A subordinate bird was once seen to hold a depressed posture, in an awkward position, for 15 seconds. In the wild, depressed postures were seen infrequently; a male returning to his nest-hole was surprised at the entrance by the emergence of the female: he immediately assumed a depressed posture.

Horizontal Posture (Fig. 3). The most intense of all threat displays seen was the Horizontal Posture. The behavior consists of a low crouch with the head drawn back on the shoulders. The bird orients toward the opponent with the plumage sleeked but not compressed. The orientation is maintained even if the opponent is flying, and no vocalization was ever heard during the

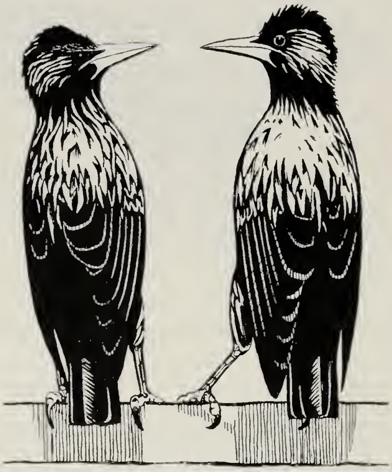

FIG. 4. *Tall Posture.* The erect stance is very striking to observe.

display. When seen in the wild, attack or pursuit followed it promptly. The display in the wild occurred three times when a returning male discovered another male in his territory. Once the defending male displayed from a housetop, then flew directly to a Starling (presumably a male) on a lawn 150 feet away where a severe fight took place on the ground; the birds were so exhausted that they lay in place for more than 5 minutes before departing. This method of attack differs from charging by being swift. It includes no vocalizations and has none of the postural characteristics of Charging.

The display was seen in the caged birds. In January 1964 the two top birds in the hierarchy (Y and BY) persecuted other birds by swift and unpredictable aggression: the Horizontal Posture was a common preface to vicious attack; it was not related to dominance status.

The Tall Posture (Fig. 4). The Tall Posture is usually a mutual display by two birds, and consists of each jerking the body taller in small increments in response to the movements of the other. In the large majority of cases (22 of 25) in which there was displacement, the bird that became taller dominated (perhaps only for that encounter). In most encounters involving the Tall Posture, however, the outcome was adjustment without displacement: usually one of the birds yielded by giving the Depressed Posture (Fig. 2). In some cases the dispute was not settled by the Tall Posture and Bill-fencing usually followed (see below). The most common stimulus for the display was the arrival of another bird at an occupied perch. In two encounters of 25, the taller bird was displaced by Bill-fencing, and in one case there was no visible height difference. In the other 22 the taller won.

Fig. 5. *Dance-fighting.* The actual attack is made with the feet rather than the beak, analogous to a captor pouncing on prey.

In wild birds the Tall Posture was seen only in the roosting situation. In July 1963 a large flock of Starlings was roosting in densely foliated maple trees on the poultry farm of the Pennsylvania State University. The birds arrived at the roost well before dark. but observation was difficult because of the leaves. However, several times birds landed on a limb between two others, whereupon all three engaged in mutual tall posturing. If both perched birds displayed, escape of the intruder was the rule; but many times the intruder overcame the resistance of one bird and succeeded in perching.

Bill-fencing. Practically all Bill-fencing followed failure of a bird to dominate the opponent by the Tall Posture. The postural components of Bill-fencing are the same as for the Tall Posture: a stiffly erect attitude and raised crown feathers. The jabs with the beak are traded one-for-one and in intense situations continue until one bird yields and escapes or gives the Depressed Posture. This posture may or may not be followed by cessation of the attack. The display was not seen in the wild. No vocalization was heard during Bill-fencing in the laboratory.

Supplanting Attack. The Supplanting Attack of the Starling seems to be little different from that seen in many songbirds. The aggressive bird simply jumps or flies toward a perch occupied by another bird. In the laboratory seldom was the victim taken unaware; he usually escaped easily. Surprise attacks occurred, however, and often resulted in fighting. Vicious Bill-fencing was the usual manner of fighting in contested supplantings, and in no case did both birds remain on the perch in question even though one might have shown intense submission. Many of the supplantings seen in the wild differed from the laboratory situation in that the attacker did not aim at the exact spot occupied by the victim; the aggressor might land as much as 2 feet from where the other had sat.

Dance-fighting (Fig. 5). A typical Dance-fight begins when an aggressive bird jumps into the air, feet extended toward the opponent. The response of the opponent is to dodge the aggressor and then jump into the air in return or else to escape. The display is very swift and the jumps by each bird may number as high as four. Usually the display ended as quickly as it had begun. Dance-fighting was never followed by pursuit, and the damage done by the fight is slight if any. Bathing behavior was always accompanied by much Dance-fighting, and even a subordinate bird would return in a moment to displace his attacker in this situation. Only two instances of Dance-fighting at the feeder were ever observed. In the wild the display was seen only a few times, all of them in the flock feeding situation in fall and winter. Encounters in the wild were limited to a single jump, the victim escaping.

Wing-waving (Fig. 6). Wing-waving is a flamboyant display seen in the breeding season and on warm days in the fall. The perched bird gives a characteristic vocalization called "screaming" by Davis (1959), and simultaneously waves the wings in rotating fashion. Although both wings are waved together they are not necessarily in synchrony. Between sessions of Wing-waving the wings are left partially extended or drooping. In every case of Wing-waving observed the feathers of the crown were raised, and in the intense form of the display they were fully erect, giving the bird a "big-headed" appearance.

Wing-waving males often perched in trees near their nest-holes; this was particularly true in the early part of the breeding season (approximately late February).

Crowing (Fig. 7). Crowing was the name given by Davis (1959) to describe a characteristic vocalization and the accompanying behavior. It was

FIG. 6. *Wing-waving.* Note vertically flexed tail; flexure occurs with each burst of vocalization. The bird perches near the defended nest-hole.

seen in both caged and wild birds, beginning about the middle of February. Males spent much time in the spring simply perched near their nest-holes Crowing. The body posture is similar to that in Wing-waving (aside from the obvious difference in wing motion); the body is held at a variable angle from upright to horizontal. The tail is flexed vertically during vocalization and the hackles of the throat are puffed out and vibrated, apparently mechanically and passively, by the sound-producing apparatus, giving the bird the appearance of having a "beard." Usually the crown feathers are depressed; the bill is pointed upward and is opened only slightly. Table 3 summarizes the differences and similarities between Crowing and Wing-waving.

Wing-waving was seldom seen in the close presence of a female unless an intruder or competing male was also present. On the other hand, Crowing occurred in the presence of either sex. In the prelaying period Starlings frequently gathered in the top of a still-leafless tree and crowed for the last quarter hour before flying off to roost for the night. Two males owning holes less than 15 feet apart, who squabbled during the day over the boundaries of their territories, often sat in this tree Crowing, apparently at ease with each other. About a dozen birds were in this group but sex determination by binoculars was impossible. Thus, the presence of females in this group was not known.

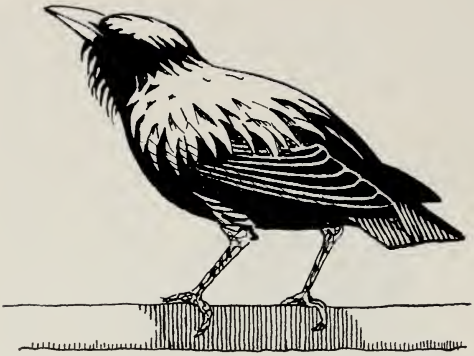

FIG. 7. *Crowing.* Note puffed throat feathers, tightly depressed crown, and nearly closed beak. Often the bird rises to an almost vertical position.

Males often crowed, as well as wing-waved, during the pauses between sidling-threat advances, but the actual competing for dominance by means of Crowing noted in the laboratory by Davis (1959) was not recognized; all displacements in the Sidling-threat situation appeared to be due to the imminence of attack or the actual attack by the sidling bird.

The function of Wing-waving remains obscure. Davis (1959) suggested that it served as communication to indicate at a long distance the presence of a bird that owned a territory.

TABLE 3

THE DIFFERENCES AND SIMILARITIES BETWEEN WING-WAVING AND CROWING

Characters without overlap between the two displays are marked**.

Character	Wing-waving	Crowing
Body posture	Horizontal to 45° angle	Horizontal to 45° angle
Wings**	Waved in circular, asynchronous fashion, or held drooping	Folded against body
Tail	Flexed vertically	Flexed vertically
Throat feathers	Puffed out, vibrated but not conspicuously	Puffed out, vibrated conspicuously
Crown feathers**	Conspicuously erect (Fig. 5)	Depressed (Fig. 6)
Bill	Sometimes widely agape, usually always open; pointed upward	Opened slightly; may be closed; pointed upward
Vocalizations	Higher pitched than crow—more stereotyped; always present in wing-waving	Vigorous but of measured tempo; quite complex with much imitation

TABLE 4

THE PERCENTAGES OF WINS OF 12 MALE STARLINGS IN AGONISTIC ENCOUNTERS
"Win" is defined as a physical displacement. Number in ( ) is the size of sample.

Symbol	First period observations July–August 1963	Second period observations Dec. 1963–Jan. 1964
Y	81 (37)	100 (57)
BY	68 (59)	94 (90)
WY	42 (53)	50 (28)
BW	29 (31)	64 (47)
YY	70 (27)	50 (14)
YG	84 (56)	46 (107)
R	41 (29)	37 (30)
BW	43 (44)	39 (38)
YW	24 (38)	21 (33)
WW	50 (18)	11 (56)
W	33 (33)	22 (23)
BR	11 (37)	2 (51)

The dominance hierarchy.—From the beginning it was apparent that the flock of Starlings was not organized into a social hierarchy of the "peck-right" type (Armstrong, 1947; Allee, 1951). Birds displaced one another at the feeder with no seeming order. Encounters were recorded by the identity of the participants; word descriptions of the action were often included, and after about a week a tentative hierarchy was recognized. At the end of the July–August period the order of the flock was well understood.

TABLE 5

THE RELATIVE FREQUENCY DISTRIBUTION OF APPROACHES AND/OR ATTACKS BY VARIOUS BIRDS
Social rank in descending order (based on the overall win–loss diagram for July–August 1963).

	Won against a:		Lost to a:	
Symbol	Dominant	Subordinate	Dominant	Subordinate
Y	—	8	—	1
YY	0	2	0	2
BY	0	10	0	5
WY	4	8	2	4
YG	2	15	0	0
RW	2	1	6	5
R	2	3	3	0
WW	0	1	2	1
BW	5	0	4	1
W	5	1	3	0
YW	1	0	1	0
BR	5	—	7	—

TABLE 6
A COMPARISON OF THE OBSERVED AND EXPECTED VALUES OF THE NUMBER OF BIRDS APPROACHING AND/OR ATTACKING SUBORDINATES

Symbol	Hypothetical probability of encounters with subordinates	Encounters with subordinates	
		Observed	Expected
Y	1.00	9	9
YY	0.91	4	4
BY	0.82	15	12
WY	0.73	12	13
YG	0.64	15	11
RW	0.55	6	8
R	0.45	3	4
WW	0.36	2	1
BW	0.27	1	3
W	0.18	1	2
YW	0.09	0	0
BR	0.00	0	0

In a flock of 12 birds, 66 pair-combinations are possible. Of this number eight were never observed in the July–August period, and seven were never observed in the December–January period; in the latter YY had no encounters with two different birds; no other bird had more than one unresolved relation.

Changes in rank occurred in the time between the two observation periods; most were small, but BW rose five places while YG descended three places. BW (Table 4) won a higher per cent of his encounters in the second period, but this figure tells little about the bird's aggressiveness: it does not tell whether BW sought the encounters that he won, which is a much better indicator of aggressiveness. Table 5 shows the relative frequency of voluntary approaches (and attacks) made by the birds of the flock, for the July–August observation period. For example, WY won against a dominant bird four times and against a subordinate bird eight times. It also lost to a dominant twice and to a subordinate four times.

If approach (or attack) occurs on a random basis, then the probability that an opponent is a subordinate is 1.00 for the *alpha* bird and 0.00 for the *omega* bird. Therefore, we may examine the data and ask if the birds in the flock approached (or attacked) subordinates more or less than expected by chance (Table 6). The number of encounters expected by chance, against which the observed values were compared, were computed by multiplying the hypothetical probability by the total number of encounters in which both individuals were identified, that is, the data of Table 5. For example, WY had 12 encounters with subordinates. On a chance basis 0.73 times 18 or 13 should have been with subordinates. When the observed and expected values

TABLE 7

THE NUMBER OF INDIVIDUALS OVER WHICH EACH BIRD ALWAYS WON, FOR BOTH JULY–AUGUST 1963 AND DECEMBER 1963–JANUARY 1964

Dominance hierarchy in descending order (based on the overall win–loss diagram for the period in question).

August 1963		December 1963–January 1964	
Symbol	Number	Symbol	Number
Y	5	Y	11
YY	4	BY	8
BY	4	WY	4
WY	2	BW	5
YG	5	YY	5
RW	2	YG	2
R	1	R	2
WW	2	RW	4
BW	2	YW	1
W	3	WW	1
YW	1	W	1
BR	0	BR	0

are summed for groups of four birds, the numbers observed clearly are indistinguishable from chance expectation.

Qualitative remarks in the notes seemed to indicate that the dominance hierarchy underwent a change toward more rigidity with time. Observations of the frequency of agonistic behavior were not taken, but the birds seemed to fight with less vigor and less often. Existing data offer a way to substantiate the claim of greater rigidity. Table 7 shows the number of individuals over which each flock member always won, for both observation periods. (It is fully recognized that given enough observation time, very likely *no* bird will win 100 per cent of the time over any other bird.) The data show that in spite of the longer duration of the second period, the top birds do have more complete dominance than in the first period, indicating greater rigidity.

The replacement of six birds of the flock with five new birds was a dramatic event. Out of a total of 152 encounters observed, 75 per cent were between the birds ultimately emerging as the top five members of the new hierarchy. The six lowest members of the flock made only seven of the 76 approaches (Table 8). The bird GG initiated 24 approaches and won every one. The bird Y did not make any approaches or attacks immediately following the introduction. On the day after introduction, however, Y had a total of nine encounters during observation with BY and GG, winning over the latter by six to three. The most vicious fighting was seen between GG and BY (the former *beta* bird); it may be significant that GG dominated the proceedings after introduction

TABLE 8

THE RELATIVE FREQUENCY DISTRIBUTION OF 76 APPROACHES AND/OR ATTACKS BY VARIOUS BIRDS

Social rank in descending order (based on the overall win–loss diagram for 22 February–3 March 1964) (* = new birds).

Symbol	Won against a:		Lost to a:	
	Dominant	Subordinate	Dominant	Subordinate
Y	—	11	—	1
GG*	2	22	0	0
BY	4	9	3	0
YG	1	4	0	0
D*	3	4	5	1
RR*	1	1	1	0
RW	1	0	0	0
RY*	0	0	0	0
WR*	2	0	0	0
R	1	0	0	0
BR	0	—	0	—

almost completely. BY challenged him immediately on introduction; the two fought "tooth and nail" with GG emerging dominant over BY.

DISCUSSION OF RESULTS AND CONCLUSIONS

Specific display patterns of male Starlings.—The Wing-flick display appears to serve as both a threat and a bluff; when given by a subordinate bird to a dominant bird, it usually causes the latter a moment's hesitation—which enables the bluffer to grab another morsel before being driven off. Its use as a threat requires little discussion. Use of a threat display may be a mechanism for permitting some greater variety of action of individuals, as compared to a more rigidly despotic type of hierarchy exemplified by the domestic fowl (Collias, 1951), but with yet a measure of social control over the individual. Charging seems to be an intense form of the ordinary threat, and as such we can posit no fundamental difference in its motivation.

That the Sidling was in fact aggressive in motivation was not understood at first because of the subtlety and unpredictability of its outcome. Its aggressive motivation now seems clear, but the explanation for the passive demeanor of the displaying birds remains obscure. The Twitching display was seen too few times to determine its agonistic role.

In the Tall Posture, a correlation exists between the height of the displaying bird and dominance. Wynne-Edwards (1962) presents evidence that Starlings return to the same spot on the limb to roost; the Tall Posture would seem to be an efficient mechanism for minimizing strife in the nightly settling-down process in roosts. Bill-fencing, a display closely related to the Tall Posture, seems to be a more intense form of the latter, but to understand it will require more detailed work on the Tall Posture. The Depressed Posture of the male Starling seems to be very similar to the display called submissive in the Jackdaw (*Corvus monedula*) described by Lorenz (1952), who concluded that the display serves to appease aggressors. The same conclusion is reached for the Starling, although tentatively.

Quantitative aspects.—Derivation of the dominance hierarchy by means of the win–loss diagram confirmed that the Starling shows "peck-dominance" rather than "peck-right" in caged situations.

The conclusion that the hierarchy in the flock became more rigid is based on subjective statements in the taped notes and on the data in Table 7. In a species showing peck-dominance, the probability that any bird will dominate another in 100 per cent of their encounters diminishes with the amount of time spent watching them. Since the second observation period was longer than the first, cases of 100 per cent domination should have been fewer than in the first period; and the fact that they had more is interpreted as demonstration that the hierarchy had become more rigid.

Introduction of new birds into a stable flock caused much excitement, but fighting was limited almost totally to birds ultimately emerging in the top half of the social order. One bird initiated one-third of all encounters.

SUMMARY

Wild and caged Starlings were studied to describe the behavior patterns of agonistic significance. Wild birds were watched in all seasons, while study of the caged birds was confined mainly to birds in nonbreeding condition. Twelve displays were recognized as having aggressive implications. Only superficial consideration was paid to the vocal aspects of behavior, but some calls seem to be aggressive in motivation and may constitute in themselves agonistic displays. Two displays were seen exclusively in wild birds; there were no displays different in quality seen in the caged birds.

Study of the dominance hierarchy in the caged birds showed that it was of the peck-dominance type, in which no bird is immune to attack from subordinates. The hierarchy shifted unexplainably, but became more rigid with time.

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NEW LIFE MEMBER

Dr. B. Franklin McCamey, Jr. has recently become a Life Member of the Wilson Ornithological Society. Dr. McCamey has been the Executive Secretary of the Hawk Mountain Sanctuary Association and naturalist at the Sanctuary, but this spring he became Director of the new Cincinnati Nature Center at Milford, Ohio. A graduate of Yale University and Yale Forestry School, he holds a Ph.D. from the University of Connecticut. His ornithological interests include population dynamics, photography, and banding. He is currently a vice-president of the Eastern Bird Banding Association. He is also a member of the AOU, The Wildlife Society, Society of American Foresters, Sigma Xi, Ecological Society of America, and the Northeastern Bird Banding Society. Dr. McCamey is married, has one married daughter, and includes among his interests most phases of outdoor activity.

GENERAL NOTES

Alpine birds of the Little Belt Mountains, Montana.—The Little Belt Mountains, an isolated range within the plains of central Montana, were the subject of a study by Hoffmann (1960. *Montana State Univ. Occasional Papers*, 1) in which he reported 95 species of birds. Yogo Peak (8,801 feet) and Big Baldy (9,715 feet), located approximately 50 miles southeast of Great Falls, are the only peaks in this range which reach into the alpine zone.

The present paper, based upon data collected in the alpine tundra on Yogo Peak 19 June to 7 August and 15 to 18 September 1964, add two species to Hoffmann's list and reports 15 species new to the alpine zone. Only four species were found nesting above timberline and two others at timberline. Hoffmann found a Killdeer (*Charadrius vociferus*) nest on the tundra in 1958 but none was seen in the present study. The Rock Wren (*Salpinctes obsoletus*) and the Vesper Sparrow (*Pooecetes gramineus*) may also nest above timberline in years when the weather is not as cold and wet as it was in 1964.

The Horned Lark (*Eremophila alpestris*) and Rosy Finch (*Leucosticte tephrocotis*) apparently breed on Big Baldy but were not observed to breed on Yogo Peak.

These observations are a portion of work done under support of a National Science Foundation Summer Fellowship. I am grateful to Dr. Robert S. Hoffmann for his help and criticism of the manuscript. All observations are from Yogo Peak unless otherwise indicated.

SPECIES ACCOUNT

Rough-legged Hawk (*Buteo lagopus*).—Not previously reported from the Little Belt Mountains. One seen 21 July and 27 July.

Ferruginous Hawk (*Buteo regalis*).—One seen 4 July. Its presence did not bring the usual high-pitched chirp from the yellow-bellied marmots (*Marmota flaviventris*) on the rocks below. Hoffmann saw this species only once within the mountains, over lower montane forest.

Golden Eagle (*Aquila chrysaetos*).—Seen daily, often in pairs. The marmots always gave a call and ran under the boulders when an eagle was overhead. Occasionally an eagle was observed to attack.

Prairie Falcon (*Falco mexicanus*).—Seen by Hoffmann but not in the alpine zone. One seen 6 July and 14 September.

Peregrine Falcon (*Falco peregrinus*).—Not previously reported from these mountains. One seen 29 and 30 June and 5 and 6 July.

Sparrow Hawk (*Falco sparverius*).—Hoffmann did not find this species above timberline and I saw it only twice (14 and 27 July), though it is a common late-summer visitant in the alpine zone in other mountain ranges.

Common Nighthawk (*Chordeiles minor*).—Not previously reported from the alpine zone. Several were flushed from a dirt road each evening between 20 and 28 June.

Olive-sided Flycatcher (*Nuttallornis borealis*).—Not previously reported in the alpine zone. One observed singing and feeding from a snag overlooking the tundra, 13 July.

Horned Lark (*Eremophila alpestris*).—One male was observed singing daily from late June to mid-July, but no females were seen. On 28 July a singing male was heard in an open park adjacent to Tepee Butte (8,000 feet) southwest of Yogo Peak. Pairs and small flocks were observed in parks at 7,800 feet on Prospect Ridge on 15 September. Hoffmann found pairs only on or near Big Baldy, with only one transient on Yogo Peak and none in the surrounding grassy parks.

Violet-green Swallow (*Tachycineta thalassina*).—Occasional. Not previously reported from the alpine zone.

Clark's Nutcracker (*Nucifraga columbiana*).—Occasional on alpine meadows and adjacent forest. Not previously reported from the alpine zone.

White-breasted Nuthatch (*Sitta carolinensis*).—Not previously reported from the alpine zone. One was seen 29 July just below timberline and another 27 July a few hundred yards upslope from the timber in a boulder slide. Hoffmann did not see this species in the Little Belt Mountains, but it had been reported by Williams (1882. *Bull. Nuttall Ornith. Club*, 7:61–63).

Rock Wren (*Salpinctes obsoletus*).—Though Hoffmann found this species common on Yogo Peak, they were uncommon in 1964, probably because of the extremely wet weather throughout June and July. They were heard singing only on sunny days. The peak of activity occurred during the first week of July when five singing males were observed on territories on the south-facing slopes of Yogo Peak. Wrens were not observed thereafter until 20 to 23 July when a pair and one young were seen. These may have moved up from lower elevations.

Robin (*Turdus migratorius*).—Occasional. One nest was located in a small fir tree on Tepee Butte above 8,000 feet and contained two or more young which fledged on 16 July.

Mountain Bluebird (*Siala currucoides*).—Common. One nest found in an old building was begun on 20 June, completed 22 June, and contained four eggs on 28 June.

Townsend's Solitaire (*Myadestes townsendi*).—Hoffmann saw this bird above timberline only once. I located one nest built in a road cut below timberline at 7,600 feet and containing three eggs on 9 July.

Ruby-crowned Kinglet (*Regulus calendula*).—Hoffmann observed this species at timberline on one occasion and I also observed it once, on 26 July.

Water Pipit (*Anthus spinoletta*).—Common. Of 33 nests, 16 were under rocks, 15 in tufts of grass, one in a rodent hole, and another in a pocket in a bank.

Western Meadowlark (*Sturnella neglecta*).—One bird was observed singing on 22 July, the first record for the alpine zone.

Brewer's Blackbird (*Euphagus cyanocephalus*).—Not reported previously from the alpine zone. A pair seen 23 June.

Cassin's Finch (*Carpodacus cassinii*).—Hoffmann found these scarce in the Little Belt Mountains, but found one near timberline. I observed only one at timberline on 5 July.

Rosy Finch (*Leucosticte tephrocotis*).—Hoffmann found these only on Big Baldy where intergradation between *L. t. atrata* and *L. t. tephrocotis* appears to occur. I found *atrata* or intermediate forms on Yogo Peak on 31 July and 2 August, but they apparently do not nest in the cirque on the east face of Yogo Peak.

Pine Siskin (*Spinus pinus*).—Occasional. Not previously reported from the alpine zone.

Vesper Sparrow (*Pooecetes gramineus*).—These appeared occasionally on the tundra in June, singing, and a male was regularly observed singing from a small tree overlooking a meadow at timberline. Not previously reported in the alpine zone.

Oregon Junco (*Junco oreganus*).—Common. Of eight nests, two had three large young and one egg, three had three eggs, one had four eggs, and two had five eggs. Fledging dates for four nests were 12, 13, 13, and 18 July. The nestling periods for two nests were 10 and 12 days. Of the eight nests, three were under rocks and five were in tufts of grass.

Chipping Sparrow (*Spizella passerina*).—Occasional. Not previously reported from the alpine zone.

White-crowned Sparrow (*Zonotrichia leucophrys*).—Common. Of seven nests located, one had four eggs, three had five eggs, two had four young, and one had five young. Young fledged at one nest on 15 July. Nests were placed as open cups in the meadow (three), in small (less than one foot high) shrubby cinquefoil (*Potentilla fruticosa*) (three), and one was under a rock. Adults apparently do not brood their eggs during rainstorms, but they were observed on several occasions to rush to their unprotected nests when a rainstorm turned into a hailstorm. Hail damage to two eggs in each of two nests resulted in abandoned nests.—Richard E. Johnson, *Department of Zoology, University of Montana, Missoula, Montana (Present address: Department of Zoology, University of California, Berkeley, California), 17 May 1965.*

Regurgitation of food by Mallard Ducks.—That water birds, by carrying resistant disseminules within their intestinal tract, are important agents of dispersal for many aquatic organisms is well known (Löffler, H., 1963. *Vogelwarte*, 22:17–20; Malone, C. R., 1965. *J. Wildl. Mgmt.*, 29:529–533; Proctor, V. W., 1964. *Ecology*, 45:656–658). The dispersal of freshwater species not capable of active overland transport and lacking resistant disseminules, while not so well documented, has largely been attributed to transport via the external surfaces of birds. A recent observation indicating that dispersal via the avian intestinal tract might be a possibility for even these organisms prompted this note.

During experiments to determine the effects of avian digestion on algal oospores and ostracod eggs, six-month-old female Mallards (*Anas platyrhynchos*) were fed to repletion on *Chara* sp. Two of the five birds under observation regurgitated portions of their meal about 45 minutes following its ingestion. Each bird vomited a ball, about one inch in diameter, of loosely compacted *Chara*. Apparently the food had not entered the stomach for it was not obviously altered by digestive processes. The cause of the vomits is unknown but it seems likely that the birds simply had overeaten. Trials were repeated numerous times but vomits never again occurred.

This observation bears little significance to the dispersal of either *Chara* or ostracods, since both possess resistant disseminules which survive passage through the intestinal tract of various birds (Proctor, V. W., and C. R. Malone, 1965. *Ecology*, 46:728–729). However, if organisms not capable of withstanding avian digestive processes were attached to plants ingested and later regurgitated by a flying bird, dispersal would be effected. Two excellent examples of organisms which might take advantage of this unique mechanism of transport exist.

Bondesden and Kaiser (1949. *Oikos*, 1:252–281), in attempting to explain the dispersal of aquatic gastropods, fed snails to ducks but found that all the snails were killed by digestion. They suggested that snails might be dispersed if vomited from the crop but did not offer evidence that this could occur. I have previously shown that aquatic snails and their eggs, when ingested by ducks, are unharmed before entering the gizzard and might be carried internally and dispersed if regurgitated from the crop (Malone, C. R., 1965. *Nautilus*, 78:135–139). At that time I pointed out that little is known of the rate of food passage from the crop into the gizzard of ducks. Even less is known concerning the occurrence and frequency of regurgitation.

Jubb (1964. *Ostrich*, 35:115–116) stated that the dispersal of fish cannot be explained by birds because fish do not possess resistant eggs. However, he failed to consider the possibility of fish or their eggs being carried within a bird's crop and later regurgitated.

For those organisms easily killed by avian digestion and by desiccation, such as fish, transport via the crop of birds would be a highly advantageous means of passive overland transport. This mechanism of dispersal largely has been neglected and data related to it are needed. Reports of regurgitation of food will make worthy contributions to the growing body of knowledge concerning the role of water birds in the dispersal of aquatic organisms.—CHARLES R. MALONE, *Department of Biology, Texas Technological College, Lubbock, Texas, 14 June 1965.*

Record of Mourning Dove kill by American Kestrel.—The following note concerns an additional prey species to the list of foods of the Sparrow Hawk, or American Kestrel (*Falco sparverius*) published by D. S. Heintzelman (1964. *Wilson Bull.* 76:323–330).

On 31 March 1964, I observed a male Kestrel attack and kill a Mourning Dove (*Zenaidura macroura*) at the University of Delaware farm, Newark, Delaware. From my automobile and with the aid of binoculars, I first observed the Kestrel perched in a large oak tree located on the border of a cornfield. As the hawk glided from the tree toward the middle of the cornfield, I could see its talons were outstretched and it appeared to strike something on the ground. Immediately, a Mourning Dove flew away, but the hawk remained on the ground. As I approached the area on foot, the hawk took flight, returned to the same oak tree, and perched. A Mourning Dove lay quivering on the ground with the entire top of its skull torn off. Apparently the injured bird was aware of my approach as it attempted to fly. Assuming that the bird was mortally wounded, I obtained a wire cage 2 × 2 × 4 feet with ¼-inch plywood ends and a 4- × 4-inch door and placed the dove inside. The 4- × 4-inch door was left open. I returned to my car and waited. After 10 minutes the hawk returned, alighted atop the cage, and, after much scrutiny, entered. The cage was oriented in such a way that the plywood end hid my

FIG. 1. American Kestrel with Mourning Dove it had just killed and decapitated.

approach from the hawk. I cautiously walked 50 yards to the cage and succeeded in closing the door. I had Mr. John T. Linehan witness my findings. With his aid, I took several pictures of the hawk and the dove (Fig. 1). I then banded and released the hawk. —Charles A. Lesser, *Department of Entomology, University of Delaware, Newark, Delaware, 17 May 1965.* (Published as Miscellaneous Paper No. 496 with the approval of the Delaware Agricultural Experiment Station Publication No. 359 of the Department of Entomology.)

Soft-shelled eggs in a Bobwhite nest.—On 17 May 1963, an unattended Bobwhite (*Colinus virginianus*) nest was found adjacent to a fence along a roadside near Bogota, Jasper County, Illinois. The nest contained seven eggs that appeared to be normal by visual examination, although the eggs were not handled. The nest was revisited on 20 May, at which time only four eggs, all soft-shelled, remained in the nest bowl. Three of these eggs were intact and one had been pecked, probably by an avian predator; very likely, avian predators had consumed the three eggs that were missing. The intact soft-shelled eggs were of normal dimensions, and were fertile (by germinal disc) but unincubated. Except for lack of a well-defined canopy, construction of the nest was characteristic of other Bobwhite nests. The nest bowl, consisting of dead leaves of redtop (*Agrostis alba*) and cheat (*Bromus secalinus*), was situated in a diffusion of blackberries (*Rubus* spp.). To our knowledge, this is the first account of soft-shelled eggs deposited in a nest by a wild Bobwhite.

Soft-shelled eggs are quite frequently produced by domestic fowl (*Gallus gallus*), especially during periods of heavy egg production (A. Romanoff and A. Romanoff, 1949. "The Avian Egg." John Wiley & Sons, Inc., New York), and also have been reported among pigeons (W. M. Levi, 1941. "The Pigeon." R. L. Bryan Co., Columbia, South Carolina). Eight soft-shelled eggs laid by wild Pheasants (*Phasianus colchicus*) occurred among 873 eggs not deposited in nests, but only one such egg was found among 10,724 eggs contained in 1,344 pheasant nests studied in Illinois during the five years 1957–61 (R. F. Labisky, unpublished data).

The immediate cause of soft-shelled eggs is either a failure of the secretive glands of the uterus to deposit the calcareous shell or violent peristalsis which prematurely speeds the egg through the uterus (Hewitt, 1939. *J. Amer. Vet. Med. Assoc.*, 95:201–210). Soft-shelled eggs may be produced by birds under conditions of unusually great disturbance, excessive feeding, or inadequate ingestion of minerals (i.e., calcium, phosphorus, and manganese) required in shell formation (Hewitt, op. cit.). Diseases, particularly Newcastle and bronchitis, caused domestic hens to lay thin-shelled eggs (P. D. Sturkie. 1954. Avian physiology. Comstock Publ. Assoc., Ithaca, New York). Among domestic fowl, induced hypothermia reduced calcium deposition and caused the premature expulsion of thin-shelled eggs (Sturkie, 1946. *Poultry Sci.*, 25:369–372). The persistent laying of soft-shelled eggs (at least four eggs) by the Bobwhite hen in a single clutch was likely indicative of a prolonged, and perhaps permanent, physiological malfunction.—Jack A. Ellis and Ronald F. Labisky, *Section of Wildlife Research, Illinois Natural History Survey, Urbana, Illinois, 9 April 1965.*

Notes on the distraction display of the Virginia Rail.—During the summers of 1963 and 1964 I twice had the opportunity to observe in some detail the distraction or "diversionary" display of the Virginia Rail (*Rallus limicola*). The observations were made in a 2.4-acre cattail (*Typha latifolia*) marsh bordering Lake Wingra, in the University of Wisconsin Arboretum, at Madison.

On 12 June 1963, at 1915 hours, as I examined an empty rail nest in the marsh, an adult Virginia Rail approached the nest site, giving repeated sharp *keck* calls. It walked about the nest site at a distance of two to four meters, with both wings held widely spread and lowered. From this position it often moved forward unevenly, with head lowered, tail raised, and the wings maximally spread, approaching within one meter of me. The body feathers were not raised. The bird continued displaying for 15 minutes, dodging between cattail clumps, approaching me, then moving away. During this time another bird, presumably its mate, was heard calling in the cattails five to eight meters away, but was not seen. I then moved about 10 meters from the nest site and stood quietly for a few minutes. Within five minutes the birds ceased giving the sharp call notes, and began a lower, rather rasping "clucking" call; immediately young chicks were heard peeping. One chick, eight meters from a calling adult, was seen running through the cattails toward it.

I witnessed a similar display on 31 May 1964, again at a nest. When I first found the nest, at 2000 hours, it was empty, and coincident with my approach an adult rail gave sharp *keck* calls from the cattails nearby. When I returned to the nest at 2015 an adult was on the nest. It left the nest when I was one-half meter away, and five downy

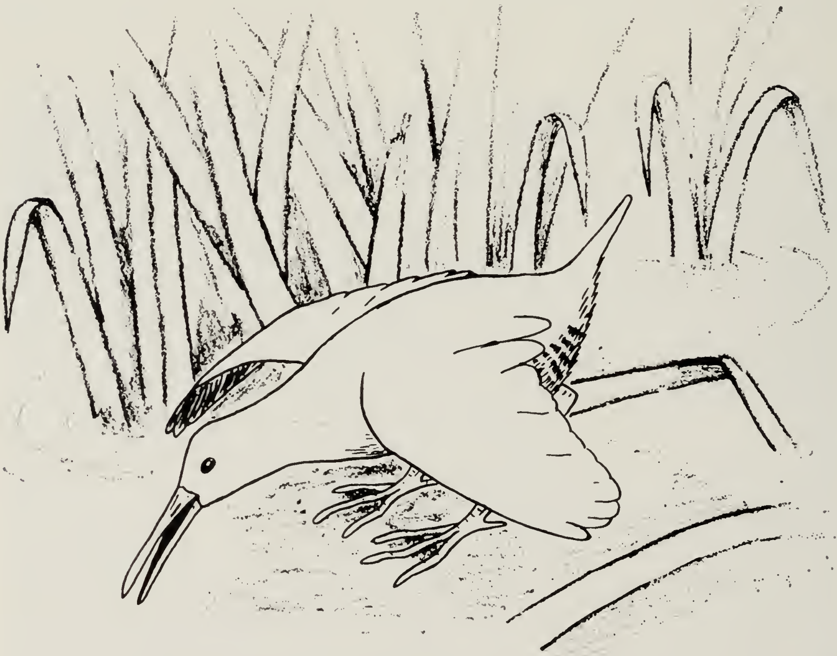

FIG. 1. Body position during distraction display. From field sketches made 31 May 1964.

chicks scattered from the nest in all directions. I caught one of the young, and as I held the chick, which remained silent, the adult ran about at a distance of one to three meters from me, with its head lowered, wings widely spread, and tail raised (Fig. 1), uttering sharp *keck* calls every two or three seconds. The body feathers were not raised. It moved erratically through the cattails, rocking from one side to the other, and occasionally beat at the water with its wings. After I released the chick, which immediately ran into a dense cattail clump, the adult moved farther away, continuing to display until I left the area, five minutes later.

Observations of distraction displays by Virginia Rails have been reported by Weber (1909. *Auk*, 26:19–22) and Pospichal and Marshall (1954. *Flicker*, 26:1–32). The bird observed by Weber, at a nest containing 10 eggs, remained near the nest, "strutting about with her feathers puffed up and wings spread like a turkey cock," uttering a low grunting sound. In contrast to this description, the birds I observed displaying did not raise the body feathers. Pospichal and Marshall reported that adults with young moved about the nest site, often walking toward the nest with head and neck bowed and outstretched and wings partially outspread and bowed, frequently giving regularly spaced rasping calls. —John A. Wiens, *Department of Zoology, University of Wisconsin, Madison, Wisconsin, 1 August 1965.*

The Carolina Parakeet in Illinois.—Little is known about the distribution of the now extinct Carolina Parakeet (*Conuropsis carolinensis*) in Illinois. The earliest published references are in the accounts of explorers and fur traders. McKinley (1960. *Wilson Bull.*, 72:274) summarized the earlier literature on the Carolina Parakeet in the Mississippi Valley. My account summarizes the available information pertaining to the distribution of the parakeet in Illinois. Two additional records for the state are included, and corrections regarding two earlier publications are noted.

Hahn (1963. "Where is that Vanished Bird?" Royal Ontario Mus.) listed two Illinois specimens among the 720 skins and mounts and 16 skeletons possessed by various institutions and individuals. One of these specimens (Chicago Acad. Sci. Coll.) was collected by R. Kennicott in Union County, Illinois. Conflicting data are available for the date of collection: The specimen label lists 1857, but the Museum Catalog card has the note "about 1855." The second specimen (U.S. Natl. Mus. Coll.), a male, is the one listed by Baird (1858. "Pacific Railroad Survey," 9:68) as being collected at Cairo, Illinois, in about 1834, and presented to the U.S. National Museum by Kennicott. Recently Daniel McKinley informed me (letter, 18 September 1965) that this latter specimen was actually collected by J. K. Townsend, not Kennicott, and just how Kennicott got it is unknown.

Smith and Parmalee (1955. *Illinois State Mus. Pop. Sci. Ser.*, 4:36) reported a sight record (substantiated by T. E. Musselman) of a flock near Kates Lake, Adams County, about mid-April 1884. McKinley (1960. op. cit.) felt this represented a late date for that area.

In March 1963, while looking over the small Currier bird collection in the Aurora Historical Museum, I discovered a well-mounted Carolina Parakeet, listed as Number 17, and reported as being from the Aurora area. An actual collection date for the specimen was not given but brief notes accompanying the specimens stated that they were prepared in the 1880's. This collection was donated by Dr. Charles R. Currier, father of the late Dr. Clark Currier, and contains only locally collected specimens.

Daniel McKinley (letter, 18 September 1965 and 7 October 1965) informed me of a fourth Illinois specimen which is in the collection of the late Harold H. Bailey at Rockbridge Alum Springs Biological Laboratory, Goshen, Virginia. The specimen is a female collected along the Illinois River on 8 May 1879 and originally in the collection of Matthew Clugston.

From the data presented it is apparent that the parakeet was still present in the Illinois River Valley until 1880, and was not extirpated about 1861 as cited by Swenk (1934. *Nebraska Bird Rev.*, 2:55–59). Bent (1940. *U.S. Natl. Mus. Bull.*, 176:12), refers to references regarding two sight records for the Chicago area in 1912, but feels that these are based on escaped cage birds. With the disappearance of the parakeet from surrounding states prior to 1890, little doubt this is correct.

I'm greatly indebted to Mr. Daniel McKinley of Lake Erie College for furnishing data from his files, and also Dr. William E. Southern of Northern Illinois University for suggestions and advice.—Harlan D. Walley, *717 North Elm St., Sandwich, Illinois, 15 November 1965 (originally submitted 12 July 1965).*

A Florida winter specimen of *Dendroica petechia gundlachi*.—On 2 December 1961, a dead Yellow Warbler (*Dendroica petechia*) in good condition was found floating in Tavernier Creek, Key Largo, Monroe County, Florida, by Alexander Sprunt IV and the author. Subspecific identification proved the specimen to be the West Indian race, *gundlachi* (formerly known as the Cuban Golden Warbler). To my knowledge this represents the first specimen of *gundlachi* taken in the United States during the winter months and confirms the resident status of this form in the Florida Keys. There have been many recent sight records during the winter season. The specimen (No. 4717) has been deposited in the reference collection of the Department of Zoology, University of Miami.

Since its discovery in the Lower Florida Keys in 1941 this West Indian race has apparently extended its breeding range into the Upper Keys and to the keys of Florida Bay. Though no actual nests have been found, singing males have recently been discovered during the breeding season on Virginia Key near Miami and on the Oyster Keys of western Florida Bay in the Everglades National Park. It is reasonable to expect that within the near future the breeding range of this warbler will extend to suitable mangrove habitat on the mainland of south Florida.—Richard L. Cunningham, *Everglades National Park, Homestead, Florida, 5 August 1965.*

Notes on mate and habitat selection in the Yellow Warbler.—The typical habitat of the Yellow Warbler (*Dendroica petechia*) is "moisture-loving shrubs and small trees" (Bent, 1953. *U.S. Natl. Mus. Bull.* 203). We have some observations indicating that the vegetational nature of the territory selected by the male influences the female's choice of a mate.

We studied the behavior of a population of Yellow Warblers at Howland's Island, New York from 30 April to 9 May 1963. The birds were concentrated along a river and the population density was very high. However, the habitat varied: although all of the study-area territories possessed tall trees, one part of the area, occupied by five males, seemed to differ only in having little or no vegetation less than 20 feet tall. The first female arrived on 4 May and on 8 May we censused the females. The five males in the areas without shrubbery were unmated. while only two of the 10 males in the adjacent area with shrubbery were unmated. We could not continue the study beyond 8 May, by which date most females were building. It is certainly possible that all the unmated males eventually obtained mates. However, they were bypassed by the first females. Since most nests in the area were low (three to 10 feet), the female's preference for a territory with shrubbery is probably related to this. Verner (1963. *Proc. Internatl. Ornith. Congr.* I:299–307), has shown that the nature of the habitat is also important in the female's selection of a mate in the Long-billed Marsh Wren (*Telmatodytes palustris*).

This poses the question whether the female chooses the habitat or the male. The answer is probably that both are important. An unmated female is attracted to a singing male, then features of the territory as well as male responses determine whether she will remain. Thus, there is a "double check" which functions to assure reproductive success. Males make the initial choice of a territory, and certain environmental features are important in their choice. Then the female bases her selection of mate at least partially on features affecting the availability of suitable nest sites. Females that arrive earlier obtain a greater choice of potential mates and territories. Selection for early arrival of females, however, is probably counterbalanced by other selective pressures such as cold weather, which in some years may result in food shortage.

This study was supported by a Frank M. Chapman Memorial Grant and NSF (GB-891).—Millicent S. Ficken and Robert W. Ficken, *Department of Zoology, University of Maryland, College Park, Maryland, 13 April 1965.*

Preferences for food by birds at a winter feeding station.—Although preferences by certain species for certain foods are recognized, few data exist. The present observations made 10 miles northeast of Harrisburg, Pennsylvania, record what preferences birds had for certain foods and, in addition, weather conditions and flock size. The feeding station was a backyard having a north-facing slope with grass, wild flowers, and bushes. The northern edge is lined with small to medium-sized elm and maple trees.

Six feeding stations, constructed of plywood, were partitioned into four sections. The left side was larger to prevent the food from scattering. All openings faced toward the observation window. Four different common bird foods were used: (1) medium-sized cracked corn, (2) pieces of white bread, (3) sunflower seeds, (4) commercial bird-feed mix, consisting mainly of seeds from which sunflower seeds and corn kernels were removed. Two handfuls of each food were placed into a section every three days. About every third or fourth refilling, all foods were cleaned out and each food was moved one section to the right, to eliminate habitual return to the same section.

Observations of 15 minutes each at random times during the day, totalling 20 hours,

TABLE 1

RECORDS OF SIX SPECIES' FOOD PREFERENCES GIVEN IN PERCENTAGES

Species	House Sparrow[1]	Starling[2]	Slate-colored Junco[3]	Black-capped Chickadee[4]	Tree Sparrow[5]	Evening Grosbeak[6]
Total birds recorded	765	365	167	183	45	20
Cracked corn	29.3	26.0	18.6	2.7	17.8	0.0
Pieces of bread	4.3	64.7	0.0	0.0	0.0	0.0
Sunflower seeds	1.3	4.4	0.6	85.9	0.0	100.0
Wild seeds	65.1	4.9	80.8	11.4	82.2	0.0

[1] *Passer domesticus.*
[2] *Sturnus vulgaris.*
[3] *Junco hyemalis.*
[4] *Parus atricapillus.*
[5] *Spizella arborea.*
[6] *Hesperiphona vespertina.*

TABLE 2

FEEDING HABITS IN RELATION TO WEATHER CONDITIONS FOR 75 PERIODS AND 1,296 BIRDS

Sky	Per cent of periods	Per cent of birds
Sunny–clear	44.0	44.7
Medium–cloudy	10.7	14.7
Overcast	32.0	32.3
Rain or snow	13.3	8.3
Temperature (F)		
11–20	9.4	7.4
21–30	12.0	10.7
31–40	46.6	55.0
41–50	21.4	18.8
51–60	10.6	8.1
Wind (mph)		
0–5	58.8	71.0
6–10	20.0	14.5
11–15	12.0	7.5
16–20	6.6	5.5
21–25	2.6	1.5

were made generally every other day from late September 1963 to early April 1964. On some days two observations were taken. The weather conditions were obtained by an outdoor thermometer, Beaufort wind scale, and the local weather reports.

The totals in the tables include all the birds that took food. For example, 765 records of House Sparrows could have included only 300 different birds. Data were obtained for 15 species, but were sufficient for discussion for only six. Records of choice of food are summarized in Table 1.

The relation of feeding habits to weather (Table 2) indicates that in most conditions approximately the same percentages of birds were observed for each condition as that condition was of the total. Possibly a few less birds fed in the rain or snow than expected. The wind, however, played an important part. A comparison of observed percentage (71.0) against expected (58.8) for 0–5 miles per hour was significant by a chi-square test when contrasted with all the other wind velocities together.

Analysis of the number of birds at the feeder showed that most birds ate singly. On 912 occasions different species came together at the feeders. One individual soon drove off the intruder and ate alone 645 times. Only two species occurred in larger flocks, the House Sparrow and the Evening Grosbeak. The House Sparrow fed alone 144 times, with another 86 times, with two others 47 times, and only four times ate in a group of six.

The change in position of the various foods confused the birds for a short time. A Starling, accustomed to bread in the first section, would either fly away or move back and forth until it located the bread.—BURNELL A. CRIST, *The Pennsylvania State University, University Park, Pennsylvania, 19 March 1965.*

Fire in birds' nests.—During the 1965 nesting season I noticed two independent and widely separated newspaper accounts of fires occurring in birds' nests built in attics. I attempted to verify the circumstances of each. Although no ornithologist saw the nests or birds and much of the evidence is circumstantial, I believe it probable that the House Sparrow (*Passer domesticus*) in one instance, and the Starling (*Sturnus vulgaris*) in the other instance carried a spark, perhaps a smoldering cigarette, to its nest.

The first of these events occurred in a residential area of Toledo, Ohio. The city fire department answered an alarm at 1607 Freeman Street at 7:23 PM, 14 June 1965, and found a smoldering fire in the nest of a House Sparrow. A few days later I visited the site and talked with the resident, Mrs. Amanda Caudill, and also discussed the circumstances with Fire Chief Carl J. Nalodka and Lieutenant Robert J. Patterson, who had been at the scene. Chief Nalodka had concluded that the fire had probably been carried to the nest by a bird, and he had stated so in his formal report.

The nest was situated about nine meters above the ground just under the roof at the front of a two-story house. Sparrows had gained entrance to the attic space through an opening between the wall and the roof. Into the space between the joists and rafters where the sloping roof met the plastered ceiling of the upper story, they had packed a mass of nesting material, mostly grass. The material was entirely within the building, and neither the grass nor the opening was visible from the ground because of the eavestrough below it. When pulled out and piled loosely in a basket, the material had a bulk of fully 10 liters. The nest cavity was well within the mass, but nearer the entrance than the back. It contained young birds not yet feathered.

The fire appeared to have begun near the entrance and to have burned a narrow path slowly through the packed grass, not spreading or becoming a flame until it reached the looser strands at the edge of the mass farthest within the attic. At this time the firemen arrived and extinguished it before much of the grass had burned. The surrounding wood was charred but not ignited.

The fire was reported by two boys, about 7 and 10, who smelled the smoke. They had been reading in another part of the attic which was floored. They disclaimed any approach to the nest, and there was no evidence that they had been playing with tobacco or matches. In fact the nest was not easy to reach; the roof was so low at this point that a fireman had to lie flat on the joists to reach the nest at arm's length. To reach it from outside the house, a person would have needed a ladder. There were no electric wires nearby. It would have been impossible for a person to have thrown a lighted object into the nest from the yard or street. I know of no instance of spontaneous combustion in so small a quantity of dry grass. Therefore, it seems probable that the bird had carried to the nesting mass a smoldering spark of some kind, such as a cigarette or a straw left from a trash fire.

The circumstances of the second event were investigated by Betty Strath, who relayed the information to me through Douglas A. Lancaster.

The fire occurred at Watkins Glen, New York, on Sunday, 15 August 1965, at the home of Richard Sheesley, 108 Madison Avenue. A passerby saw smoke coming from the roof of the house and reported it to the owners. The fire department came promptly and removed some shingles to get to the source of the smoke. Here in a smoldering nest of a Starling they found a partially burned cigarette. The location of the nest, fully concealed under the roof, precluded the possibility that the cigarette had been placed there by a human being. The firemen, therefore, reported that the fire had been caused by a burning cigarette carried to the nest by the bird.—HAROLD MAYFIELD, *River Road RFD, Waterville, Ohio, 25 February 1966 (originally received 21 July 1965).*

ORNITHOLOGICAL NEWS

At the Annual Meeting of The Wilson Ornithological Society held at University Park, Pennsylvania, 28 April–1 May, Aaron M. Bagg was elected President of the Society, succeeding Roger Tory Peterson. The names of the other newly elected officers of The Society appear on the inside of the front cover of this issue of *The Bulletin.*

The 48th Annual Meeting of The Wilson Ornithological Society will be held from 15–18 June 1967 at Crawford Lodge in Crawford Notch in the heart of the New Hampshire White Mountains. At that time of the year we can expect to find many northern birds at the height of their nesting season. Members should start planning now for what promises to be a very attractive meeting. Robert Smart of New Hampton, New Hampshire will be the local chairman.

The Executive Council voted unanimously to award two Louis Agassiz Fuertes Research Grants for 1966. The recipients were Douglas D. Dow for a study of "Habitat selection in the Cardinal" and Ralph W. Schreiber for a study of "Non-breeding behavior of the Herring Gull." Funds were available for two awards partly as the result of a gift to the Research Fund by an anonymous donor.

The Editor wishes to acknowledge his grateful thanks to Dr. Andrew J. Berger who has retired from the Editorial Advisory Board after nine years service in that capacity. Dr. Berger had previously been Assistant Editor of *The Bulletin* and a member of the Executive Council. The Society owes him much for his long and faithful service.

ORNITHOLOGICAL LITERATURE

A New Dictionary of Birds. Edited by Sir A. Landsborough Thomson. Thomas Nelson & Sons Limited, London, and McGraw-Hill Book Company, New York, 1964: 7¾ × 10¼ in., 928 pp., 17 col. pls., and 31 photos by various artists and photographers, numerous line drawings. $17.50.

Reviewing an encyclopedia, which this work is in spite of its name, is quite a different matter from reviewing a book or paper concerning a single topic. In the former instance the reviewer can make no pretense of having read the entire work, but must base his appraisal on selected subjects in which he has special competence or about which he seeks information. Because of this, a review of an encyclopedia becomes highly personal and subjective. I have had this book on my desk for six months, using it almost daily as a reference, purposely delaying a review until I felt I knew it well enough to appraise it from the viewpoint of my particular needs.

The first introductory section of the book is a "List of Major Articles on General Subjects" arranged under broad headings, e.g., "form and function," and further subdivided into more specific sections, e.g., "facies and integument." This is of value to one wishing an introduction to, or a review of, a given field and is particularly handy for the instructor who may assign selected topics to supplement an ornithology textbook.

The second section is "A List of Major Articles on Bird Groups" arranged by orders and families. A dual function is served in that the list is also a convenient summary of the classification adopted, which is basically that of Peters' "Check-list of Birds of the World."

A list of plates, a list of the contributors with their titles, academic degrees, and professional positions (a rather pretentious display to the American eye), and finally an editorial introduction, defining the aims and scope of the volume, conclude the preliminary material.

The bulk of the book consists of a series of clearly written articles of wide range and varying lengths, thoroughness, and scientific quality, arranged alphabetically, starting with "abdomen" and ending with "zygomatic arch." Detailed accounts of species, or broader taxa, are presented under their English vernacular names, but cross-references from the Latin names are given. For example, if one looks up "Prunellidae" he finds "Prunellidae: a family of the Passeriformes, suborder Oscines (see Accentor)."

The subject matter is not confined to these topics obviously avian in character, but extends to areas bearing on the entire field of ornithology and even to those areas well apart and perhaps unnecessary to include in a book of this nature. For instance, there is an excellent four-and-one-half page article on "statistical significance," a rather loosely conceived account of "vegetation" (including climate and physiography), and even a brief definition of "taiga." Cross-references abound, e.g., "siege: see assembly, noun of" and "aspergillosis: see disease."

An index to generic names used in the body of the book and conversion tables for the British and metric systems conclude the volume.

The plates have been judiciously chosen to illustrate specific topics, which is a pleasant departure from most ornithological books where they are so often used for their decorative value. The many line drawings, for the most part, also serve useful purposes.

There is no doubt that "A New Dictionary of Birds" is one of the most important and useful ornithological publications of recent decades; there is no other single source of information of such breadth. It is also nearly as certain that because the field of ornithology is expanding with such rapidity it never again will be possible to attempt a similar work.

The sheer magnitude of this book is its greatest virtue, but by the same token it is inevitable that some areas of ornithology have been slighted, overlooked, or emphasized beyond their importance. Probably no person could have done a more competent job than A. Landsborough Thomson in laying the framework for this mammoth undertaking, in securing the cooperation of the 200 collaborators, in writing many articles, and in collating the resulting mass of information. Because this is apparently the best result that one could expect, there is a hollow ring to criticisms, which are so easily made of any large undertaking. Anyone with a little perseverance can readily discover discrepancies and also subjects which have been omitted or are all but lost because they have not been cross-indexed. The editor has invited (p. 35) the reader to supply him with corrections and suggested additions for inclusion in any subsequent lists of corrigenda and addenda. It is hoped that these supplements can be published, for they would enhance this already invaluable book.—RAYMOND A. PAYNTER, JR.

THE BIRDS OF THE PALEARCTIC FAUNA. Non-Passeriformes. By Charles Vaurie. H. F. & G. Witherby, London, 1965: 10 × 7¼ in., xx + 763 pp. $20.00.

Readers of novels and aficionados of the cinema are well aware of the "sequel" phenomenon; the second attempt of a writer or director seldom manages to maintain the standard of the first, especially if that first was a universally acclaimed and brilliant feat. This phenomenon may be found in scientific publications, too, and some of us who were so enthusiastic about the first volume of Dr. Vaurie's check-list find that the second, covering the non-passeriform birds, does not fully match the high quality of its predecessor. Perhaps this is inevitable.

It must be stated at once that most of the features of Dr. Vaurie's first volume which were singled out for praise (see 1959. *Wilson Bull.*, 71:286–288) are present in the second as well: for example, the treatment of geographic variation, subspecies and synonymy, and the authoritative information on distribution, especially in the eastern Palearctic. Careful study of the second volume suggests, however, that Dr. Vaurie, having devoted over a decade of his life to this project, may have become just a little tired of it. There are more minor errors, typographical and otherwise, than in the first volume; pertinent references have been overlooked; and the thorough revisionary treatment given to virtually every genus of Palearctic passerine was not applied with equal thoroughness to the non-passerines. Any taxonomist can be sympathetic with Dr. Vaurie's preference for working with specimens of songbirds rather than with large water birds, but I regret that certain families and genera, for which new revisions are badly needed, were passed over rather quickly.

The difference in the amount of revisionary work done in preparation for the two volumes may be ascertained from a comparison of the series of papers collectively entitled "Systematic Notes on Palearctic Birds" which appeared in *American Museum Novitates.* Prior to the publication of the first volume, 33 such papers on passerine birds appeared. Only 20 were published on the non-passerines, and these covered only 25 genera of 13 families (of the 47 families admitted by Vaurie). Detailed attention was given to the birds of prey, pigeons, woodpeckers, nightjars, a few plovers, and a few other miscellaneous species. This is not to say that no other groups were studied in preparation for the book. The text abounds with taxonomic discussions and footnotes. The advantage of the Systematic Notes, however, was that Dr. Vaurie had sufficient space to explain the reasoning behind his taxonomic decisions, and often to present tables and range maps, space simply not available in the book itself.

Dr. Vaurie's taxonomic discussions, both in the Systematic Notes and in the book itself, are confined almost exclusively to the specific and subspecific levels. This is unfortunate, since his generic treatment is uneven, and he seldom if ever indicates whether the generic classification is his own, based on personal study of generic characters, or whether he is accepting on faith the work of an (unnamed) earlier authority. Among the plovers, for instance, he apparently follows Bock (1958. *Bull. Mus. Comp. Zool.*, 118:27–97), as he combines *Squatarola* into *Pluvialis*, but keeps the latter and *Eudromias* as distinct from *Charadrius*; the A.O.U. Check-list recognizes all four genera, while the B.O.U. Check-list calls them all *Charadrius.* Vaurie also followed Bock in combining all "lapwings" into the single genus *Vanellus*, but added a footnote (p. 390) to the effect that recent studies indicate that at least one of the suppressed genera of lapwings, *Hoplopterus*, may be distinct. In contrast to this sketchy treatment of the generic classification of plovers, Vaurie analyzes in detail Bock's taxonomic proposals at the specific and subspecific levels (1964. *Amer. Mus. Novit.* No. 2177).

Other examples of Vaurie's generic classifications which might well have merited discussion, or at least citation to an authoritative generic revision, are: the shearwaters, for which both *Procellaria* and *Puffinus* are recognized (see 1965. *Ibis*, 107:403); the crakes, with both *Poliolimnas* and *Coturnicops* being combined into *Porzana*; the herons, in which some but not all of the "lumpings" proposed by Bock (1956. *Amer. Mus. Novit.* No. 1779) are followed; and the family Laridae in general.

Many more of the birds in the present volume have Holarctic distributions than in the volume on passerines. Vaurie's excellent command of the literature of Palearctic birds does not extend to that on Holarctic or primarily Nearctic birds. In a number of instances, he omits important pertinent references, or cites older papers when more recent and more complete studies are available. Among the references which might well have been cited (and, in some cases, followed) are: Cooch and Beardmore (1959. *Nature*, 183: 1833–1834) and Cooch (1961. *Auk*, 78:72–89) on the Blue-Snow Goose complex (the breeding range given by Vaurie is inaccurate); Todd (1950. *Condor*, 52:63–68) on the White-fronted Goose; Todd (1953. *J. Washington Acad. Sci.*, 43:85–88) on the Dunlin; and Tuck (1960. "The Murres," Ottawa) on the genus *Uria.*

Article 32c (i) of the *International Code of Zoological Nomenclature* (1961) requires the abandonment of hyphens and diacritical marks in scientific names. Dr. Vaurie ignores this dictum (cf. *Meliërax*, *Hirund-apus*), and I confess I share his reluctance to omit the hyphen in a name like *semenow-tianschanskii* (p. 263)!

A few points on taxonomy and distribution may be mentioned here in systematic sequence. (1) Dr. Vaurie considers *Ixobrychus sinensis* to be monotypic, synonymizing all of the proposed subspecies without any comment whatsoever; having examined the material of the Chinese Least Bittern in the American Museum of Natural History, I find myself questioning not the validity of the taxonomic treatment, but whether Dr. Vaurie based his decision on a fresh examination of this species, and if not, the authority followed in this "lumping." (2) Dr. Vaurie should know that the Glossy Ibis breeds north to Long Island, New York. (3) Although the synonymy in this volume supposedly includes all post-Hartert names, Vaurie missed *Eubranta* Verheyen (1955. *Bull. Inst. Roy. Sci. Nat. Belgique*, 31: no. 6:9. No type species given; type species designated as *Anas leucopsis* Bechstein by Parkes, 1958. *Ann. Carnegie Mus.*, 35:119). (4) The Mandarin Duck is introduced and well established in England. (5) Dr. Vaurie follows Todd and Friedmann in denying nomenclatorial recognition to a population of gyrfalcons recognizable only in juvenal plumage; on the other hand, see Phillips and Dickerman (1965. *Wilson Bull.*, 77:298–299) for a discussion of the principle involved in such cases. (6) Vaurie follows Delacour in dividing the pheasants of the genus *Phasianus* into two "species," *colchicus* and *torquatus*, separated only by the color of adult males. On Delacour's own evidence (1951. "The Pheasants of the World":231), this is a division based on convenience, not on biology. (7) I know of no basis for Vaurie's inclusion of the Mariana Islands in the range of *Asio flammeus ponapensis*, which appears to be known with certainty only from Ponape in the eastern Carolines (see Baker, 1951. *Univ. Kansas Publ., Mus. Nat. Hist.*, 3:218–219).

Minor errors are somewhat more common in the second volume than in the first. In addition to several obvious typographical errors, I note the following: p. 486, footnote, "Matibac" for Mabitac; p. 686, the reference to the Lack paper should be under the family Apodidae, not under the genus *Collocalia.*

A few physical changes have been made in the production of the second volume. It is sturdier than volume 1; the binding is slightly heavier, as is the paper, making the entire book rather thicker, although there are only a few more pages. In my earlier review, I praised the "light-weight but strong and opaque paper" used in the first volume. It appears that I was overenthusiastic. The paper was not completely opaque, and some people apparently found objectionable the slight showing-through of print. More serious is the fact that, in two copies of Volume 1 at hand, the edges of the paper have already begun to yellow slightly. Let us hope that the paper in Volume 2 is more permanent as well as more opaque.

In my review of Dr. Vaurie's first volume, I listed differences between his treatment of classification and nomenclature and that of the A.O.U. Check-list, for species appearing in both lists. Such a compilation for volume 2 would be far too lengthy to print here; I counted 19 differences by the time I reached the geese and swans, and gave up. Interested readers of *The Wilson Bulletin* can make their own comparisons.

I must now fall back on one of the oldest clichés of book reviewing, and also must defy one of the rules of the game. How many ways have reviewers found to say, "In spite of my criticism of minor points above, I wish to re-emphasize the importance of this fine contribution to our basic literature"? Dr. Vaurie may well be proud of his two volumes, which will constitute a major reference work for many years to come. On the other hand, the reviewer is *never* supposed to review the book the author *didn't* write. But this reviewer will continue to regret that Dr. Vaurie did not see fit to give his thorough and thoughtful revisionary treatments to more groups of non-passerines. While this has resulted in a volume with some shortcomings, my regret should be construed primarily as a compliment to Dr. Vaurie's work!—KENNETH C. PARKES.

ECOLOGY AND BIOENERGETICS OF THE LONG-BILLED MARSH WREN IN GEORGIA SALT MARSHES. By Herbert W. Kale, II. Publ. Nuttall Ornithological Club, No. 5, 1965: 9 × 6 in., 142 pp., including 22 figures and 61 tables. $4.00 postpaid.

Incorporated here are the results of four years' fieldwork (1958–61) and two years' laboratory studies (1962–63), leading first to an M.S. thesis and ultimately to the Ph.D. dissertation. The advantages of such a continued study are abundantly evident in the remarkable scope of the investigation. While many diverse areas have been brought to focus on one basic problem—the bioenergetics of this wren population—no major part of the study was irrelevant. The presentation is logically divided into three basic sections: (1) breeding biology, (2) population ecology, and (3) population bioenergetics.

A discussion and summary conclude the text material. Twenty of 61 tables are included in three appendices, followed finally by all figures at the end of the book.

Kale deals very concisely with the breeding biology of the Sapelo Island population, drawing useful comparisons and contrasts from extensive studies in other populations. The brevity of this section clearly reflects its peripheral relationship to the central investigation. The section on population ecology treats territory size, natality, mortality, nesting success, fledgling productivity, turnover rate, and density. By setting up sample study areas and determining mean territory size, comparing the ratio of occupied to available habitat (utilizing aerial photographs), and characterizing the mating system (4 per cent of males bachelor, 91 per cent monogamous, 5 per cent bigamous), Kale was able to estimate the total number of breeding pairs in the entire marsh. Determinations of clutch size and mortality provided information on reproductive success from which, in combination with the size of the breeding population, annual wren production, and turnover rate were derived.

Estimates of population density are expressed in terms of ecological density (birds per unit of suitable habitat) and occupied area density (birds per unit of defended territory). Ecological density was on the order of 20 pairs per acre, while occupied area density was near 43 pairs per acre. Kale interprets this difference as indicative of an unsaturated wren habitat; more will be said of this conclusion below.

In the section dealing with bioenergetics, Kale presents determinations of energy content and wet, dry, and ash weights of all marsh wren tissue, including adults of both sexes during different seasons of the year, fledglings, and various age-classes of eggs and nestlings.

A number of hand-reared captives were used to calculate energy consumption in two ways. The first involved measurements of gross food intake under known conditions of temperature and photoperiod. Knowledge of the energy content of the food supplied permitted calculation of gross energy intake (11.6 kcal/day); and assessment of unassimilated energy (fecal—2.7 kcal/day) led to determination of net energy consumption (8.9 kcal/day) and assimilation efficiency (76 per cent) under experimental conditions. In a separate series of tests, Kale measured oxygen consumption of the wrens and from this calculated that an average individual utilized on the order of 8.8 kcal/day—strikingly close to the estimate based on measurement of food intake. Mean gross energy intake for the population as a whole was estimated at 351 gcal/m^2–day, while mean respiratory energy flow was 242 gcal/m^2–day. Mean annual production was estimated at 457 gcal/m^2–year.

The next phase involved an analysis of the wren's diet, its energy content, and its abundance in the habitat. Stomach contents of 195 individuals taken at all times of the year were analyzed and identified at least to family and in several cases to species. By volume, insects comprised 82.2 per cent of the total sample, spiders comprised 11.6 per cent, other arthropods 2.0 per cent, and molluscs 3.6 per cent. Among adult insects identified, seven orders and at least 16 families were represented; eggs and larvae were taken as well. The whole pattern is very much that of a food generalist, the wren being an important predator of various insects that feed on the marsh vegetation and upon other insects and spiders that are themselves predators of the same range of herbivorous insects.

Measurement of available food supply was effected primarily by collecting 10 one-square-meter quadrat bag samples and examining all the invertebrate fauna taken. These samples were taken on 10 different days, between 4 March and 4 August, from both streamside and levee situations. In addition, removal sweep samples provided incomplete measures of the density of flying forms. These data indicated a mean density of 300 mgm (dry)/m^2; analyses of caloric content indicate about 1,500 gcal/m^2.

The text is refreshingly free of typographical errors; there are, however, the usual minutiae that reviewers seem to delight in correcting or criticizing. For example, "Kcal/gm" (p. 44, line 39) should read "Kcal/day"; "CO_2" (p. 52, line 2 below the table) should read "O_2"; and "Density per square meter" (p. 45, Table 22) should be "Birds per square meter." Kluyver (as it appears on the original publications) has been misspelled in every instance (p. 1, line 26; p. 69, line 14; p. 70, line 31; and in all citations in the bibliography). "Table" (p. 44, line 21) should be "Tables." The word, "data," is the plural of "datum" and as such requires plural verbs ("include" instead of "includes," p. 14, line 22) and modifiers ("those" instead of "that," p. 27, line 19).

From observations of ecological density and utilized area density, Kale concludes that the Sapelo Island wren habitat is not saturated. At the same time, however, his estimates of the rate of energy consumption suggest that an average wren family consumes on the order of "19% of the estimated mean standing crop of insects and spiders" within the territory daily! This clearly represents an extremely high rate of predation on available food supplies within territories, and Kale suggests that movement of insects from unoccupied locations may significantly augment the food supply. At best, this clouds the apparent significance of the relationship between the two density measures. Kale is justifiably cautious in reaching a decision relative to the role of food supply as a factor controlling population size, particularly in view of the fact that estimates of the food supply were based on only 10 bag samples collected on 10 different days over a five-month period. Furthermore, it is not clear if these samples came from occupied or unoccupied portions of the marsh.

Kale asserts that the combination of territorial and colonial behavior apparently prevents overexploitation of the food supply, a conclusion that seems inconsistent. In the first place it implies that these phenomena together limit population size, since this will determine whether or not the food supply is overexploited. By Kale's own admission, we see it is not possible at this point to determine the precise relationship between population size and food supply. In the second place, if, as Kale suggests, the available habitat is not saturated, it seems unlikely that territorial and colonial behavior together could prevent additional individuals from occupying the remaining suitable portions if there were more birds seeking territories. And finally, this suggestion refers to an intrinsic mechanism of population regulation that keeps the population well within the limits of environmental requisites. This implies natural selection at the level of the population, a concept which I find untenable.

In my opinion, the most serious shortcoming of this publication is the extent of redundancy in tabular and figured material. Just a few of the many instances in which this occurred are cited here: Figure 21 presents graphically the same data on food organisms that are provided in Table 35. Table 42 provides an individual breakdown of the measurements of different males' territories, when these results have been summarized and statistically analyzed in Table 4; Table 5 repeats part of the information provided by Table 4; and Figure 14 presents graphically the frequency distribution of different territory sizes. Many of the data on wing length, live weight, dry weight, etc., presented in Table 15 are repeated in Tables 43, 44, and 45. Several other instances of slight to extensive redundancy of material presented in two or more tables or in graphs could be cited. The net effect, at least on this reader, was frequent confusion in relating tabular, graphic, and text material. This might have been avoided with better organization of tables, including only those data critical to an understanding of the study.

The above criticisms are not intended as a general castigation of this publication; its merits far outweigh its weaknesses. In my opinion, it is a great credit to Dr. Kale that of all the various factors about which information was sought, only the measurement of available food supply seems to be significantly inadequate—and this is perhaps the most difficult aspect to deal with. The very complex integration of numerous facets of field and laboratory work reflects the thoroughness and foresight with which the study was executed. Every serious student of animal ecology should be acquainted with this book. Hopefully its tremendous scope will provide a model for future investigations.—JARED VERNER.

SPECIATION IN WRENS OF THE GENUS CAMPYLORHYNCHUS. By Robert K. Selander. University of California Publications in Zoology, Volume 74. University of California Press, Berkeley and Los Angeles, 1964: iv + 306 pp., 36 figures, 39 tables, 30 photos. $6.00.

Wrens of the genus *Campylorhynchus* occur in diverse habitats from the southwestern United States to southern South America. This is the first comprehensive review of the entire genus, and a welcome addition to the literature on avian taxonomy and evolution. The report is based on museum study of borrowed specimens, and specimens in the Museum of Vertebrate Zoology, many collected by the author and his co-workers, and on approximately six months of field studies in Mexico during 1952–54.

Selander recognizes 12 species of *Campylorhynchus* arranged in two species groups, the Heleodytes group and the Campylorhynchus group. The former is composed of six species, *rufinucha*, *griseus*, *jocosus*, *gularis*, *yucatanicus*, and *brunneicapillus*, the last four comprising a superspecies. The Campylorhynchus group also contains six species, *nuchalis*, *fasciatus*, *zonatus*, and *megalopterus* in the superspecies *zonatus*, and *turdinus* and *albo-brunneus* in the superspecies *turdinus*. The author had field experience with four species of the Heleodytes group and two species of the Campylorhynchus group. Since he nowhere treats these species in his taxonomic order, I so list them for the convenience of the reader: *brunneicapillus*, *jocosus*, *yucatanicus*, *gularis*, *rufinucha*, *griseus*, *zonatus*, *fasciatus*, *megalopterus*, *nuchalis*, *turdinus*, *albo-brunneus*. Those who agree with the results of Selander's analysis will favor this arrangement over that of Paynter in the "Check-list of Birds of the World" (1960. Vol. 9:379–386). Besides the difference in arrangement of species, Selander's treatment differs from Paynter's in: 1) tentatively assigning full species status to *C. albo-brunneus*; 2) recognizing *C. griseus pallidus*, *C. brunneicapillus anthonyi*, *C. zonatus panamensis*, and *C. turdinus chanchamayoensis* (all synonymized, though some questionably, by Paynter); and, 3) synonymizing *C. rufinucha castaneus* with *C. r. capistratus* and *C. brunneicapillus couesi* with *C. b. guttatus.*

The introductory portion of the paper contains important information on nostril structure, molts and plumages, cranial ossification, and iris color. These sections are especially significant in that they establish the means by which subadult birds can be aged. As an example, the species exhibit characteristic patterns of development of a fully ossified skull. The most rapid cranial ossification apparently occurs in *Campylorhynchus brunneicapillus*, in which complete ossification ensues within six months after the postjuvenal molt. At the opposite extreme is *C. griseus chiapensis*, in which two-year-old and probably older birds may still have incompletely ossified skulls. Lack of data for most species of the Campylorhynchus group severely hampers comparison of the two groups in features such as cranial ossification.

The main part of the paper consists of a species by species treatment of variation, effects of plumage wear, sexual dimorphism, racial characteristics, comparisons, ecology, and racial and species relationships. Coverage varies from a little over one page devoted to *C. nuchalis* to some 70 pages for *C. rufinucha*; discussion of *C. rufinucha* concerns the interbreeding between *C. r. humilis* and *C. r. nigricaudatus* in the southwestern corner of Chiapas. Considering the time lapse from the completion of Selander's work (1955) to its publication, it seems unfortunate that his recent (1965. *Auk*, 82:206–214) re-examination of the hybrid zone between those two forms could not have been incorporated within it (although it is briefly summarized in footnotes). The two morphologically very distinctive races hybridize in a zone 20–25 miles wide along the narrow coastal plain of Chiapas southeast of Tonalá. Small semi-isolated wren populations, comprised mostly of hybrid individuals, occur at several places within the hybrid zone. The ecological aspects of the two races and the hybrid populations are clearly and thoroughly discussed. Observable introgression is limited, and phenotypically pure populations of the two races occur within about 30 miles of one another. This apparent lack of introgression does not preclude the possibility that actual introgression of genes and gene combinations of high selective value may occur. It is possible, and even seems likely, that introgression of tried genes and gene combinations of proven value would be a significant source of variation for the interbreeding populations, regardless of whether or not the introgression is apparent. Hence, I suspect that, contrary to the author's opinion (p. 111), their hybridization may have had and may continue to have a significant effect on their evolution.

Selander convincingly demonstrates that *C. jocosus* and *C. gularis* are not conspecific. Perhaps he even overstresses their differences, which seem of the type that might have resulted from interaction between them (populations of the two presently occur within 42 miles of one another). *C. yucatanicus* is distinctive and is a full species related more to *C. jocosus* than to *C. brunneicapillus*, with which it is often held to be conspecific. The strong resemblance between *C. jocosus* and some races of *C. rufinucha* is noted (p. 139). Although the two most likely are good species, it is unfortunate that the author did not devote some field time to the area of Oaxaca where they are sympatric. An unusual finding is the smaller size of birds of upland compared with lowland populations of *C. z. zonatus* in central Veracruz. The endemic Chiapas wren (*C.* "*chiapensis*") is considered a race of the otherwise South American *C. griseus*. The statement (p. 176) that *C. megalopterus nelsoni* probably ranges to the Zoquitlán, Puebla, area is proven by a specimen not seen by Selander, taken four miles west of Zoquitlán in 1954 (specimen in Cornell University collection). In view of the importance of *C. albo-brunneus aenigmaticus* concerning the problem of conspecificity of *C. albo-brunneus* and *C. turdinus*, it is difficult to understand why the author did not find an opportunity to examine the unique and critical type series (in the Philadelphia Academy of Natural Sciences collection) reported upon by de Schauensee as long ago as 1948. The sections on the ecology of the various forms are particularly complete and lucid.

Following the main part of the paper are interesting sections on vocalizations and behavior, helpers at the nest, and egg color. These might better have been placed in one miscellaneous part with some sections of the introductory portion of the paper. Admittedly it is difficult to put such items under fully appropriate headings, but certainly "Heteropreening Ceremonies" ought not to be included under "Vocalizations." Song differences among species of the genus are stressed, although it sems impossible to assign taxonomic significance to these differences until we know more than is presently known about their functions. Selander presents evidence suggesting that helpers at the nest (one-year-old birds) are commonly found in species of the Campylorhynchus group, as well as in several species (*jocosus*, *griseus*) of the Heleodytes group. However, evidence for actual helping, i.e., first-year helpers carrying food to nestlings, is presented for but two species, *C. zonatus* and *C. jocosus.*

Variability in mensural characters in *Campylorhynchus* is very like that of jays of the genus *Aphelocoma* (Pitelka, 1951. *Univ. California Publ. in Zool.*, 50:195–464). Weight is the most variable of nine mensural characters studied by Selander, who also examined the degree of sexual dimorphism in these characters. The sexes are most dimorphic in bill depth in the Heleodytes group, while bill length and width show normal dimorphism (females having the lesser measurements). The reverse situation is found in the Campylorhynchus group, where bill depth and width show normal sexual dimorphism and bill length is the feature in which members of the group are most dimorphic.

Selander (p. 216) compares his classification of *Campylorhynchus* with that of Hellmayr (1934. *Field Mus. Nat. Hist. Zool. Ser.*, 13:128–151), whose appraisal of relationships within this genus was hindered by his failure to take into account the possibility of secondary simplification of pattern in different phyletic lines. There is no doubt that Selander's efforts and his more broadly biological approach have improved the classification of these wrens. His discussion of evolution within the genus seems to lack only a consideration of the initial divergence of the Heleodytes and Campylorhynchus groups. Although *C. zonatus* appears to be the modern species most like the ancestor of the Campylorhynchus group, and *brunneicapillus* and *gularis* among extant species of the Heleodytes group seem most to resemble its ancestor, there is no attempt to ascertain characteristics of the common ancestor of the two groups, i.e., the ancestral species of *Campylorhynchus.* He is nevertheless very successful in establishing evolutionary trends and relationships among the existing species.

The nomenclatural history, synonymies, and locality records for the forms recognized by Selander are contained in an "Appendix." I fail to understand why the author did not choose to treat here the species in the linear sequence demanded by his classification.

The paper is remarkably free from error. There is a typographical error in the number of a type (p. 236, under type of *H. occidentalis* Nelson, the number should be 142836), and the type of *C. brunneicapillus affinis* (p. 238) is actually two cotypes. It is confusing to see the Academy of Natural Sciences at Philadelphia represented by different symbols (PAS on p. 2, ANSP on p. 185). The photographs are well reproduced, and clearly show what the author intends that they show. Data and statistics are exhaustively treated in the numerous tables. The figures are well executed, but several (e.g., Figs. 20, 21) are too small for finer details to be readily apparent to the reader. The text is occasionally verbose, but quite readable, and arguments are logically and forcefully presented. Like many of us the author is at times prone to be dogmatic in his zeal to prove his points; however, the evidence he marshals is usually so convincing as to render the dogmatic statements inconsequential.

General ornithologists, as well as those especially inclined toward systematics, evolution, behavior, and ecology, will find this report well worth reading. The final word has doubtless not been said about the systematics of these wrens, but Selander has abundantly documented our present knowledge of *Campylorhynchus*, and he has logically applied this knowledge in updating its classification and presenting the evolutionary history of its species. He is to be complimented for the production of this thorough and significant treatise.—Lester L. Short, Jr.

THE BIRDS OF CAPE COD, MASSACHUSETTS. By Norman P. Hill, M.D. William Morrow & Co., New York, 1965: 5½ × 8½ in., xx + 364 pp., 12 photos, 10 drawings of plants by Marcia G. Norman. $6.00.

I have heard it said that there is not an acre of Massachusetts which has not been searched for birds and sometimes, when I receive yet another volume about birds in another area of the Bay State, I am inclined to believe it. Now comes "The Birds of Cape Cod" to go alongside "Birds of the Connecticut Valley," "Concord," "Martha's Vineyard," "Nantucket," and others on my already crowded shelf of books on Massachusetts birds.

This attractive book by Dr. Hill is a thoughtfully and meticulously executed summarization of a wealth of data acquired by him, the late Ludlow Griscom, and many other persons over a long period of years. Cape Cod is no ordinary place for birds. Owing to its his abundant material in a masterful manner and presented it in the most concise form. It is unfortunate, though not serious, that in following "The A.O.U. Check-List" (fifth edition, 1957), he did not heed the corrections in nomenclature later published in *The Auk* (1962. 79:493–494); also that he did not make a final check on the scientific names used. *Dendroica pensylvanica* is misspelled and the same name, *Bombycilla cedrorum*, is used for both the Bohemian and Cedar Waxwings.

The ornithological summary, running to 32 pages, is meaty and readable—one of the best digests of information on a regional study that I have ever reviewed.

I confess to some annoyance by the author's giving his medical degree after his name on the title page and the title of "Dr." before his name on the jacket. I hope that this is simply a coincidence rather than an overt attempt to break what has been a long-standing tradition in American ornithology, namely, that a man's profession is neither a measure of his stature as an ornithologist nor of his contributions to our knowledge of birds.—OLIN SEWALL PETTINGILL, JR.

ADVENTURE LIT THEIR STAR. By Kenneth Allsop. Crown Publishers, New York, 1964: 8½ × 6 in., ix + 222 pp., 11 illus. by Anthony Smith. $3.95.

Kenneth Allsop's book, a reprint of the 1939 edition, may be regarded as a piece of fiction but it has the ring of authenticity. What he writes about a pair of Little Ringed Plovers (*Charadrius dubius*) in Great Britain, their migrations, their searches for secluded physiographic peculiarities, position on the Atlantic seaboard, and subjection to a tempering oceanic climate, it is on the one hand remarkably limited in its breeding habitats for birds and on the other "wide open" to wintering birds and birds of passage. Of the 354 species satisfactorily recorded, hardly more than 100 breed with any regularity, while 200 are involved in migration in the fall and half that number in the spring. Quite understandably, the Cape has been a popular point of convergence by Massachusetts ornithologists and bird watchers from fall to spring, a fact clearly reflected in the tremendous amount of information from which Dr. Hill has been able to draw.

The book begins, logically, with a description of Cape Cod that I find satisfactorily thorough, followed by its ornithological history—an altogether impressive account of the attention given its birds by famous and not-so-famous people in the annals of New England natural history. Then, with introductory explanations, comes the main body of the book—the systematic or annotated list of 384 species (30 hypothetical)—and finally an ornithological summary, a bibliography, and an index to those species in the systematic list.

The treatment of each species in the systematic list adheres to a set outline (modified when necessary to suit available data), consisting of eight paragraphs separately titled Status, Fall, Winter, Spring, Summer, Distribution, History, and Subspecies. Under

Status is not the information one would expect but rather the basis for including the species in the list. Often it amounts to naming collections in which the species is represented, but now and then it is a one-word statement, "Presumptive." This, Dr. Hill explains, "indicates a species which, on careful consideration of the evidence, I believe to have been correctly recorded but on the basis of sight records alone." For information on relative abundance that most of us would anticipate under Status, we must look under each of the next four seasonal categories. Here we find, in addition, inclusive and extreme dates and dates of maximum numbers. Under Distribution is included ecological information relating chiefly to habitats. Under History are notes on such matters as "invasions" (with dates) and significant changes in populations and breeding status. This category exceeds all the others in being more than of local interest; anyone concerned about trends in populations will find it pertinent.

All in all, the systematic list stands as a great credit to Dr. Hill for he has assimilated spots in which to build a nest, their behavior when confronted with the destruction of their previous nesting grounds, their reactions to such innovations of man as radar may not always be found in the literature as phenomena described or demonstrable. But it is so persuasively depicted the reader feels that, if the events described did not occur exactly as the author puts them down, they must have transpired in some such fashion in order to have happened at all. No one has been an active participant among the tens of thousands of birds in spring migration winging over the English Channel (or up the Atlantic or Mississippi Flyways). But the author's depiction of the event, the sense of peril and struggle, is so objectively yet intimately told that the reader catches the urgency of the participants themselves—the insistent drive to reach land becomes a part of the reader's experience. The cold, hard odds that not all will reach safety is implied with a minimum of the anthropomorphic.

The book is divided into three parts of which the first division (except chapters 6 and 7) and the first five chapters of the third division deal with the plovers without much intrusion of the human actors. The rest of the book, a comparatively small portion actually, deals with the struggle of Richard Locke to recover from tuberculosis and to find the nest of the Little Ringed Plover. The bouts with illness are the accessories of the novelist but no one interested in the outdoors will fail to respond to the obstacles, the excitement, and the frustrations which beset Locke in his quest. Allsop writes with economic imagery. A heron comes in "slanting down on its great cloaks of wings, stilt-like legs jammed out for the landing" (p. 60). London gulls each evening "oared across the sky like flotillas of white skiffs" (p. 100). His observations of the plovers, their mating, nesting, and resting behavior, their reactions to other animals in the area, are set down with a keen and discriminating eye for fresh and salient metaphor and image.

In a foreword to this welcome reprint, the recipient of the John Llewellyn Rhys Memorial Prize, Allsop writes that the work is "a combination of personal observation, recorded facts and imagination. Imagination was sparingly used, for I wanted the story to be truthful and factual, wildlife seen through binoculars' lenses" (p. vii). In the main he has hewn to this line. Actually, so objective is his writing generally that when he permits human connotations to enter a description of an avian reaction, the reader feels the bump of unreality. For instance, when in a description of the female's response to the male's courtship display, the reader finds this human interpretation: "She watched him fixedly, acutely conscious of the flow of excitement that the insistent song aroused in her" and further along learns that the female is "enchanted by the glimmering stream of his flight," he—this reader at least—cannot help wishing Mr. Allsop would not do this when he can do objectivity with such precision.

The fate of Allsop's plovers in this book ends on a happier note than Fred Bodsworth's curlews in "The Last of the Curlews" (1954). As Allsop points out in his Foreword, the first nest of the Little Ringed Plover in Great Britain was discovered in 1938. But the 1956 survey indicated 70 pairs and the 1959 survey nearly a hundred pairs. Latest returns, those of 1963, total at least 175 pairs (pp. vii, viii). "Birds can easily be overlooked," he concludes (p. viii). If that is true for "the London area's two hundred gravel pits" (p. vii), may it not be even truer of certain species of North American birds in such large areas in the United States as Texas or Alaska or, in Canada, such areas as the Prairie Provinces?— HERBERT KRAUSE.

LETTER TO THE EDITOR

Sir:

In a review appearing in the September, 1965, issue of *The Wilson Bulletin*, Tom Cade implies that the authors of "Birds of Prey of the World" have shown too casual a regard for acknowledging the work of others, and makes some reference to "plagiarism."

This is a serious allegation, and in fairness to ourselves and our readers, we feel obliged to point out that it has no basis in fact. Authors are credited in Acknowledgments and two separate Introductions, and the Bibliography fully covers our sources under general or specific headings, sometimes in the extensive Bibliographies of our major source books. Any source that "may not be found at all" is the observation of John Hamlet, based on a *lifetime* of field work. Curiously, the reviewer credits the co-author with nothing more than supplying "trained birds."

If he had used the Bibliography as suggested, Dr. Cade would have had no trouble finding the original source of the information about the Gabar Goshawk on p. 257. Having duly noted the bird's range, anyone slightly familiar with ornithological literature would turn to *Regional References, Africa*, and look first for titles that might contain descriptions of behavior, notably G. L. Van Someren's "Days With Birds," where it is indeed listed in the index under Gabar Goshawk, p. 105. No more than 20 minutes need be spent in the library. On the basis of this one example, which is *in* the Bibliography, Dr. Cade says there are "numerous cases" in which we "failed to include references." We contend that he has not bothered to look for them.

Finally, as Dr. Cade concedes on many occasions throughout the review, our book was not intended to be a technical monograph. In his own words, it is "well designed to excite the interest and acquisitiveness of all devotees of the raptors" plus those who do not know what the word "raptor" means. It has been our experience that real conservation of the birds of prey can only begin with understanding and keen personal interest in them.

s/ Mary Louise Grossman and John Hamlet

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REPRODUCTIVE BEHAVIOR OF HAIRY WOODPECKERS
I. PAIR FORMATION AND COURTSHIP

Lawrence Kilham

This report concerns the breeding behavior of Hairy Woodpeckers (*Dendrocopos villosus*) which I have studied from 1957 to 1965 in Seneca, Maryland, and later, and to a greater extent, in Tamworth and Lyme, New Hampshire, from its onset in midwinter until separation of parents and young in midsummer. I have been in the field observing these birds on nearly every day of the year for the last two years. It has become apparent in these studies that Hairy Woodpeckers exhibit much individuality in behavior, a situation first noted in Maryland where a female did an extraordinary amount of drumming in fall, winter, and spring months (Kilham, 1960). Comparisons of observations between Maryland and New Hampshire suggest that there may be regional differences in behavior patterns in the two areas. The activities of this species are unusual in a number of ways. One is that the female occupies the breeding territory in the fall and it is the male which comes to her at the onset of the breeding season, and another, a readily recognizable difference in feeding habits between males and females which I have described elsewhere (Kilham, 1965). The present report concerns pair formation, courtship, nest site selection, and subsequent papers will treat nesting and agonistic behavior in relation to habitat.

METHODS OF COMMUNICATION

The terms vocalizations and displays are used separately below for convenience of presentation, although display is more generally used as a term including both vocal and nonvocal performances.

Vocalizations.—(a) Speak. This is a common note of *D. villosus* in all months of the year. It expresses mild excitement, as when a Hairy Woodpecker, scared from a feeding place, waits impatiently to return. Single *speaks* act as location notes on other occasions. Some Hairy Woodpeckers give repeated, shrill *speaks* which suggest the piping notes of a Robin (*Turdus migratorius*) when an intruder approaches the nest.

(b) Whinny. A series of *haan*, *haan*, *jer*, *jer* or other variations of uniform notes given so rapidly that they almost run together. I have heard these vocalizations rarely in fall and early winter months. They become more frequent in spring, especially as the young develop. Juveniles and their parents use whinnies in keeping in touch with each other.

(c) Sputter. This is given in situations of alarm during the breeding season, as when parents are excited near a nest with young. It has elements of a whinny, but is loud and sharply varied with versions such as *chip-cha-*

haa-haa or *chrr-charr-jer-jer*, a kind of lilting, sardonic laughter, well drawn out.

(d) Greeting notes. The members of a pair which have been separated for a time may greet each other on rejoining with exuberant notes ranging from a rapid *queek, queek, queek*, to *chewi, chewi, chewi, woick, woick, woick*, or *joick, joick*.

(e) Intimate notes. Low *teuk, teuks* and other variations are exchanged or given by the female alone when coming into the proximity of her mate or moving out on a limb, inviting him to follow in copulation.

(f) Conflict. Males or females in conflict may give especially shrill *queek, queek, queek* notes or occasionally a *wick-a-wick-a-wick* which sounds not unlike a vocalization of flickers (*Colaptes auratus*).

(g) Vocalizations of nestlings. Young Hairy Woodpeckers can remain silent in the nest but usually break into a steady, rapid *click, click, click* against an even background of other sound at the approach of a parent. The notes become harsh and mechanical when an adult reaches the entrance with food. As I have found with captives, nestlings can also make cheerful, chirpy–chittery vocalizations and a contented *pee-purp-pee-purp* when settling down to sleep after being fed. Sudden fright sets off surprisingly harsh, pulsating notes heard on no other occasion.

Vocalizations of parent and young Hairy Woodpeckers may have regional variations. In New Hampshire but not in Maryland I have heard a pleasant *brrrrrrr* which sounds like a tree toad (*Hyla versicolor*) used when a parent approached young with food. Two hand-raised individuals greeted me in this fashion during their first summer in an aviary.

Drummings.—Hairy Woodpeckers communicate a range of meanings with their drummings which may vary from four to 11 or more bursts a minute depending on emotional intensity. The male usually drums more than the female, but she may do a considerable amount of drumming. One female, previously described (Kilham, 1960), drummed far more than her mate.

(a) Calling for a mate. The members of a pair may roost at a distance from each other and the male, instead of going in search of his mate, usually drums until she joins him. She may drum for him at other times of day when they have been separated.

(b) Drumming for copulation. A male, when at a peak of readiness for copulation in late April or early May, will drum for half an hour or more if needed to attract his mate, if she is not in the vicinity. Copulation usually follows shortly after she returns. Females may also drum for copulation or pseudocopulation earlier in the season.

(c) Location drumming. When a female, sought by her mate, returns from a distance, she may announce where she is by a low burst of drumming.

The male stops drumming immediately, but may resume after a few minutes if she comes no closer.

(d) Duets. Hairy Woodpeckers form pairs in midwinter nearly 3 months before they nest in late April. Among activities strengthening the pair bond during this period are duets of drumming, in which a burst from one stimulates a burst from the other. Such duets may continue for 15 or more minutes over a distance of 100 yards, with either sex taking the lead. Duets occurring later in the season are usually of a different nature. In these the drumming can be intense and prolonged when the male favors one nest site and his mate another.

(e) Territorial drumming. This is done primarily by the male on a tree opposite to the territory of an adjacent pair. He appears to seek or to be responding to a challenge of the opposite male to have an answering duet. The female does relatively little of this type of drumming in late winter when males are most active, but may do a good deal in fall months when establishing her territory alone.

(f) Demonstrative drumming. A woodpecker may start drumming intensively on whatever indifferent place it happens to be in response to an avian intruder in the vicinity of its nest or roost hole.

(g) Miscellaneous drumming. It is not always possible to assign a reason for drumming. A Hairy Woodpecker may rest on a bare limb in full sunshine, drumming now and then while preening, for what may be just the pleasure of doing so.

Tapping.—A Hairy Woodpecker of either sex searching for a nest site may percuss as it moves up a tree trunk or drum a burst here and there. When it locates a place seemingly suitable for a nest excavation it taps at a countable rate of two to three taps a second, thus communicating interest in a definite spot to its mate, who may be enticed to fly over to inspect. Tapping may be done sporadically at times of changeover in the work of excavating later on.

Wing ruffle.—Hairy Woodpeckers can fly silently or make a loud *brr* in flight. This *brr* is generally expressive of disturbance or excitement but can also act as a location noise when an individual, for example, is leaving its mate or attendant juvenile to fly elsewhere.

Displays.—(a) Crest-raising. Done by itself or accompanying other displays. It indicates interest or excitement.

(b) Bill-waving. A Hairy Woodpecker in conflict with a member of its own sex may jerk its body about, half-start its wings, and wave its bill like a baton, with head held somewhat backward and tail outspread (Kilham, 1960). This display is also used against nonspecific competitors such as Starlings (*Sturnus vulgaris*).

(c) Frozen pose. An individual may freeze with body flattened against a tree trunk and bill pointed straightforward when anticipating an attack from a rival or a passing predator.

(d) Resting motionless. Members of a pair may cease all activity and remain motionless within sight of each other for 5 or more minutes when in close accord, either by a nest hole in process of excavation or even in midwinter prior to some act of courtship, such as precopulatory behavior. For such active, energetic birds, these sudden motionless periods are a striking form of behavior.

(e) Courtship flight. An irregular type of flight, either fluttering and batlike, or floating, is occasionally observable at moments of emotional intensity, as when a Hairy Woodpecker is approaching its mate, its nest, or a symbolic nest site earlier in the breeding season.

(f) Full-wing threat display. An individual may hold its wings at a 45 degree or greater angle over its back when attacked in conflict or even assume the pose when in the air and floating in to alight on a tree where a rival is waiting. A single Hairy Woodpecker, after emerging from its roost hole, may perform in similar fashion when dodging around a tree trunk in play against an imaginary enemy.

Ceremonies.—(a) Symbolic nest site. A female Hairy Woodpecker in January or February may alight below a branch stub on a decadent aspen (*Populus tremuloides*) and drum, sometimes in prolonged fashion, until her mate approaches, when she will immediately start to tap. If he flies toward her, she may leave in courtship flight, leaving him to alight where she had been. Such trees are nearly always aspens, unsuitable for actual nest holes, and no excavations are attempted. The same tree may be used on many successive mornings.

(b) Pantomime of copulation. A female may suddenly fly to the vicinity of her mate in midwinter giving *teuk, teuk* notes and alight on a limb 1½–2 inches in diameter and 3 feet or so from the tree trunk, to assume a crosswise position inviting copulation. Her mate may show no response, move close then leave, or actually mount in a semblance of full copulation (Fig. 1) a month or two before fertilization could, expectedly, take place. Precopulatory behavior plays an important role in courtship behavior. I have not observed courtship feeding in *D. villosus*, but this appears to serve much the same function.

Hairy Woodpeckers communicate in more ways than indicated above, since variations of tone and pattern, as well as of associated displays and the nature of attending circumstances, add to the range of meanings conveyed by their vocalizations, drummings, and displays. This larger context of communications among birds has been well described by Smith (1963).

Figure 2 summarizes the various displays and activities of Hairy Wood-

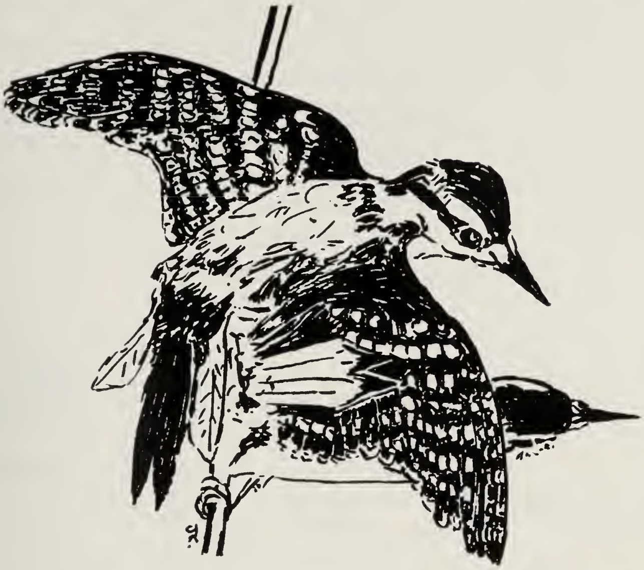

FIG. 1. Hairy Woodpeckers (male above) in full copulation.

peckers in relation to the time of their use or occurrence within the entire breeding season.

PRE-BREEDING SEASON ACTIVITIES

Male and female Hairy Woodpeckers pay little attention to each other in fall months in New Hampshire when leading independent lives. Thus, of 48 times I encountered individuals on mornings from September through November 1963, they were together as pairs on only four occasions, of which three were in September. The woodpeckers exchanged *chewi* notes when at all close as they moved through the woods in brief association.

In December 1963 I observed a male and female which had roost holes 50 feet apart (see Fig. 3) and often greeted each other on emerging in the morning. On 15 December the male MA flew to where the female FB was feeding and displaced her. She moved away a few feet giving *teuk, teuk* notes. Since she gave these intimate notes not infrequently, I wondered whether these two birds might not form a pair later on. FB, however, was roosting within her breeding territory and MB, her mate of the previous year, began to appear in the vicinity of her roosting place as early as 24 December. Peaceful at first, he became increasingly aggressive toward MA until FB went to roost elsewhere on 24 January 1964. MA continued to roost in the same place until

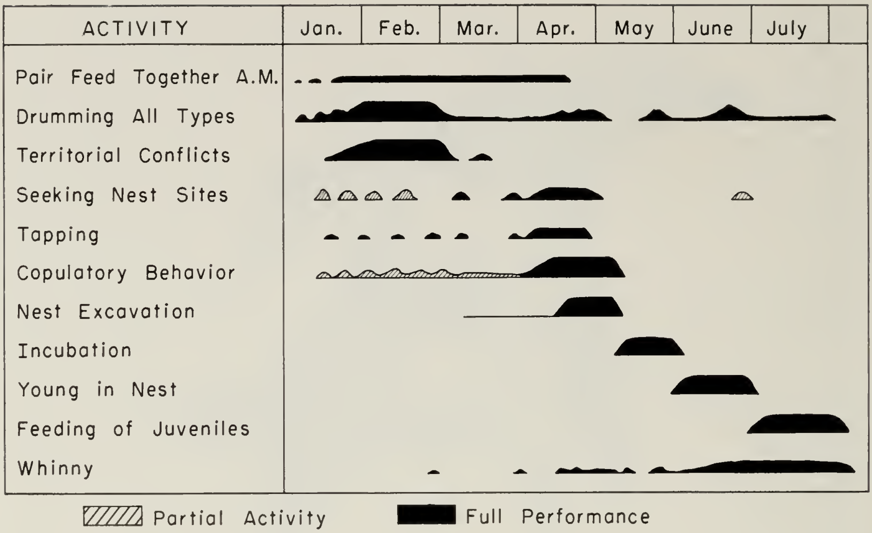

FIG. 2. Diagrammatic summary of displays and activities of Hairy Woodpeckers in the breeding season.

March, flying each morning to the adjacent territory of FA (Fig. 3) to whom, I believed with less evidence, he had been mated the year before.

EARLY BREEDING BEHAVIOR

The breeding activities of Hairy Woodpeckers do not represent a continuous development, but rather occurs in successive phases. These are used to facilitate the descriptions given below.

Phase I.—Mid-January to early March was a period of pair formation, courtship, and territorial conflicts. (The agonistic behavior of Hairy Woodpeckers, however, as observed on a year-around basis, will be the subject of a subsequent report.)

Activities of a well-established pair.—The close harmony between the members of Pair B, which were together for at least three breeding seasons, was reflected in the following episodes:

(a) Symbolic nest tree.—At 8:00 AM on 10 January 1965 FB flew to an old aspen and rested motionless for 20 minutes below the stub of a broken branch. Her mate, MB, rested equally motionless 70 feet away. When FB broke the silence by tapping four sets of four to five taps each, he moved closer and drummed for 7 minutes at a rate of four bursts a minute. FB tapped in a prolonged manner as her mate came within 20 feet. She then flew away. The aspen trunk where she had rested for 30 minutes was too narrow and too decadent to have made an actual nest site.

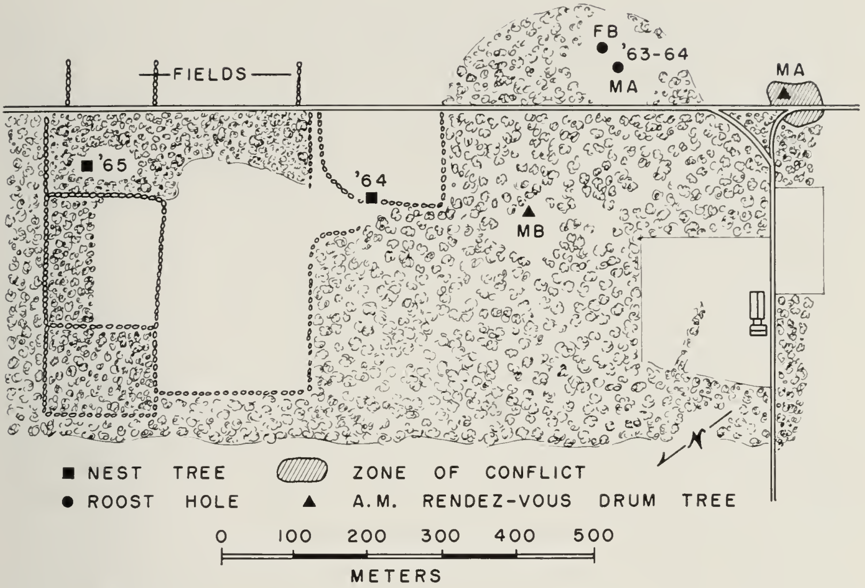

FIG. 3. Map of the breeding territory of Pair B Hairy Woodpeckers showing locations of nest, roost, and drumming trees.

The activities involved, however, appeared to bring the two birds together again, after months in which they had lead separate lives.

(b) Copulatory behavior.—MB started drumming on a dead aspen at 7:20 AM on 8 February 1964 while FB was feeding in woods below. After a few minutes she flew to him in fluttering flight, giving *teuk* notes, and alighted on a branch in a precopulatory pose. MB became silent and motionless, then flew away.

A more complete performance took place on 29 February when FB drummed a few bursts, then flew to her mate as before. This time he mounted and fell off gradually to the left in what appeared to be full copulation (Fig. 1) two months prior to actual nesting.

(c) Beginning of a nest excavation.—On 3 March 1965 MB began an excavation which he continued to work on sporadically until late in April. It never became more than a perfect entrance, since the underlying wood was too hard. The tree was a special one in the lives of the two woodpeckers, however, since the pair had not only made a similar abortive excavation here in 1964, but were to make their actual nest hole in it in 1965, 5 feet below the entranceway begun in March. This situation appeared to reveal that the members of this pair had time to spare. Being well adjusted both to each other and to their territory, the fashioning of the entranceway in leisurely fashion became a mutual enterprise, serving as an outlet for their not as yet fully developed instincts for actual nesting. They had no need for the extensive drummings and flights back and forth of neighboring pairs. Such activities were nearly always indicative of efforts to reach equilibrium in what to the woodpeckers involved were either new situations or ones which, for some reason, were not complete. A key feature in the habitat for these birds is a suitable nest tree. Harmony or continued disturbance between members of a pair usually hinges on its presence or absence and ideal trees can be few and far between.

Activities of newly formed or less well established pairs.—FA retained the same breeding territory but had different mates in each of two successive years. Her two mates had quite different characters. MA in 1964 lacked zeal, both for territorial conflicts, in which he was always pushed around, and in courtship, as shown by frequent failures to respond in full to his mate's signals. MA′ in 1965, on the other hand, was more average. He fought hard for the limited time needed to establish the territorial boundary and he appeared to want a close pair bond as much as his mate. The experiences of FA with her two contrasting mates were as follows:

(a) Pair formation.—The first time I encountered MA′ was when he was drumming at the top of a tall, dead pine on the morning of 22 January 1965. Then I heard an answering drum from FA some distance away. MA′ immediately started flying in her direction by way of successive trees, on which he stopped to drum and listen. It thus appeared that she was attracting him to her breeding territory.

(b) Symbolic nest tree. On the early morning of 26 January 1964 MA drummed in a leisurely fashion of four bursts a minute on a dead roadside aspen. The exact location, below a branch where the trunk was 6 inches in diameter, was suggestive of a nest site, but too decayed to offer any real possibility. FA drummed on the same spot on 8 February. When he approached, she tapped, then flew away with exuberant *teuk, teuk* notes. More or less similar performances took place in succeeding weeks, with MA showing increasingly less interest. On 15 February, for example, FA drummed four times a minute on the aspen and when MA came 100 feet along the road, she stopped and rested. When he started to move away, she began drumming again. MA now idled about without coming closer until she finally gave up drumming after a half hour of trying to attract him to what was little more than a demonstration of the pair bond. She kept up her performances on the aspen until early March. On some days, as on 24 February, she would finally fly to MA, who still paid little attention, while she held a strained pose or resorted to displacement pecking.

Her mate of the following year was far more responsive. On 31 January 1965 FA drummed on the same place on the aspen as in 1964, although the trunk had meanwhile broken and was leaning against another tree. She subsequently adopted another aspen farther down the road. When she started to tap here on 4 March, with bursts of four to 12 taps each, MA′ flew to her in courtship flight giving exuberant *chewk, chewk* notes. She left in a similar flight as he alighted where she had been.

(c) Drumming.—MA made contact with his mate each morning not by looking for her but by drumming on a high, dead branch of a sugar maple, his rendezvous tree (see Fig. 3), until she gave some response, usually by drumming on her aspen. Duets between the two might last for 15 minutes. The fact that the members of this pair were not well adjusted seemed to explain their excessive amounts of drumming, far more than I had encountered with eight other pairs which I followed in Lyme in 1964 and 1965.

The drumming of Male C, who appeared to be without a mate for a period in mid-February, differed from that of Pairs A and B, which used moderate rates of four to five bursts a minute. On 12 February 1964 he drummed for a prolonged period at eight bursts a minute. Three days later, however, MC drummed at an extraordinarily fast rate of 26 bursts a minute, from 70 feet up in the same maple.

Phase II.—The period of early March to early April was a lull of less active courtship between the earlier period of border conflicts and the subsequent one of preparation for nesting.

(a) Drumming.—Pair B, which behaved harmoniously through two breeding seasons, was comparatively quiet. It was nearly the end of March before MB settled on an indifferent black cherry stub, low down and partially surrounded by trees, as his rendezvous drumming place (see Fig. 3). He drummed here solely to attract his mate in the early morning. On 4 April 1964, for example, MB had drummed for 10 minutes when FB approached with a *brr* of wings. He immediately stopped and waited. When she came no closer, he drummed again, and she flew to him with *queek, queek* notes, alighting close by in a precopulatory position. Having apparently obtained these indications of responsiveness on the part of FB, MB flew off and she followed shortly afterward. MB used the same drum tree, in similar fashion, in the following year.

The unusual amount of drumming carried on by Pair A in February continued in even greater degree in March 1964, a fact which made the two birds easy to locate on early mornings. Their drumming had now shifted to a lumbered area with tall, mast-like, dead pines, and now had the appearance of being largely play. Thus one, then the other, might take the lead in leisurely duets which might end when FA flew to the pine where MA was drumming and took his place, as he flew away in courtship flight. She would then drum on the spot where he had drummed, only to be replaced by him a little later. MA did the larger part of the drumming. The awareness of his mate to what he was doing, even when feeding out of sight and at a distance, was illustrated by an episode on 30 March. She was working on a fence post under a canopy of pines. When MA stopped drumming 100 yards away and flew off with a *brr* of wings, she immediately lifted her head to give shrill *queek, queek, queeks,* then continued her work.

FA did far less drumming with her new mate MA′ in March of the following year. On 16 March 1965, however, I found her drumming in prolonged fashion on one of the mast pines while MA′ fed in woods below in seeming unconcern. When she stopped, he flew up, then moved out on a short limb where she had assumed a precopulatory position, and the two nearly touched bills. There had been almost none of this type of behavior between FA and MA in the previous year.

(b) Copulatory behavior.—Eight days after the above episode on 16 March, MA′ tried to mount FA under similar circumstances, but she swung under a limb at the last moment. Copulatory behavior was minimal in this period as compared with earlier months when territorial conflicts had been at their peak. There is a not infrequent association between the two forms of behavior. Although conflicts were few in Phase II, Males E and F did have a sharp bodily encounter on their mutual boundary on 13 March 1965, following which ME flew directly to FE, who moved out on a limb giving a frog-like quaver as well as *teuks.* He mounted in full coition. It appeared as if the high emotional tone engendered by the clash had carried over without a pause into sexual behavior.

(c) Excavations.—The very early location of a nesting tree by Pair B in 1965 probably reflected the fact that the two woodpeckers, together for at least 3 years, were closely adjusted both to each other and to their territory. On 31 January, for example, I was able to locate MB by the sound of his tapping. He gave repeated bursts of four to five taps on a live aspen with a rotten center where, as described for Phase I, he started a nest entrance on 3 March. I continued to watch him for the remainder of the month. This was fairly easy, for he usually did his excavating in leisurely fashion in the middle of the day, with pauses to rest and preen in the sun. FB did little of this early excavating. On 13 March, however, she did work for 17 minutes at the hole, which was deep enough for her to get her head inside. It was not much deeper when abandoned in late April.

(d) Feeding together.—A further expression of the closeness of bonds between members of pairs of Hairy Woodpeckers was that they usually fed not far from each other as they moved through woods on early mornings from January through April.

Phase III.—A period from early April to early May of nest site selection, excavation, and increasing copulatory behavior. The first of these activities was much the same as for the symbolic nest sites of Phase I, but the trees involved were sound enough to be good prospects. I witnessed a typical example of the search for a site on 18 April 1960 when I heard slow, irregular, but prolonged tapping in the woods at Tamworth. I then located a female tapping just below a fresh, oval-shaped hole in a maple stub. She would tap, then rest motionless. When her mate finally came to inspect, she flew off giving *jeeks.*

(a) Excavating.—Hairy Woodpeckers excavate throughout the day with the male doing the larger part of the work, especially in forming the entrance and upper part of the cavity. Sawdust is tossed from the hole directly. Occasionally, however, as exemplified by ME on 28 April 1963, a male may wriggle out from his nest hole with a bill full of sawdust, then fly to a tree trunk 30 or more feet away to shake it loose. Since nest sanitation at a later date follows the same pattern, it is possible that the sawdust maneuver represents the awakening and trial of a form of instinctive behavior before it is actually needed. Similar behavior occurs among other woodpecker species, including Yellow-shafted Flickers (*Colaptes auratus*) and Yellow-bellied Sapsuckers (*Sphyrapicus varius*) (Kilham, 1959*a*, 1962*a*).

On 1 May 1965 FB exhibited an aberrant form of excavating when she flew from her excavation 10 times in succession to discard sawdust 40 feet away. While this type of sawdust removal is not characteristic of woodpeckers, it does occur among other members of the Piciformes, as I have observed for the Double-toothed Barbet (*Lybius bidentatus*) in East Africa.

(b) Display flights.—Pair H, in Tamworth in 1961, had an excavation 18 feet above the ground in a maple next to the house and separated from woods by 30 yards of open lawn, a situation favorable for observation of flights to and fro. FH might fly from the woods with short, quivering wing strokes, making *joick, joick, joick* notes, alight on a limb of the maple, then float down to the nest entrance on outstretched wings. MH would then wriggle out, leaving her to excavate. He sometimes flew off in fluttering flight or even circled about the lawn in a similar manner before entering the woods.

(c) Copulatory behavior.—I followed Pair F for an hour early on the morning of 16 April 1963 as the two birds moved through woods in Lyme, feeding in loose association. At 7 AM, when their circular course had brought them back by their excavation in a hop hornbeam (*Ostrya virginiana*), FB gave *teuk* notes and elevated her tail. Full copulation followed. I found FF at her excavation again 3 days later. She tapped a few times, rested motionless for 10 minutes, then flew off in fluttering flight accompanied by *queeks.* I now followed the pair, from 6 to 7 AM, as they fed through the woods. The male took the lead in each of two copulations during this time, once by simply approaching FF from below on a tree trunk and, on the second occasion, by drumming a few bursts, then flying to her. By the last week in April MF was working up to 40 minutes at a stretch excavating in the hornbeam. He now took the lead in all copulations. Since the two woodpeckers were no longer feeding together, he had to drum for her to come when he was ready, as exemplified on 28 April. On this morning MF drummed loudly on an oak near the excavation, looking all about as he did so. I then heard a low answering drum. Ten minutes of silence followed. FF then began to give *teuk* notes and MF glided down to copulate. Two copulations observed on 2 May were likewise close to the excavation and were preceded by similar performances. It was on this date that MF spent his first night in the nearly completed nest hole.

Copulations of Pair B followed a pattern which differed somewhat from that described above. Thus MB had just spent his first night in his new nest hole on 2 May 1965 and was looking out at 5:45 AM when FB began a loud drumming, 200 yards away. He then flew out to move toward her slowly from tree to tree, giving a few low drums in reply. She moved out on a limb as he approached and copulation occurred. The two birds then separated to feed. At 6:08 AM, however, MB returned to drum on exactly the same place where FB had drummed previously, then became silent as she flew in. Copulation with close cloacal contact followed, for the second time within 15 minutes. Incubation for Pair B was well under way 4 days later.

DISCUSSION

The striking feature of the early breeding behavior of Hairy Woodpeckers is that their courtship is a lively affair carried out with an exuberance and closeness of the pair bond expressed by varying combinations of displays, intimate notes, and copulatory activity. All of these patterns of behavior are in marked contrast to those of the related Downy Woodpecker (*Dendrocopos pubescens*) observed under similar circumstances (Kilham, 1962*b*). One might suppose on first approach that similarities in plumage of these two species, as well as in their principal forms of vocalization and display, would mean similarities of breeding behavior as well. Yet little closeness of the pair bond was apparent, even with a hand-raised pair of *D. pubescens* which bred and incubated eggs for two successive years in an aviary (Kilham, 1962*b*). The usual greetings of the two birds was limited to a harsh chirp. Hand-raised Hairy Woodpeckers, on the other hand, appeared to enjoy not only the company of each other, but also of those who cared for them, coming to the wire with outbursts of intimate vocalizations as if greeting one of their own kind.

The generalization of the Heinroths (1958) that many woodpeckers are not particularly fond of their mates may well apply to *D. pubescens.* Observations on other species, however, such as the Hairy, Pileated (*Dryocopus pileatus*), and Red-bellied (*Centurus carolinus*) woodpeckers, as well as Yellow-shafted Flickers (Kilham, 1960, 1959*b*, 1961, 1959*a*), indicate that they form close pair bonds, expressed by a variety of vocalizations and displays. While *D. pubescens* is the smallest of this group, size bears no relation to closeness of pair bonds among birds. Red-breasted Nuthatches (*Sitta canadensis*) appear in present studies, for example, to be as attentive to each other in the breeding season as did large Black-and-White Casqued Hornbills (*Bycanistes subcylindricus*) (Kilham, 1956).

The role of females varies among woodpeckers. Thus, while female Hairy Woodpeckers occupy territories at the onset of the breeding season and attract the males to them (Shelley, 1933; Kilham, 1960), males among Red-bellied Woodpeckers and Yellow-bellied Sapsuckers (Kilham, 1961, 1962*a*) establish the breeding territories and take the lead in most activities, leading to actual nesting. The fact that the female of *D. villosus* is on familiar ground may give her an initial advantage psychologically. Her intimate notes, copulatory poses, and tappings at symbolic nest sites all suggest that she takes the lead in winter courtship, while her mate engages in territorial conflicts, then gradually adapts himself to his new situation.

The individuality of Hairy Woodpeckers has been evident in a variety of circumstances. One of these concerned a highly unusual female observed over fall, winter, and spring months in Maryland (Kilham, 1960) and another, differences in feeding habits between males and females observed in New Hampshire (Kilham, 1965). Individuality of this latter type may serve to improve utilization of the environment. From whatever cause it has arisen, however, it is possible that a long period of courtship, with mutual adjustments, may be what enables a species to tolerate wide degrees of individuality without endangering the close cooperation requisite for nesting success.

The extent of individuality doubtless varies among birds. Howard (1952), in her observations made on close acquaintance and in an absence of fear, found that Great Tits (*Parus major*) were more individualized than other species of tits (Paridae) as well as being more intelligent. She felt that the two attributes went together. This situation could hold as true for woodpeckers as for tits and it is of interest that Cobb (1960) found the brain of woodpeckers comparable to that of the Passeriformes in size and development.

Comparisons between European and American woodpeckers can be fruitful in alerting one to behavior patterns which might otherwise be overlooked.

The Great Spotted Woodpecker (*Dendrocopos major*) of Europe, for example, resembles *D. villosus* in a number of aspects of its breeding behavior (Kilham, 1960). It is ecologically more diversified, however, in guarding food stores within special territories in fall and winter months (Pynnönen, 1939) and in extracting seeds from pine cones (Blume. 1962). Pynnönen has further (1943) described local differences in which populations of *D. major* in Finland live primarily on plant food and ants and those in mid-Europe feed on beetles and beetle larvae. One should be alert for differences among local populations of *D. villosus.* Although these might be difficult to establish without larger numbers of observations, I have observed patterns of behavior in Maryland not encountered in New Hampshire. Among these (Kilham, 1960) were duet flights, also described for *D. major* by Pynnönen (1939), occurrence of breeding behavior in the fall, and a shyness comparable to that usually associated with Pileated Woodpeckers which made observation difficult. A further difference lay in size of breeding territories. These seem to become smaller as one moves south. This also may be true for *D. pileatus* (Kilham, 1959*a*) as well as for *D. villosus*, and is possibly due to more insect food being available over more months of the year in warmer climates.

Although Huxley (1942) considers the Great and Lesser Spotted (*D. minor*) woodpeckers "extremely similar in appearance and habits," anyone accustomed to the much closer plumages of Hairy and Downy woodpeckers might not find the European pair nearly so much alike. A recent guide (Peterson et al., 1954) distinguishes *D. major* from *D. minor* "by black back with large white shoulder patches and crimson under tail coverts," alike in both sexes. If these striking color patterns of red, black, and white have evolved for any particular reason, it may be that they serve as a warning coloration in association with aggressive habits and the guarding of stores of food within special territories, both for the Great Spotted (Pynnönen. 1939) and Red-headed Woodpeckers (*Melanerpes erythrocephalus*) (Kilham, 1958).

It will take years of observations on local populations of Hairy Woodpeckers to understand the totality of their behavior, of which their reproductive behavior forms only a part. No one description is likely to fit over the entire range. It is hoped, however, that continuing studies on agonistic and nesting behavior of *D. villosus* in relation to environment will permit further interpretations as well as extend observations given above.

SUMMARY

Observations on Hairy Woodpeckers indicate that the breeding season begins in January when the male starts coming to the female's territory, in which nesting eventually takes place after nearly 3 months of preliminary courtship. Courtship activities vary in extent and pattern from pair to pair. The basic forms are precopulatory behavior, intimate notes, display flights, duets of drumming, and tapping before symbolic or potential

nest sites, in all of which the female often takes the lead. As nest holes near completion in late April, males take the lead in copulatory behavior, often drumming to attract their mates. Two pairs of Hairy Woodpeckers which nested in adjacent territories in 1964 and 1965 are described in detail to bring out differences in behavior which may occur among individuals. A final discussion centers on the comparative behavior of woodpeckers.

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THE COEXISTENCE OF TWO WREN SPECIES OF THE GENUS *THRYOTHORUS*

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THE ecology of closely related species of birds has been the subject of much study. It has often been found that when two such species occur sympatrically they exploit the environment differently (e.g., Hartley, 1953; MacArthur, 1958), a fact which presumably contributes to their success in coexisting. Apparent exceptions to this pattern have revealed themselves, upon closer inspection, not to be exceptions at all. The discovery of yet another apparent exception is worth reporting because it is unusual in other ways. Two sympatric species of Mexican wrens of the genus *Thryothorus* appear to respond to each other ecologically as if they were identical species, reproductively as if they were different species. The observations which indicate this unusual situation were made during the course of another project (Grant, 1965*a*). They require verification by a more thorough study which, it is hoped, may be stimulated by the following account.

THE SPECIES AND DISTRIBUTION

Observations were made of *Thryothorus s. sinaloa* (Sinaloa Wren) and *T. felix pallidus* (Happy Wren) in the months March to August 1961–1963. The two species are resident and sympatric over a large part of western Mexico. Their ranges coincide from Sonora south to Guerrero, and that of *T. felix* extends farther southward into Oaxaca. All observations were made in the zone of sympatry, mainly at Puerto Vallarta, Jalisco, and Tepic, Nayarit, but also in nearby areas in these two states. Some observations were also made of the Tres Marías Islands form of *T. felix*, which is recognized as an endemic subspecies, *T. f. lawrencii*.

MORPHOLOGY

Plumage.—In each species males and females have identical plumage. *T. felix* differs from *T. sinaloa* principally in having a bolder black-and-white face pattern, a less conspicuous, white, postocular stripe and rufous, as opposed to gray–white, underparts. These differences appear to be important in species recognition if only because on the Tres Marías Islands, where *T. sinaloa* is absent, *T. felix* has a plumage more similar to *T. sinaloa* (illustration in Grant, 1965*b*): the insular subspecies has a reduced face pattern and the underparts are white and not rufous. There are no reports in the literature of hybridization of the two species, nor was any evidence of such revealed in this study.

TABLE 1

MEASUREMENTS OF ADULT MALES COLLECTED AT TEPIC AND PUERTO VALLARTA

		T. felix	*T. sinaloa*
Wing	N	21	22
	$\bar{x} \pm 2$ SE	57.0 ± 0.58	59.1 ± 0.75
Tarsus	N	20	21
	$\bar{x} \pm 2$ SE	21.71 ± 0.24	20.90 ± 0.28
Bill length	N	20	20
	$\bar{x} \pm 2$ SE	10.78 ± 0.22	10.84 ± 0.25
Bill width	N	11	20
	$\bar{x} \pm 2$ SE	2.95 ± 0.09	2.90 ± 0.06
Bill depth	N	11	20
	$\bar{x} \pm 2$ SE	2.39 ± 0.09	2.54 ± 0.04
Fresh weight	N	6	11[1]
	$\bar{x} \pm 2$ SE	14.90 ± 0.76	17.45 ± 0.49
Weight after freezing and thawing	N	5	18
	$\bar{x} \pm 2$ SE	14.54 ± 1.12	15.33 ± 0.40

NB. Measurements made as described in Grant (1965*c*). Linear dimensions in millimeters, weights in grams.

Symbols: N = sample size. $\bar{x} \pm 2$ SE = mean ± 2 standard errors.

[1] Includes 10 individuals from Guadalajara, Jalisco.

Dimensions.—*T. sinaloa* is larger than *T. felix*, as indicated by body weight and wing length data (Table 1). However, the tarsus of *T. sinaloa* is relatively and absolutely shorter than that of *T. felix*. It might be expected that the bill lengths of the two species would differ by 10 per cent or more (cf. Hutchinson, 1959), but in fact they differ by less than 1 per cent. Differences in width and depth of bill are a little greater, but the overall difference in size and shape of the bill is quite small. The island form of *T. felix* has a bill 13 per cent longer than its mainland counterpart (Grant, 1965*c*).

ECOLOGY AND BEHAVIOR

Territoriality.—Territories of the two species were found to be more or less nonoverlapping and contiguous (Fig. 1). An observation of an individual of one species at a particular place was never followed on the next day by an observation of an individual of the other species at that place. This suggests that territoriality is interspecific as well as intraspecific. Members of the two species were observed either displaying to or chasing each other on at least three occasions at Tepic during the early part of the breeding season. In July and August (the end of the breeding season) mutual tolerance was observed. On one occasion an adult *T. sinaloa*, an adult *T. felix*, and a juvenile *T. felix* foraged on the ground for 5 minutes in a small area which varied from 1 to 2 square meters.

FIG. 1. Estimated territories of *T. felix* and *T. sinaloa* in a census area of 4 hectares (10 acres) ca. 9 km NW of Tepic, Nayarit. NB. The boundary of the census area is not a natural one. Total length of the area is 2,000 km, approx. Daily surveys were made 20–26 May 1963. Each bird seen or heard was recorded. Territory boundaries are estimated from observations made during and after the census period. Symbols: f = Single record of *T. felix*: s = Single record of *T. sinaloa*.

No heterospecific courtship or pairing was witnessed in this study.

Song.—The songs of four individuals of *T. sinaloa* and seven individuals of *T. felix* (a sample of more than 100) were recorded at Tepic in June 1963 with a National transistor tape recorder, and later analyzed with a Missilyzer Sound Spectrograph. Sonagrams of the songs of the two species are reproduced in Figure 2, and demonstrate the similarity in song of the two species. It was found impossible to discriminate between the two species by listening to their songs in the field. Each species sings two types of song, referred to here as type A and type B, in a variable but often alternating sequence. The introductory notes of both types of song are to some extent variable, but the later parts show constancy. There is a possibility that the terminal four notes of the type A song of *T. felix* differ from the corresponding notes in the song of *T. sinaloa*, but larger samples are required to establish this. No consistent

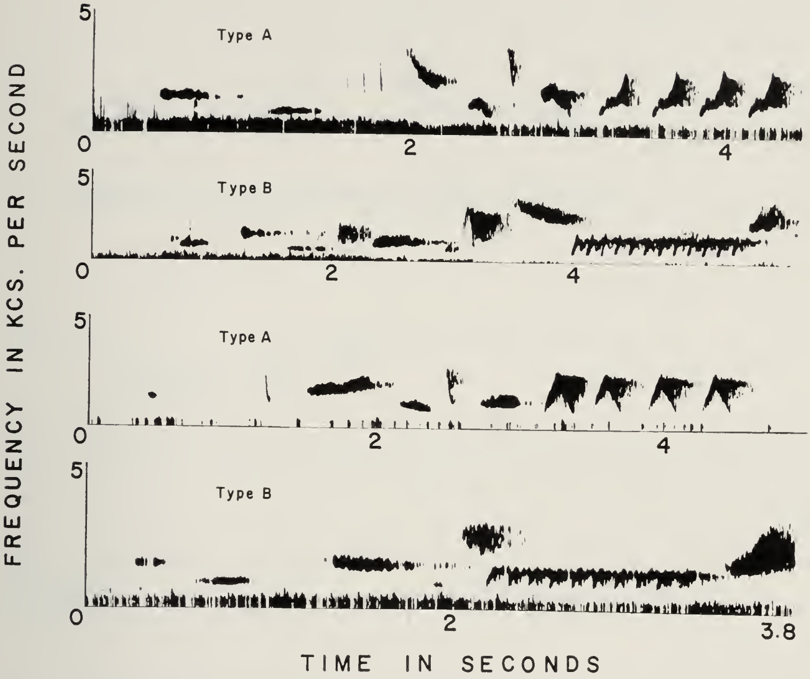

FIG. 2. Songs of *T. felix* (top two) and *T. sinaloa* (lower two) recorded at Tepic, Nayarit, June 1963.

differences between the species were found in these small samples. In passing, it is worth mentioning that the components, variation, and structure of these songs bear a strong resemblance to those of the heterogeneric Bewick's Wren (*Thryomanes bewickii*) (is this really in a different genus?), members of which have a repertoire of two to four songs (Borror, 1964). In contrast they bear little resemblance to those of the homogeneric Carolina Wren (*Thryothorus ludovicianus*) members of which may sing up to 36 different songs (Borror, 1956).

Observations revealed that songs were produced by the birds in a territorial context. Also it was sometimes found that a recording of one species played back within the territory of an individual of the same species evoked a singing response from a previously quiet individual of the other species in an adjacent territory. Both species behaved in this way. No attempt was made to standardize this procedure or to measure the results.

When two members of a pair are foraging they often vocalize alternately (antiphonally). The vocalizations of the male and female are believed to be

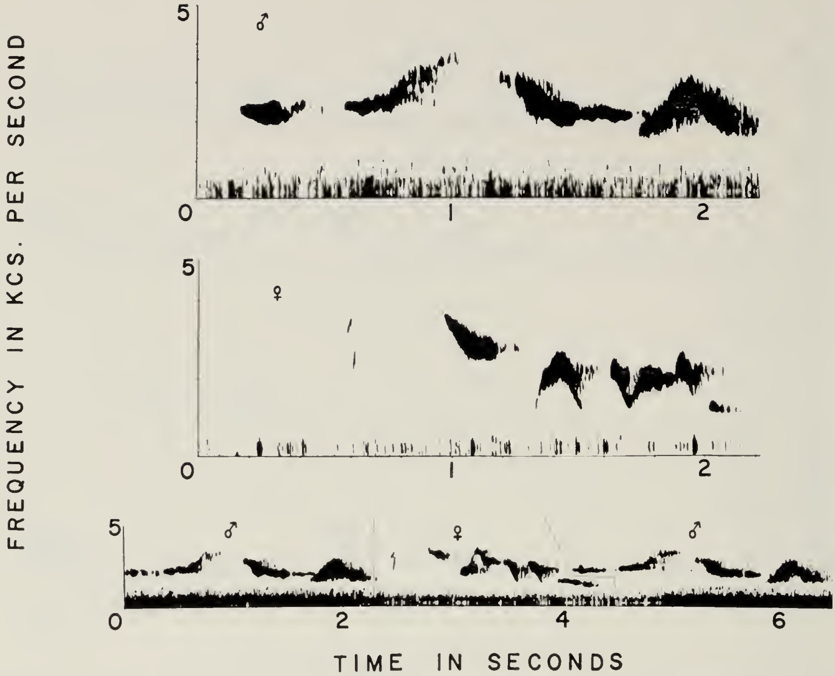

Fig. 3. Contact calls of *T. felix* recorded on María Magdalena, Tres Marías Islands, June 1963.

consistently different: the identity of the sexes was established by collecting birds previously observed and heard to sing these "contact calls." Birds which sang the territorial song were sometimes heard to change to the "male" component of the contact call, but never to the "female" component. An individual was never heard singing both components (cf. Thorpe and North, 1965). Although contact calls were not recorded from individuals of *T. sinaloa* they are almost certainly produced by them. The island form of *T. felix* was never heard to sing either type A or B of the territorial songs (in April, June, July, and August) or any other type except the contact call (Fig. 3). This is produced frequently by a single bird or a pair both before and during the breeding season. It appears to serve a communication function while the pair is foraging in undergrowth (Grant, 1965*b*); it may also serve a stimulatory function during and after courtship. Whether it has taken on an additional function in the context of territoriality on the islands or whether territoriality has been relaxed there is not known. A few observations suggest that the former is the more likely.

Habitat.—The two species occur together in the same habitat, mainly tropi-

TABLE 2

NUMBER OF SPECIMENS COLLECTED AT PUERTO VALLARTA, MAY TO AUGUST 1961

	Numbers	Per cent
T. felix	26	38.2
T. sinaloa	42	61.8
NUMBER OF PAIRS RECORDED IN A CENSUS STRIP OF 4 HECTARES (10 ACRES) AT TEPIC, MAY 1963[1]		
T. felix	8	61.6
T. sinaloa	5	38.4

[1] Six surveys on consecutive days. For further details see Grant 1966*d*.

cal deciduous forest, thorn scrub, oak–hornbeam forest, and associated vegetations. Both species occupy territories in a spectrum of habitat configurations from thick forest to isolated clumps of shrubs in a field, with *T. felix* perhaps occurring most frequently in the thicker vegetation and *T. sinaloa* most frequently in the sparser parts (cf. Selander and Giller, 1959; Zimmerman and Harry, 1951). However, no absolute difference in habitat preference between the species was detected by the author.

Observations at both Tepic and Puerto Vallarta indicated that substantially more than 50 per cent of the territories occupied by one species in one year were occupied by the same species in the following year, but that some interchange of territory occupancy did occur. *T. felix* was found in *T. sinaloa* territories of the previous year in numbers equal to *T. sinaloa* in previous *T. felix* territories. Thus, the proportions of the two species in any one region appeared to stay the same despite the changing of territories.

Numbers.—From two sources of information it appears that the two species are not numerically equal where they coexist. Specimens of the two species were collected at Puerto Vallarta in 1961 with no deliberate effort made to collect one species preferentially. Table 2 shows that here, in an area approximately 2 km square, *T. sinaloa* outnumbered *T. felix* approximately two to one. In a census of 4 hectares at Tepic in 1963 the same ratio was found, but the proportions of the two species were reversed (Table 2). As mentioned above, there was no indication that these ratios changed in the years 1961 to 1963.

Food.—More than 20 gizzards of specimens of each of the two species, collected between April and August inclusive, 1961–63, at Tepic and Puerto Vallarta, were examined. The data for *T. sinaloa* have been unfortunately lost, those for *T. felix* are presented in Table 3. In only one gizzard of an adult *T. felix* was vegetable matter found, and even then animal matter pre-

TABLE 3

CONTENTS OF 25 GIZZARDS OF *THRYOTHORUS FELIX PALLIDUS* EXPRESSED AS PER CENT OCCURRENCE IN THE SAMPLE

Coleoptera	80	Isoptera	4
Lepidoptera (larvae)	32	Diptera	4
Hemiptera	20	Lepidoptera (adult)	4
Hymenoptera	12	Fruit	4
Orthoptera	4		

dominated. From the data it can be said that at this time of the year both species feed mainly on coleopterous insects, extensively on Hemiptera and larval Lepidoptera and to a lesser extent on Araneida, Hymenoptera, Isoptera, Orthoptera, Diptera, and adult Lepidoptera. Before the date from *T. sinaloa* gizzards were lost it was determined that there were no significant differences between the species in the relative frequency of these items or in the approximate size of the food taken.

Foraging.—Observations on the foraging characteristics of the wrens were not quantified, but they did not reveal any obvious difference between the species in either the parts of the environment exploited or in the manner of exploitation. Differences, if they exist, must be small. Both species forage at a height of less than 2 meters, often on the ground: both species forage rarely in the canopy of trees, as much as 10 meters above the ground. However, since tarsus length is correlated with the nature of the perches used (Grant, 1966*a*; Selander, 1964), and since *T. sinaloa* has a shorter tarsus than *T. felix*, a difference in feeding positions may exist. On the Tres Marías Islands *T. felix* is, if anything, more terrestrial than either mainland form.

Nests.—The two species construct a nest of the same shape, that of a flask or retort bent at the base of the neck through 120–180°. The nest is built over a twig or slender branch and near its tip, and in such a way that the bowl of the flask hangs down on one side and the neck hangs down on the other. It is made of grass stems, shreds of bark, fine twigs, etc., and measures approximately 22 to 25 cm long and 10 to 12 cm in maximum height and breadth. There are slight and insignificant differences between the two species in the height and orientation of the nest (Table 4). The preferred orientation of both species is with the entrance facing north or west. Both species were found building nests within 1 meter of the nest of an aculeate hymenopteran, *Polybia occidentalis* (Oliv.) (Fig. 4). The nests were also frequently on species of acacias which are covered with highly aggressive ants of the genus *Pseudomyrmicus.* Nests were usually above open ground, water, or a bromeliad (cf. Sutton, 1948), and not close to other vegetation. In these several

TABLE 4
NEST CHARACTERISTICS

THE NUMBER OF NESTS AND THE DIRECTIONS IN WHICH THEIR ENTRANCES FACED

	N	NW	W	SW	S	SE	E	NE
T. felix	3	1	2	2	–	–	–	1
T. sinaloa	1	1	3	–	1	–	1	1

NEST HEIGHT ABOVE GROUND (IN METERS)

	N	Range	$\bar{x} \pm 2$ SE
T. felix	18	0–9	3.03 ± 0.85
T. sinaloa	9	1.3–3.5	2.62 ± 0.54

ways the two species exhibit identical adaptive defenses to the threat of nest predators.

On the mainland only one of a total of 18 nests of *T. felix* was found built upon the ground. On the Tres Marías Islands only two nests were found altogether, one on the ground and the other at half a meter above ground. That such low nesting is probably of general occurrence on the islands is suggested by the fact that old nests were frequently seen in mainland forests, conspicuously supported on the limbs of trees, but were never seen by the author on the islands, nor have they ever been recorded there by other ornithologists. Atypical ground nesting on the Tres Marías Islands has also been reported for White-tipped Dove (*Leptotila verreauxi*) (Grayson, 1871). It is presumably less hazardous on the islands than on the mainland in view of the relative lack of predators.

Breeding season.—The timing of the breeding season of the two species appears to be the same. At Tepic nest building was first observed in the second week of May. The first eggs were found in the third week of May and the first fledged young were observed in the first week of June. Some pairs of both species were found attending nests as late as July, either having started breeding late, been forced to renest, or having started a second brood. A few observations indicated that five eggs was the usual clutch size in both species. No determination of breeding success was made. *T. felix* breeds as much as 7 weeks later on the Tres Marías Islands than on the mainland, for reasons which are not completely understood (Grant, 1964, 1966*b*).

DISCUSSION

Lack of evidence of hybridization or heterospecific courtship and pairing suggests that the two species are reproductively isolated. Similarity of song

FIG. 4. Nests of *Thryothorus felix* and *Polybia occidentalis* in an acacia, about 4 km north of Puerto Vallarta, Jalisco, June 1963. The two nests are approximately one-third of a meter apart and are supported by the same complex of branches. *Polybia* nest on the left, *Thryothorus* nest on the right. The entrance to the wren's nest is on the left.

suggests that species discrimination is achieved not by song but by means of plumage, movement, and postures. The similarity of song also probably helps the maintenance of mutually exclusive territories by ensuring that in territorial defense a male will respond to the song of another male of either the same or the other species in the same way (cf. Dixon, 1961). Exclusive territories are presumably of adaptive advantage to both species in view of the apparent similarity in food requirements, as judged by observations on foraging behavior, diet, and size of bill and body.

Other ecologically similar species of wrens coexist in two ways. Either they occupy different habitats (Grinnell and Storer, 1924; Marshall, 1957), or else they occupy the same habitat but different parts of it as a result of aggressive dispersion (Brooks, 1934, 1947; Miller, 1941; Newman, 1961). It is probable, therefore, that coexistence in the same habitat with little or no interaction occurs only when ecological differences are large and the likelihood of competition minimal (Grant, 1966*c*). For instance, where *Troglodytes aedon, Thryomanes bewickii,* and *Thryothorus ludovicianus* occur together aggression is greatest between *T. aedon* and *T. bewickii*, intermediate between *T. bewickii* and *T. ludovicianus*, and least between *T. aedon* and *T. ludovicianus* (Sutton, 1930). In the absence of detailed knowledge of the ecology of these species the bill lengths may be taken as indicative of their food characteristics. The least compatible pair of species differ in bill length by only 8 per cent, the middle pair by 26 per cent, and the most compatible by 36 per cent (calculated from data in Ridgway, 1904). The expected correlation is thus realized.

Species in other genera display the same features. When ecological differences are small species either occupy different habitats, occupy different positions in the same habitat (MacArthur, 1958), or defend territories against each other in the same habitat (Orians and Willson, 1964). When ecological differences are substantial territories tend to be largely overlapping. For instance, the completely overlapping territories of the Cardinal (*Richmondena cardinalis*) and Pyrrhuloxia (*Pyrrhuloxia sinuata*) (Gould, 1961), species considered by Bock (1964) to be congeneric, lead one to expect a large difference in preferred food, and this is indeed likely in view of the more than 40 per cent difference in bill length (calculated from data in Ridgway, 1901). An interesting exception to the empirical rule is provided by two species of towhees (*Pipilo fuscus* and *P. aberti*) in Arizona, which sometimes occupy overlapping territories (Marshall, 1960), yet have bills of almost identical length (Davis, 1951). However, the zone of sympatry is extremely small, hence this is a limited case of coexistence. Furthermore, in this zone *P. aberti* is more confined to the woods than the other species and probably does more scratching for its food (Marshall, 1960): these differences in ecology are presumably sufficient to permit coexistence with territory overlap. It may be concluded that interspecific territorial behavior is selected for when the ecological requirements of the two species are too similar to permit them to exploit jointly the available resources (food, perches, nest sites, etc.) in the same volume of habitat without detrimental effects upon each other. The conditions under which this behavior evolves have been discussed by Johnson (1963), Orians and Willson (1964), and Wynne-Edwards (1962).

What makes *T. sinaloa* and *T. felix* unusual is that production of and response to an extremely similar complex song has also been selected for, apparently to aid the process of mutual dispersion. There is a little evidence that a similar situation exists with two species of *Pipilo* in Puebla, Mexico (Marshall, 1964). It would be interesting to know why *T. felix* is sympatric with *T. pleurostictus* in Guerrero, México, Morelos, Puebla, and Oaxaca over approximately half of the latter's range, whereas *T. sinaloa* and *T. pleurostictus* are completely allopatric. *T. pleurostictus* is larger (avg. ca. 18.5 g) than the other two species, has a bill at least 10 per cent longer than theirs, a conspicuously spotted breast, and songs distinctly different from those of the Jalisco and Nayarit birds of *T. sinaloa* and *T. felix* (songs of *T. felix* from region of overlap with *T. pleurostictus* are not available). Since *T. pleurostictus* is so different from the other two species, why does only one member of the genus coexist with it, and why is that one *T. felix*? The large differences between *T. pleurostictus* and *T. felix* suggest that the territories of the two may overlap. It would also be interesting to know the reasons for the numerical imbalance of sympatric populations of *T. sinaloa* and *T. felix* and whether it really is constant from year to year. Since there appears to be no short supply of birds for the limited amount of space, and probably limited amount of food, here is an excellent situation for the study of interspecific competition under natural conditions.

SUMMARY

Two wren species of the genus *Thryothorus* occur sympatrically over a large part of western Mexico, and were studied in this zone of sympatry. They differ in several plumage characteristics but in most dimensions they are similar, particularly in bill length, and they are strikingly similar in their songs. Reproductively, they appear to be isolated from each other. Territories are defended against individuals of the same and the other species. It is suggested that similarity of song aids this behavior, which is of mutual benefit to the species in view of their extremely similar ecology, viz., they occupy the same habitats, forage in a similar way, feed on similar foods, build similar nests, and breed at the same time of the year. Some territories are interchanged between the species from one year to the next. The two species did not occur in equal numbers in either of two study areas, *T. felix* being about twice as abundant as *T. sinaloa* in one and about half as abundant as it in the other.

On the Tres Marías Islands only *T. felix* occurs. Here it resembles more closely *T. sinaloa* than does its mainland relative, it does not have the "territorial" song of the mainland form, and it has a bill 13 per cent longer than the mainland form. These data indicate that the presence or absence of a congener has had an influence upon the evolution of the reproductive and ecological characteristics of *T. felix*.

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REACTION TO PREDATORS IN THE ROSE-BREASTED GROSBEAK

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The observations reported here were incidental to a comprehensive study of the behavior of the Rose-breasted Grosbeak (*Pheucticus ludovicianus*). The field observations were made primarily in a tract of wet woodland at the head of Cayuga Lake, Ithaca, Tompkins County, New York. A small tape recorder was used for taking notes in the field. Almost all observations were made without the use of a blind. Captive birds were also studied.

PREDATORS

Ivor (1944*a*, 1944*b*) reports male Rose-breasted Grosbeaks being taken by Sharp-shinned (*Accipiter striatus*) and Cooper's (*Accipiter cooperii*) hawks. Red squirrels (*Tamiasciurus hudsonicus*) take young (Baird, 1964), as may Common Grackles (*Quiscalus quiscula*), gray squirrels (*Sciurus carolinensis*), and Blue Jays (*Cyanocitta cristata*). Predation was not witnessed in this study, but eggs and young were found to be missing from a number of nests. Some of this predation is known to have been by man; red and gray squirrels, grackles, and Blue Jays were also common in the study area.

The closely related (if not conspecific) Black-headed Grosbeak (*Pheucticus melanocephalus*) is known to have its eggs taken by gopher snakes (*Pituophis catenifer*) (Pemberton and Carriger, 1916), and gray (*Sciurus griseus*) and fox squirrels (*Sciurus niger*) (Boyer, 1941) take young.

AVOIDANCE AND MOBBING

Gray squirrels passing close by foraging grosbeaks are avoided by a slight movement aside. Two fighting Blue Jays near a grosbeak territory were mobbed with *Chink* (a sharp call; see Dunham, 1965, for an audiospectrogram). Grackles in the trees above a grosbeak nest were mobbed with loud Chink, and two grackles in a tree above another nest were mobbed with *Squawk* (a harsh, grating call; see Dunham, 1965, for an audiospectrogram) and quickly left. Watts (1935:41–42) reports aggression toward grackles. Both sexes mob grackles, and were seen to join White-breasted Nuthatches (*Sitta carolinensis*), American Redstarts (*Setophaga ruticilla*), Black-capped Chickadees (*Parus atricapillus*), and Baltimore Orioles (*Icterus galbula*) in doing so.

P. melanocephalus will sometimes mob a mounted Screech Owl (*Otus asio*) (Altmann, 1956).

Fig. 1. *Wings-waved* in a captive female Rose-breasted Grosbeak. A, B, and C are low, medium, and high intensities of the display, respectively, followed by attack in D. Arrows indicate features discussed in the text. Drawn from photographs.

A female grosbeak model (of papier-mâché) placed one meter from a Rose-breasted Grosbeak nest was mobbed by the female with Chink (and tail-flicking). This was a reaction to a novel object and not one to a bird of the same species.

Man is usually avoided by moving away, especially if the bird is on the ground or in a shrub, but less often if it is in a tree. Near the nest or building site individual variation in reaction is striking. Extreme examples are a female that always bit a mirror held at her nest and had to be repeatedly shoved aside to inspect the young, and a female that always slipped off the nest when approached within 100 meters although the nest and nest shrub were well concealed. Most individuals hesitate to approach the nest if a man is near, and mob him with Chink from perches near the nest (see also Allen, 1916).

Ambivalent turning of the body toward and away from the nest (with feet stationary), and displacement preening and head scratching, are common in such mobbing, and suggest a strong conflict between approaching the nest and avoiding the intruder.

WINGS-WAVED

Wings-waved is a display given when an intruder is close to the nest, at least when there are young in it. Baird (1964) records it from both adults when a red squirrel carried off the young and ate them. It has been elicited from the female by a man crawling on hands and knees near the nest (D. A. West, pers. comm.). I have seen it directed at an erect man approaching the nest, at a mirror, and at a shiny microphone and shiny camera tripod leg near the nest, in captivity.

A low-intensity performance (also seen once in the wild at a nest not yet completed) consists of tail spread, *Crest-raised* (a display seen in intraspecific agonistic contexts), Chink, sometimes lifting of the carpals out from the body, and the flicking of one wing, rendering the underwing coverts conspicuous (Fig. 1A). The highest intensity shows the feathers of the ventrum fluffed slightly, Crest-raised, tail spread fully and raised and depressed (Fig. 1B and C). The wings are opened fully and waved slowly above the back and down to the sides, both in synchrony and asynchrony (Fig. 1B and C). At the same time as the wings are open, the body is slowly pivoted in place from side to side. When the observer leaves the area of the nest Squawk given during Wings-waved is replaced by Chink and finally by silence. Wings-waved is given either at the nest or on branches close to it.

Figure 1 shows a series of stages in the reaction of a captive (tame) female to a tripod leg near the nest. (The leg can be seen at the arrow farthest right in A, B, and D, and at the white arrow at bottom center in C.) Other arrows point to features of the display mentioned above. The wings were also often held straight above the back together. In C note the sleeked crest just before flight with open bill (D) at the tripod which was bitten repeatedly.

Baird (1964) noted erection and lowering of the male's red breast feathers (see his Fig. 1D), and ruffling of the lower back plumage (see his Fig. 1, A and B) in both sexes.

Spread and movements of the tail and wings appear ritualized and are probably derived from flight intention movements, in this case to fly towards the stimulus since the intensity of these movements increases before attack (compare A with C in Fig. 1). Sleeking the crest also anticipates flight.

The wing movements and bright underwing coverts probably aid in distracting a predator's attention from the nest. The movement of red breast feathers in the male that Baird observed may also function in this way; he noted a change in hue with these movements.

Another richmondenine finch, *Cyanocompsa cyanoides*, is described as feigning a broken wing when disturbed at the nest by man (Worth, 1939).

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RED-WINGED BLACKBIRD NESTLING DEVELOPMENT

LARRY C. HOLCOMB

RED-WINGED Blackbirds (*Agelaius phoeniceus*) breed in both wet and dry situations. At present this species is increasing and more often than formerly it nests in dry situations. If young birds are in danger of falling into water they would need to grasp the vegetation quickly and balance well or they could drown. Therefore, one may assume that there might be selection for nestlings with strong grasping feet and early ability to balance over the aquatic environment. On the other hand, those nestlings falling from or leaving a nest over dry ground would not be as likely to perish. Therefore, many individual nestlings with weaker grasping and balancing abilities might survive and the elements playing a part in natural selection of those birds with stronger feet would no longer have the same role. Over a period of several years, if the wild population of upland nesters did not freely interbreed with wetland nesters, the population of terrestrial nesters might have weaker powers of grasping and slower development of the ability of nestlings to grasp, as compared to aquatic nesters.

Fankhauser (1964) reported on the renesting and second nesting of 26 color-marked Red-winged Blackbird females. He reported one bird that first nested successfully over an upland field, built a second nest which was destroyed by a predator, and then proceeded to build a third nest 600 yards away over a marshy area. This demonstrates that in some instances Red-winged Blackbirds build a nest at one time over upland areas and at other times over an aquatic area. It would be essential to record the percentage of such cases in continuing studies. The present report is based on a study designed to discover the time of development of grasping and ability to balance in upland breeding Red-winged Blackbirds and also some of the factors effecting these characteristics.

Lea (1942) found that Cedar Waxwing nestlings were able to move their toes but not grasp objects at 2 days after hatching. Further, at 4 days, when placed on their backs, the nestlings were unable to right themselves. On the 9th day, they could support themselves on a perch.

King (1955) reported that Traill's Flycatcher (*Empidonax traillii*) nestlings sat erectly on their tarsi on day 8 and on day 10 were able to perch on a finger.

Laskey (1944) reported young Cardinals (*Richmondena cardinalis*) perching in the nest shrub when 9 days old.

METHODS

The study reported continued from 12 May to 22 July 1964. All records were taken within the city limits of Toledo, Ohio.

Behavioral and ecological associations and nestling development were recorded in detail. However, this paper will deal primarily with those aspects directly concerned with grasping and balancing of the nestlings.

I marked the location of each nest with a numbered tag and visited it once a day. When birds first hatched from eggs, they were placed on their backs to determine their ability to right themselves. If they could not right themselves on the first day, a second and third or fourth test was made on the following days.

In grasping and balancing experiments, a series of different sizes of dowels was used as the grasping or perching foothold. This allowed for uniform testing. Dowels ranged from 9 to 40 mm in circumference, with six different sizes being tried.

In the previous year I found that the perch should be a bit smaller in circumference than the potential perch that could be surrounded by a bird's toes. When birds perch, their toenails usually overlap. By measuring the distance between the tip of the third toe and the tip of the hallux on each day, a dowel can be used as the testing medium which is about 10–15 mm less in circumference than is the distance between the tip of toe three and the tip of the hallux. In previous experience I found that some species of birds first able to grasp, will do so while hanging bottom-side up. In this position, they soon weaken. In this study, if the birds could grasp the dowel for 5 seconds without falling, they were considered able to grasp. If they could balance for 5 seconds, they were considered able to balance. Nestlings were placed feet first on the dowelling to allow the toes a chance to surround it. If they failed to grasp it on the first test, they were given a second chance. These tests continued each day, but an individual nestling was only allowed two chances to grasp or balance on each day. The nestlings were not allowed to drop more than 2 inches to the hand of the investigator if they failed in their attempt to grasp or balance.

The effects of visual perception on early balancing were tested by placing a hood over the head of nestlings that could balance for the first time. The ability to balance or not balance was then recorded. Most of the young birds were banded before leaving the nest. The height of the nests from the earth surface, dimensions of the nest, and the vegetative substrate for the nests were recorded.

RESULTS

Table 1 shows the distribution of the 36 nests studied. The birds that were in the old weed-field had constructed their nests along one side of the field

TABLE 1

LOCATION OF RED-WINGED BLACKBIRD NESTS

	Old weed-field	Ditch bank	Second-growth vegetation*
Numbers	19	10	7
Per cent of total	53	28	19

* At least 75 feet from water in hedgerows, old fields, etc.

that had been wet early in the spring. By the time nests were constructed all of the water had disappeared.

Table 2 shows the per cent of nests located in different types of vegetation. Vegetation aiding in support of nests other than the principal support given in this table were black willow, wild grapevine, morning glory, panicled dogwood, American elm, blackberry, meadowsweet, burr oak, black raspberry, quack grass, brome grass, and timothy.

The distance from the earth surface to the top edge of the nest was measured in 22 nests. The mean height was 32.5 inches with a maximum of 84 inches and a minimum of 9.5 inches.

The dimensions of 24 Red-winged Blackbird nests were recorded. I compared the data of Beer and Tibbitts (1950) on aquatic-nesting blackbirds to those in this study (see Table 3).

Table 4 lists the data concerning grasping and balancing of nestlings from 15 nests. These represent all of the birds leaving the nests. Nestlings when first hatched could almost always right themselves when placed on their backs. Nine nests of birds could balance on the day that they could first grasp. Six nests of birds grasped the perching medium hanging upside down on the day previous to being able to balance.

Seven nests of blackbird young were hooded on the day they were first able to balance and then replaced on the dowelling. Most nestlings could balance when hooded. A few could not balance or balance but poorly when hooded.

The sex of nestlings as given in Table 4 was derived by the use of data supplied by Williams (1940) and Nero (1961). There were 31 females and nine males leaving the nest. This does not, however, represent all of the young hatched, for often young were taken by predators before they could be sexed and before they were able to grasp and balance.

The span between the tip of the first and third toe when able to first balance varied between 35 and 48 mm.

The variability in nesting substrate and height of nest from the ground is striking in the upland breeding blackbird as compared to those nesting in an aquatic habitat. The nest height of those breeding in cattail swamps is limited by the height of the substrate. The nest dimensions, although not

TABLE 2
VEGETATION IN WHICH RED-WINGED BLACKBIRD NESTS WERE DISCOVERED

Plant substrate	Number of nests	Per cent of total
Goldenrod	19	53
Panicled dogwood	5	14
Blackberry	3	8
Meadowsweet	2	6
American elm	2	6
Elderberry	1	3
Burr oak	1	3
Black willow	1	3
Black raspberry	1	3
Wild grapevine	1	3

highly variable, show some differences in the size of the nest cavity. The size of the nest cavity would certainly control to some extent the time at which the nestlings are pushed from the nest by crowding of siblings. The data in Table 3 show little difference in the mean nest dimensions of terrestrial- and aquatic-nesting blackbirds. The inner nest diameter of the aquatic-nesting birds was a little less but the inner depth was a little more than the terrestrial-breeding birds. A comparison of a larger sample of nests from both populations would be desirable.

Young (1963) found that mortality of Red-winged Blackbirds is greatest in nestlings. Nestlings begin crowding one another at 8–11 days of age and those which are crowded out of the nest might become victims of predators or drown in an aquatic environment. One of the factors influencing age-specific mortality in nestlings may be their ability to grasp and balance. Those nestlings unable to grasp the nesting materials or surrounding vegetation could possibly drown over a water habitat but might survive over a terrestrial environment. Ability to balance would also be of importance, for nestlings can only grasp a perch for a short time when hanging upside down. With ability to balance, nestlings would have a much better survival potential over either an aquatic or terrestrial environment. Thus, it may be significant that nestlings from nine of the 15 nests could balance when first able to grasp. In previous investigations with seven other species of altricial birds, there were no nestlings that could balance on the same day that they were first able to grasp. Perhaps this is an adaptation of the Redwing while nesting over an aquatic environment.

Wood (1938) reported that a Redwing nestling 2 or 3 days old would be likely to drown if it should tumble out of the nest. However, he found that a half-grown nestling will float and can swim to reeds to hold on. Even before

TABLE 3

NEST DIMENSIONS OF TERRESTRIAL AND AQUATIC BREEDING RED-WINGED BLACKBIRDS

	Terrestrial*		Aquatic**	
	Mean	Range	Mean	Range
Outer diameter, cm	11.7	9.5–15.0	11.9	10.4–13.0
Inside diameter, cm	7.8	7.5– 9.5	7.6	7.1– 8.4
Outer depth, cm	10.1	6.5–13.0	11.7	8.1–19.6
Inner depth, cm	6.5	5.0– 8.5	7.1	6.6– 8.1

* 24 nests.
** 22 nests—Beer and Tibbitts (1950).

they are ready to vacate the nest, they could swim readily and climb up the cattails to the nest.

Beer and Tibbitts (1950) report that when young blackbirds leave the nest, they climb about in the vegetation and swim readily when it is necessary to cross a little open water.

Even though young birds are known to be able to swim, this ability is probably dependent on the age of the subject, temperature of the water, and amount of resting substrate to which it could grasp. The development of ability to grasp and balance would allow young birds to climb about on the vegetation and escape some predators and to escape the water, enhancing survival.

TABLE 4

DEVELOPMENT OF GRASPING AND ABILITY TO BALANCE IN NESTLING BLACKBIRDS

Number of birds in nest	Sex ratio	Day when able to grasp	Day when able to balance	Balance when hooded
4	4 F	–	7	Poor
4	4 F	7	8	–
4	3 F, 1 M	–	8	–
2	2 M	–	9	*
2	2 F	8	9	Good
4	4 F	8	9	Good
2	1 F, 1 M	8	9	–
4	2 F, 2 M	8	9	–
4	4 F	–	9	–
3	2 F, 1 M	–	9	–
1	1 F	8	9	–
1	1 M	–	9	–
1	1 F	–	8	Good
3	2 F, 1 M	–	9	Good
1	1 F	–	8	Good

* Could not balance after hooded.

SUMMARY

Thirty-six upland breeding Red-winged Blackbird nests were discovered in Toledo, Ohio, 19 of which were in old weed-fields, 10 along ditch banks, and seven in second-growth vegetation.

The primary nest substrate consisted of 10 different kinds of vegetation. Often there was a second or third species of plant assisting as nest supports. A great deal of variation was found in the nest dimensions and in the height of the nest from the ground.

Most nestlings were able to grasp by the eighth or ninth day. More than half of them could balance on the day that they could first grasp. When a hood was placed over the head of nestlings when first able to balance, they had difficulty in balancing but most of them could still balance.

Ability of nestlings to grasp and balance may have a direct influence on age-specific mortality.

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BREEDING-RANGE EXPANSION OF THE SCISSOR-TAILED FLYCATCHER INTO MISSOURI AND IN OTHER STATES

Alexander Carl Warner

The breeding range of the Scissor-tailed Flycatcher (*Muscivora forficata*) has in the past been limited to the southern section of the grassland biome and adjacent ecotones. However, it has become evident that the range has been expanding, principally northeastward. The main objective of this study was to determine the status of this species as a breeding bird, and its distribution, in Missouri. A second purpose was to analyze nesting records from other fringe areas for evidence of range expansion, and to establish as nearly as possible the present breeding range.

AREA, METHOD, AND PERIOD OF STUDY

Fieldwork was carried out between April and October of 1961, 1962, and 1963. Most of it was done in southwestern and west central Missouri, but western Missouri north of the Missouri River was also investigated. Leads to locations of Scissortails were found in the *Bluebird* quarterly and in conversation with persons who had seen the bird. The validity of all reports was checked, by examining the locality where birds were seen or by talking with persons making the reports. One trip was taken to the center of the breeding range in central Texas to compare behavior, habitat, and population with those of Missouri.

Thus, determination of the present breeding range of the Scissor-tailed Flycatcher in Missouri was established by my field observations and through reports of others. Current breeding-range information from other states was obtained by analyzing available ornithological literature, and by corresponding with authorities in various states.

In 1961 most of the fieldwork was devoted to studying a pair of Scissortails nesting at the James A. Reed Area in Jackson County, Missouri, and in locating other nesting pairs in Jackson and Cass counties, Missouri.

During the years 1962 and 1963, range work became more extensive. Observation of nesting Scissortails during 1962 and 1963 required a major part of field time. Three weekend trips were made into northwestern Missouri where habitat seemed favorable, but no Scissortails were sighted. Several trips were taken through the southwestern Missouri counties and almost daily trips were made to southeastern Jackson County, in attempts to locate breeding pairs in the study area. Approximately 20,000 miles were driven during this study.

Binoculars (7 × 50) were used in most of the field observations. Young birds found in the nest were banded. During 1962 and 1963, attempts were made to mist-net adults by holding their young near the net, but none were caught.

BREEDING RANGE

Although the main objective of this study was to illustrate the expansion of the breeding range of the Scissor-tailed Flycatcher since the 1957 AOU Check-list, pertinent information from earlier literature has been cited to show that the expansion is not entirely a recent phenomena.

The questionable value, either wholly or in part, of early breeding-range accounts by Bonaparte (1825), Audubon (1839), Baird, Cassin, and Lawrence (1860), Baird, Brewer, and Ridgway (1874), and Coues (1874) has placed limitations on their usefulness concerning possible breeding-range expansion during that period. A comparative examination of the AOU Check-lists with these earlier reports illustrates their vagueness and inaccuracy. The practice of the American Ornithologists' Union of compiling breeding-range records has led to a progressive improvement in accuracy.

The following state-by-state analysis of breeding-range information illustrates both past and current expansion: Figure 1 shows the total species range as here outlined, with recent nesting records at the periphery indicated.

Arkansas.—Western Arkansas has been included in the breeding range of the Scissortail since Third Edition of the AOU Check-list, but Baerg (1951) stated that the species was known to nest only in Sebastian, Logan, and Pulaski counties. He reported that the species probably occurred in the other western counties of the state, but had no records.

The field records of Dr. and Mrs. Douglas James (in litt.) show that Scissor-tailed Flycatchers are found in other locations in the state. Their records have definitely established that this species nests in White, Benton, and Conway counties and possibly in Prairie, Miller, Columbia, and Faulkner counties. James reported that the population in Conway County, south of the Arkansas River, was the highest in the state, but he gave no numbers.

According to James (1965), the Scissor-tailed Flycatcher continues its eastward advance in Arkansas with many at Pine Bluff, Jefferson County and two at Lonoke, Lonoke County.

Colorado.—The first reference to any part of Colorado being in the breeding range was in the Fifth Edition of the AOU Check-list, which mentioned southeastern Colorado.

Kansas.—The early reports of Baird, Brewer, and Ridgway (1874), Goss (1891), and the first three editions of the AOU Check-list gave southern Kansas as the northern extent of the breeding-range; however, the Fourth

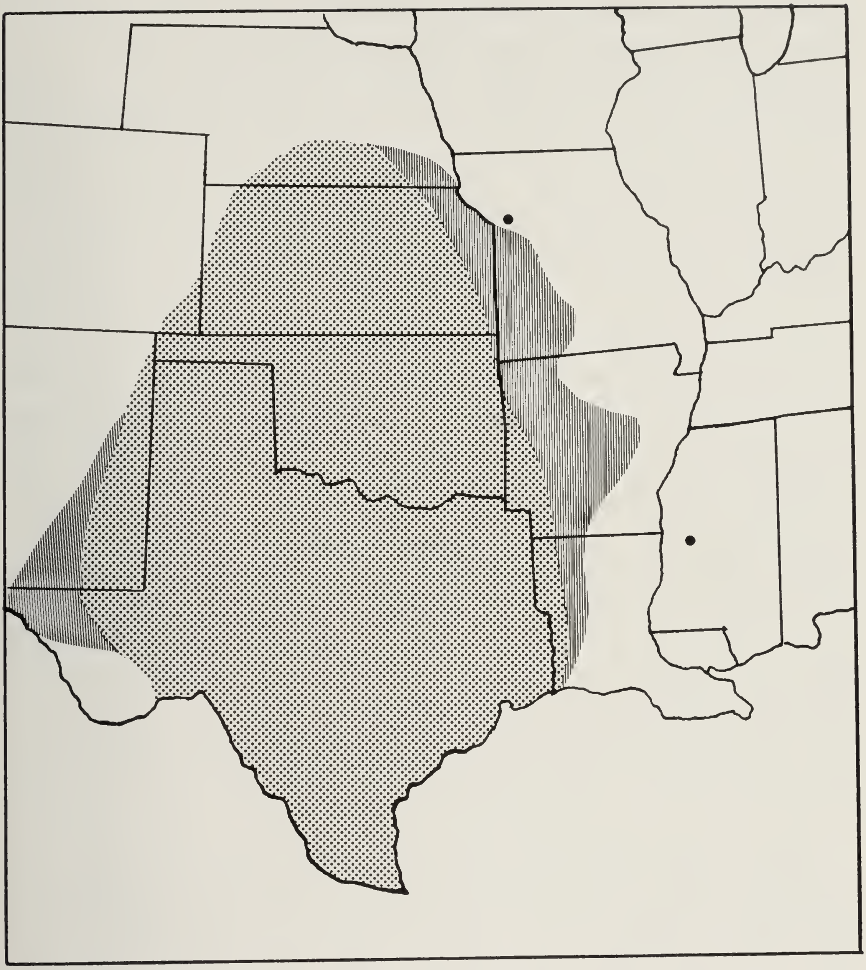

Fig. 1. Present breeding range of the Scissor-tailed Flycatcher.
░ Breeding range according to the Fifth Edition of the AOU Check-list (1957).
▥ Breeding range expansion since the Fifth Edition of the AOU Check-list.
● Possible nesting records, adults seen with young during breeding season.

Edition of the Check-list included southern Nebraska. Fitch (1950) erroneously cited Bent (1942) as setting the northern limits of the range in southern Kansas.

The Fifth Edition of the AOU Check-list gave the breeding-range as the central and southeastern part of the state, based upon Goodrich's (1945) report that the bird was breeding in central Kansas. Robert Mengel (in litt.) said that the species was seen infrequently in summer in a number of eastern Kansas counties including Douglas, where it has been found to breed.

Louisiana.—Oberholser (1938) reported the Scissortail to be a casual summer visitor in the southwestern part of the state. Oberholser also indicated that the species was reported to breed in the state but gave no definite records of nesting. The AOU Check-lists have included western Louisiana in the breeding range since the Third Edition. Lowery (1960) pointed out that the Scissortail has been recorded in Louisiana in every month of the year but is never found outside of its breeding area in northwestern Louisiana except during migration. Lowery (in litt.) said there is some evidence that in the summer of 1963 Scissortails were more numerous than before, particularly along the highway between Natchitoches and Bossier City. According to Stewart (1963) at least five pairs, two with fledglings, were seen at various times in late June and early July near Grand Cane in DeSoto Parish. This area is the "southernmost upland locality" in which breeding is definitely established (Stewart, 1963).

Mississippi.—Stewart (1963) reported that Scissor-tailed Flycatchers near Bentonia, Mississippi, on 24 July 1963, and three more, including a juvenile at Gum Cove on 15 July 1963, may have been postbreeding wanderers, but mentioned that they may have nested in the area. The species' breeding in the Gum Cove area is not improbable due to the closeness of definite breeding records in Arkansas and Louisiana.

Nebraska.—The Fourth Edition of the AOU Check-list (1931) merely stated "southern Nebraska." Haecker, Moser, and Swenk (1945) have found the Scissortail a rare summer resident in southeast Nebraska but reported the bird nesting in Adams, Lancaster, and Logan counties.

Sturmer (1959) reported a Scissortail nesting in Gage County, southeastern Nebraska, and Doris Gates (in litt.) mentioned that the Scissortail has nested there since that time. Gates found the species quite rare in other parts of Nebraska. According to Ford (1959), a specimen he collected 4 miles west of Halsey represents one of the most northerly records.

New Mexico.—Bailey (1928) indicated that the Scissortail was a "straggler" until 1912 when a pair was found breeding in Hobbs, located on the border of New Mexico and Texas. Numbers increased, and by 1915 they were nesting 2 miles south of Carlsbad, approximately 75 miles west into the state. Ligon (1961) stated the Scissortail was confined to eastern and southeastern New Mexico. In recent years the population has been increasing, and apparently has expanded its range west and is common in the Pecos Valley. Zimmerman (1962) cited a record of a Scissor-tailed Flycatcher nesting 10 miles south of Roswell on 22 June 1962.

Oklahoma.—The Scissortail is one of the state's most common birds and has even been chosen as the state bird (Smith, 1965). According to Baumgartner (in litt.), the Scissortail is a fairly common to common summer resident throughout most of the state except in the oak–hickory forest associations in the eastern counties along the Missouri and Arkansas borders, and it has a limited distribution in Cimarron County in the Panhandle of eastern Oklahoma.

Texas.—The Fifth Edition of the AOU Check-list gives the breeding range as all of Texas except the southwestern tip. Fisk (1960) reported unsuccessful attempts by two pairs of Scissortails to nest in southwestern Texas near El Paso in 1960.

Missouri.—Baird, Brewer, and Ridgway (1874), Coues (1874), Bennitt (1932), and the AOU Check-lists before 1957, to mention only a few, listed southwestern Missouri as part of the breeding range of the Scissortail.

According to Daniel McKinley (in litt.), an analysis of the unpublished papers of Otto Widman showed that Widman had no authentic records of Scissortails in Missouri, "still less of its breeding," but stated that an authentic source may have been Nehrling's "Our Native Birds of Song and Beauty," (two volumes; in English and German editions, 1896), as Henry Nehrling lived for 5 years in the western Ozarks. This, of course, does not explain the source of earlier statements.

The Fifth Edition of the AOU Check-list (1957) excluded southwestern Missouri as part of the breeding range. Edward M. Reilly, Jr., responsible for much of the range data in this edition, stated (in litt.): "The inclusion of this species in southwestern Missouri as a breeding bird in early editions must have been an error, since diligent search of the literature failed to uncover one valid breeding record."

Bennitt (1932) cited Gordon (unpublished thesis, University of Missouri) as having seen several at close range near Rocheport, Boone County, Missouri, 14 June 1924. There is no reference to age, sex, or activities of these birds. According to William Elder (pers. comm.), there is some question from Gordon's descriptions as to whether these birds were actually Scissortails.

Table 1 indicates, in chronological order, the known occurrences of the Scissor-tailed Flycatcher in Missouri by counties and Figure 2 summarizes these records.

The first definite sighting of the Scissortail in Missouri was in Morgan County in 1955 by D. A. Easterla (pers. comm.). Since then their distribution and number have greatly increased, and they have been sighted as far east as Boone County in central Missouri.

The earliest published record of nesting in Missouri was by Hilty (1957), who found a nest in St. Clair County near Lowery City. The eggs hatched on 20 June 1957, but the young were killed 9 days later by a storm.

TABLE 1

THE SCISSOR-TAILED FLYCATCHER IN MISSOURI (1955–64)

Location	Date	Number of eggs laid	Number of young fledged	Remarks	Observer
1. Morgan Co., 10 mi. south of Gravois Mills	2 May 1955			One Scissortail.	Easterla[1]
2 Clay Co.	4 August 1957			One pair sighted.	Gier (1957)
3.	4 August 1957			Pair feeding with young.	Gier (1957)
4. Liberty	1963–64			Pair nesting.	Newlon[2]
5. Mud Lake	17 May 1964			Pair observed.	Newlon[2]
6. St. Clair Co.	18 June 1957	5	0	Young killed in storm 29 June.	Hilty (1957)
Lowery City, Sec. 11, T39N, R26W	26 April 1958			Spring arrival.	Hilty
	25 May 1958			Pair observed building nest.	Hilty
	14 April 1959			Spring arrival.	Hilty
	31 May 1959			Two pairs found nesting.	Hilty
	12 June 1959			Pair found nesting.	Hilty
	18 April 1960			Spring arrival.	Hilty
	29 May 1960			Pair found nesting.	Hilty
	24 June 1960			Pair found nesting.	Hilty
	19 April 1961			Spring arrival.	Hilty
	5 July 1961	3	0	Bull snake (*Pituophis melanoleucus*) ate young.	Hilty
	15 April 1962			Spring arrival.	Hilty
	7 August 1962		3	Pair feeding with young.	Hilty
	7 August 1962		1	Pair feeding with young.	Hilty
	16 April 1963			Spring arrival, no field work during nesting season.	Hilty
7. Christian Co., Sec. 33, T27N, R21W	12 July 1958			Pair found nesting.	Fay (1958)
8. Old U.S. 65, T27N, R21W	June and July 1958			No nests located, but occasionally adults were seen.	Fay

9.	Jackson Co.	Summer 1957–58			Adults seen.	Grogan
	Reed Area, Sec. 15, T47N, R31W	Summer 1959		3	Nested, but no detailed information available.	Grogan
		Summer 1960			Pair nested.	Grogan
		16 April 1961			Spring arrival.	Grogan
		28 May 1961	5	4	Nest building 28 May, eggs hatched June.	Warner
10.	Blue Springs, State Rte. 7 Sec. 19, T48N, R30W	Summer 1961			Pair nested.	Warner
	Reed Area, see No. 9	25 April 1962			Spring arrival.	Warner
		7 July 1962		2	No nest found, but two young were seen with adults.	Warner
11.	Ranson Road and U.S. 50, Sec. 9, T47N, R31W	20 May 1962	5		Infertile eggs found 9 June.	Warner
12.	U.S. 150, Sec. 34, T47N, R32W	11 June 1962	5		Egg laying started 16 June, eggs missing 1 July.	Warner
13.	U.S. 50, half mi. west of No. 11	21 June 1962		2	Young fledged as I climbed the nest tree.	Warner
14.	Ranson Rd., Sec. 28, T47N, R31W	25 June 1962		3	Young seen feeding with adults near nest tree 7 July.	Warner
15.	U.S. 150, Sec. 36, T47N, R32W	1 July 1962	3		Nest with eggs blown out of tree 12 July.	Warner
16.	Blue Springs, see No. 10	12 July 1962	4	4	Nest found after eggs hatched and nest in same area as last year.	Warner
	Reed Area, see No. 9	14 April 1963			Spring arrival.	Warner
17.	U.S.150, Sec. 29, T47N, R32W	23 April 1963			Male sighted, but not seen again.	Warner
	Ranson Road, see No. 11	25 April 1963		4	Young feeding with adults 30 June in same area as 1962.	Warner
	Reed Area, see No. 9	26 April 1963	6	5	Nest with five eggs 22 June, nest in same tree as 1961.	Warner
18.	County road 15E, Sec. 1, T47N, R31W	3 May 1963	5	5	Egg laying began 3 June, banded 6 July.	Warner
19.	200 yds. north of above nest, Sec. 15, T47N, R31W	30 June 1963		4	Young feeding with adults 30 June, nested nearby.	Warner

TABLE 1. (*Continued.*)

	Location	Date	Number of eggs laid	Number of young fledged	Remarks	Observer
20.	Lee's Summit on U.S. 50	5 May 1963			Pair sighted, but no nest found.	Warner
21.	1 mi. west of above nest, Sec. 11, T47N, R31W	17 May 1963			Two pairs sighted in area, but no nest found.	Warner
	Blue Springs, see No. 10	17 May 1963	5		Eggs found 22 June, nested in same tree last year. Not banded as landowner refused permission.	Warner
	U.S. 150, 100 yds. east of No. 12	20 May 1963			Nest found 15 June, but could not be reached.	Warner
	Ranson Road and U.S. 50, see No. 11	20 May 1963			Pair in area, but no nest found.	Warner
22.	U.S. 150, Sec. 29, T47N, R31W, Greenwood	26 May 1963	4		Eggs found 16 June, but nest difficult to get to so no further study.	Warner
23.	Greene Co. Elwood, Sec. 15, T29N, R23W	Summers 1961–63			One pair nested on a nearby farm for 3 consecutive years.	Fay
24.	Springfield, Sec. 30, T29N, R21W	June and July 1963			Pair found nesting in city.	Fay
25.	Willard, Sec. 25, T30N, R23W	June and July 1963			Pair nested near town.	Fay
26.	County Road M, Sec. 12, T28N, R23W	27 July 1963		4	Pair with young, adults seen in area during June and July.	Fay and Warner
27.	Cass Co., 4 mi. west of Peculiar, Sec. 14, T45N, R32W	Summers 1960–62			Nested in same tree 3 consecutive years.	Warner
28.	U.S. 71, Sec. 19, T45N, R32W	27 May 1962			Pair seen only once.	Warner
29.	State Rte. 58, Sec. 15, T46N, R30W	5 May 1962			Pair seen only once.	Warner
	See No. 28	26 May 1963	3	2	Nest found 26 June, one egg infertile.	Warner
30.	Junc. of U.S. 71 and State Rte. 58, Sec. 18, T46N, R23W	16 June 1963	4		Eggs missing from the nest on 22 June. Cause unknown.	Warner
31.	200 yds. east of above location	30 June 1963	5	5	Likely renest of above pair.	Warner

32. Stone Co., Table Rock Lake	Summer 1961			Nesting activity for 2 months on south side of lake near Taney County line.	Bright
33. Boone Co., 2 mi. south of Columbia, Highway K	11 October 1961			One juvenile bird collected.	Easterla
34. Henry Co., Shawnee Mound	June and July 1961			Pair nested in area.	Warner
	June and July 1962		3	Adults seen with young in same area as last year.	Warner
	24 June 1963	2	2	Nest found when young were about 8 days old.	Warner
	25 July 1963	5	5	Second successful brood of above pair.	Warner
35. Sheldon Co.	June and July 1961–63			Adults seen on U.S. 71.	Warner
36 Vernon Co.	June and July 1961–63			Adults seen on U.S. 71.	Warner
37. Barton Co.	June and July 1961–63			Adults seen on U.S. 71.	Warner
38. Bates Co., Sec. 15, T40N, R31W	29 July 1962	3	3	Last seen when I banded three young 11 August.	Warner
39. Barry Co., U.S. 60 Sec. 31, T26N, R28W	4 June 1962	3	3	Found nest with young 30 June.	Warner
40. Half mi. east of above nest	4 June 1962	3	2	Found nest with young 30 June.	Warner
41. Newton Co.	June 1963			Single male.	Warner
42. Lawrence Co.	19 July 1963			Single male sighted in this county.	Warner
43. Cedar Co.	19 July 1963			Single male sighted in this county.	Warner
44. Dade Co.	19 July 1963			Single male sighted in this county.	Warner
45. Jasper Co.	June 1963			Single male sighted.	Warner
46. Johnson Co., Sec. 20, T47N, R25W	June 1963			Pair sighted.	Warner
47. State Rte. 58, Sec. 6, T45N, R26W	May 1964			Pair sighted.	Warner
48. U.S. 50, Sec. 21, T46N, R25W	May 1964			Single male sighted.	Warner
49. Ray Co., Coolie Lake	10 May 1964			Pair sighted.	Easterla
50. Holt Co., 5 mi. north of Forest City	16 May 1964			Collected an adult male.	Easterla

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[1] No date after name indicates not published and taken from their personal field notes.

[2] Taken from the field notes of Easterla.

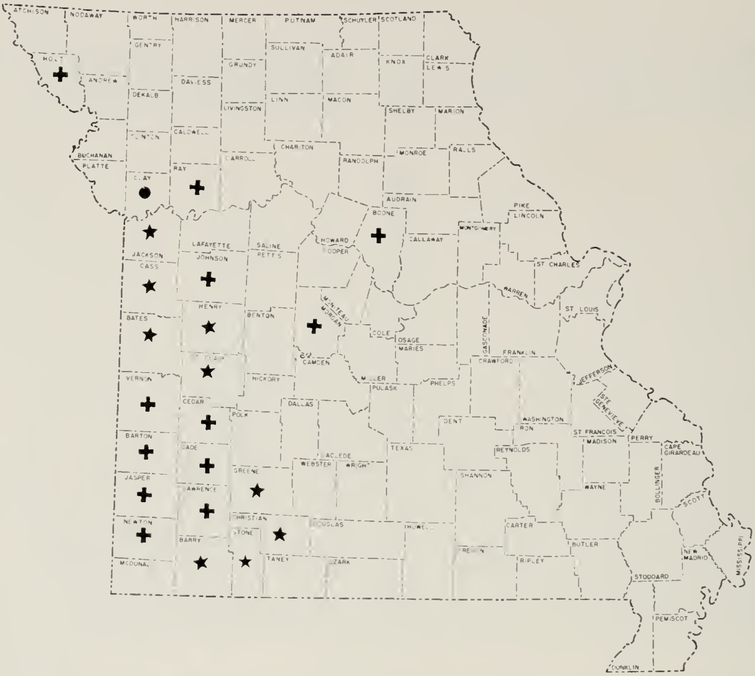

FIG. 2. Counties in Missouri where Scissor-tailed Flycatcher activity has been recorded. + Sight records; ● Adults with young but no nest found; ★ Nesting records.

Since that time they have been definitely found nesting in nine counties and adults with young birds seen in one other (Fig. 2). It is probable that lack of breeding records in many of the southwestern counties for which only sight records have been made is the result of insufficient fieldwork in these areas rather than to a lack of nesting birds.

Fieldwork was done in the west central counties adjacent to the counties with nesting birds, but no breeding pairs were found. Thus, with the exception of Clay County, the breeding range seems to be limited to the western part of the state south of the Missouri River.

SUMMARY

A study of published records and personal fieldwork indicate that the breeding range of the Scissor-tailed Flycatcher is expanding, particularly toward the northeast. Although some of the past records are vague and inaccurate, this expansion is not altogether a recent phenomenon.

The detailed records for the spread of this species into Missouri since 1955 are given together with a compilation of known breeding data. The species is now known to breed in 10 western counties of the state.

Records for recent expansion into other states on the periphery of the range are summarized.

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COLLEGE OF THE SCHOOL OF THE OZARKS, POINT LOOKOUT, MISSOURI, 5 APRIL 1965

ILLUMINATION AND WOOD DUCK ROOSTING FLIGHTS[1]

DALE HEIN AND ARNOLD O. HAUGEN

ROOSTING flight habits of Wood Ducks (*Aix sponsa*) were studied during August–November 1959–63. The objective was to describe the influence of seasonal advance on light and time associated with Wood Duck roosting flights and to determine the roles of light and time on roosting flight characteristics.

Phillips (1926) observed daily movements of a flock of 20 Wood Ducks and recorded less than 15 minutes variation in time of termination of evening flight activity. Martin (1957) reported that at two Indiana roosts morning departures usually began about one-half hour before sunrise with a mass departure usually about 20 minutes before sunrise. Evening flights began before sunset, with most birds arriving 15 to 30 minutes after sunset. However, on a rainy evening the bulk came 15 minutes earlier. Stewart (1957) measured light during five roosting flight periods in Ohio and concluded that there was little or no relationship between time of flight and light intensity. However, morning departures were usually in larger flocks, and illumination was less than at time of evening flights. Martin and Haugen (1960) described seasonal changes in times of flights at a roost at Muskrat Lake, Louisa County, Iowa, from August to October 1958. For each 10-day period that passed, Wood Ducks left the roost an average of 4 minutes earlier with respect to sunrise, and evening flights arrived an average of 7 minutes later with respect to sunset. Hester and Quay (1961) reported observations of 40 evening flights at three roosts in North Carolina during 1953, 1954, and 1960. As the season advanced from mid-October to early January, flights began 1.9 minutes later with respect to sunset for each 10 days elapsed. Times of peak and end of evening flights likewise decreased in relation to sunset. Hein (1961) observed Wood Duck roosting flights on 24 mornings and 16 evenings during August–October 1959–60 at a roost in Allamakee County, Iowa. Flight periods occurred in increased darkness and duration of flight periods grew shorter as fall advanced.

For the present study, observations were made during 294 morning or evening roosting flight periods at 30 Wood Duck roosts. These roosts were distributed between 41°0′ and 43°15′ north latitude and between 90°0′ and 94°45′ west longitude; most were in the Mississippi River bottoms of northeastern Iowa. During August–November, Wood Ducks gathered each evening

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TABLE 1

LINEAR REGRESSION EQUATIONS FOR SEASONAL CHANGES IN TIMES OF WOOD DUCK ROOSTING FLIGHTS DURING MID-AUGUST TO NOVEMBER, 1959–63

Event	Regression equation[a] $Y = \bar{y} + b(X - \bar{x})$	Degrees of freedom	*t*-value[b]
Morning flight			
Start	$Y = -28 - 0.050(X - 267)$	93	–1.50
Peak[c]			
End	$Y = -8 - 0.363(X - 267)$	93	–7.40*
Duration	$Y = 20 - 0.312(X - 267)$	93	–6.78*
Evening flight			
Start	$Y = -4 + 0.467(X - 270)$	191	10.61*
Peak	$Y = 16 + 0.201(X - 270)$	191	6.48*
End	$Y = 28 + 0.095(X - 270)$	191	3.45*
Duration	$Y = 32 - 0.361(X - 270)$	191	9.63*

[a] Regression equation is interpreted as follows:

Y = number of minutes from sunrise or sunset at which the event occurs for a given value of X.
$\bar{y}$ = mean number of minutes from sunrise or sunset at which the event occurred for the sample.
b = sample regression coefficient; i.e., average change in minutes per day for time of the event.
X = day of the year numbered from 1 January.
$\bar{x}$ = mean day of the year for the sample.

[b] *t*-value tests the null hypothesis that the regression coefficient is zero; asterisk indicates rejection of the hypothesis at 0.05 significance level.

[c] Common regression equation for all years cannot be calculated for peak of morning flight because analysis of covariance showed differences among regression coefficients for different years at 0.01 significance level.

at the same traditional sites to spend the night on the water amidst emergent vegetation. In September, peak premigration numbers at all roosts checked averaged between 370 and 600 Wood Ducks per roost in different years. The highest count at a roost was 5,400. Detailed descriptions of these roosts and roosting populations were given by Hein (1965).

METHODS

An observation point was usually selected near the center of a roost. Often it was possible to wade right in among roosting birds in the predawn darkness. Being close enough to hear ducks leave the water was helpful in spotting birds in poor light. At evening, presence of a motionless observer was unnoticed or ignored by Wood Ducks. A low place from which birds could be seen against a sky background was selected.

Evening observations began one hour before sunset and continued until the last birds arrived about 40 minutes after sunset. Observation periods for morning roosting flights began 45 minutes before sunrise, earlier than first Wood Duck departures from the roost, and continued until the roost was deserted or until 30 minutes after sunrise.

Only flights totaling 40 or more Wood Ducks in five or more flocks were

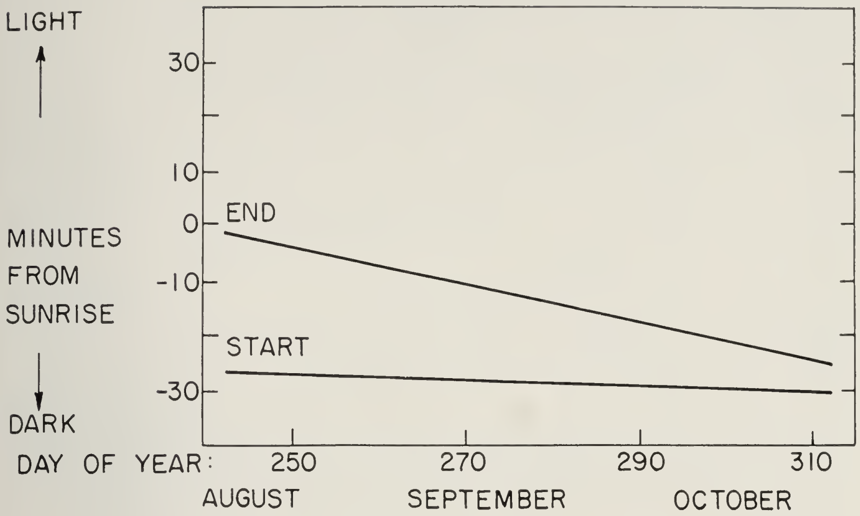

Fig. 1. Seasonal changes in time of morning roosting flights of Wood Ducks in relation to sunrise (regression equations are given in Table 1).

included in the analysis used to describe roosting flights. Numbers of birds were recorded by one-minute intervals. Times of start, peak, and end of flights were recorded as minutes from sunrise or sunset. The peak of flight was taken as the time when 50 per cent of all Wood Ducks in the roost had been counted.

The illumination associated with roosting flights was measured with a General Electric PR-2 light meter pointed at the sky directly overhead. A dynacell booster allowed readings as low as one-fourth footcandle of incident light. Readings were made throughout the observation period and were later transformed to logarithms to base 2 for linear regression analysis. Illumination was not measured in 1961.

To describe the relationships between times of flights and advance of the season, linear equations were computed to express the regression on date, of times of start, peak, end, and duration of morning and evening flights each fall. Thus, there were eight equations for each fall, making a total of 40 linear regression equations for the 5-year study. For the set of five equations describing each event in five autumns, analysis of covariance was used to test for differences among regression coefficients and among means in different years. Then, where the covariance analysis permitted, common linear regression equations were computed to describe seasonal changes in times of Wood Duck roosting flights in all years.

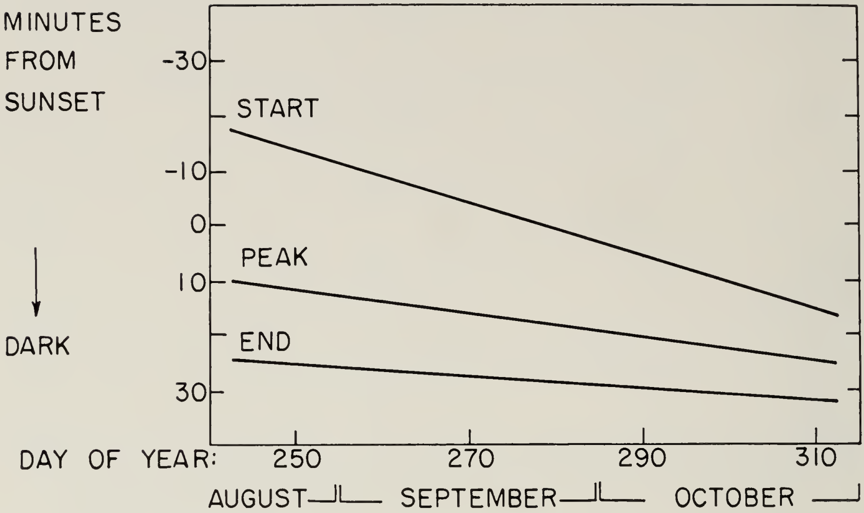

FIG. 2. Seasonal changes in time of evening roosting flights of Wood Ducks in relation to sunset (regression equations are given in Table 1).

Light relationships were analyzed by the same general procedure. For each year, equations were computed for the regression on date of light measured at start, peak, and end of morning and evening flights. For each event, analysis of covariance was used to test for differences among regression coefficients and among means in different years. Common linear regression equations were then computed to express seasonal changes in illumination associated with Wood Duck roosting flights in all years.

RESULTS

Analysis of covariance indicated that seasonal changes in times of flights were similar in all five fall seasons. Only for the time of peak morning flight were regression coefficients in separate years different at the 0.01 significance level. Start of morning flight and end of evening flight showed the least tendency to change as the season progressed, while end of morning flight and duration of evening flight changed most markedly (Table 1).

In mid-August, Wood Ducks began leaving the roost about 25 minutes before sunrise, and all had departed before sunrise. For each 10 days that passed, the last birds left the roost 3.6 minutes earlier with respect to sunrise. Thus, by early November, duration of morning flight averaged less than 5 minutes, and often the departure was in one or two waves about 30 minutes before sunrise (Fig. 1).

TABLE 2

LINEAR REGRESSION EQUATIONS FOR SEASONAL CHANGES IN ILLUMINATION ASSOCIATED WITH WOOD DUCK ROOSTING FLIGHTS DURING FALL, 1959–63

Event	Regression equation[a] $Y = \bar{y} + b(X - \bar{x})$	Degrees of freedom	t-value[b]
Morning flight			
Start	$Y = -0.75 - 0.036(X - 268)$	85	10.44*
Peak	$Y = 0.45 - 0.060(X - 268)$	85	10.07*
End[c]			
Evening flight			
Start	$Y = 4.45 - 0.074(X - 270)$	146	14.19*
Peak	$Y = 1.39 - 0.067(X - 270)$	146	11.21*
End	$Y = -0.54 - 0.046(X - 270)$	146	12.63*

[a] Regression equation is interpreted as follows:
Y = illumination at which the event occurs for a given value of X.
$\bar{y}$ = mean illumination at which the event occurred for the sample.
b = sample regression coefficient; i.e., average change in illumination per day.
X = day of the year numbered from 1 January.
$\bar{x}$ = mean day of the year for the sample.
All illumination values are given as logarithms to the base 2 of footcandles of incident light.

[b] t-value tests the null hypothesis that the regression coefficient is zero; asterisk indicates rejection of the hypothesis at 0.05 significance level.

[c] Common regression equation for all years cannot be calculated for end of morning flight because analysis of covariance showed differences among regression coefficients for different years at 0.01 significance level.

Mean duration of evening flights decreased from about 45 minutes in mid-August to about 8 minutes in early November (Fig. 2). During each 10 days that elapsed, mean time in relation to sunset decreased 4.7 minutes for start, 2.0 minutes for peak, and 1.0 minutes for end of evening roosting flight.

Analysis of covariance permitted computation of common linear regression equations to describe seasonal changes in illumination measured at start, peak, and end of evening flights and at start and peak of morning flights (Table 2). In mid-August, morning flights began when illumination reached 1 footcandle; by November, birds departed with less than one-fourth footcandle of light (Fig. 3). Light concomitant with peak of morning flights decreased similarly as fall advanced. Evening flights likewise occurred with less light as the days passed. In mid-August, flocks arrived at the roost while illumination ranged from about 70 down to about 2 footcandles. Late-October flights arrived with light values between 4 and one-fourth footcandles (Fig. 4).

Certain changes in flight times accompanied poor visibility conditions. These changes tended to adjust flights toward times when illumination was similar to that prevailing for roosting flights on clear days. Thus, on dark, foggy days the morning departure from the roost was delayed, and time of first arrival of evening flights was advanced. Therefore, flights on mornings with poor visibility were compressed in time by a delay of the beginning of

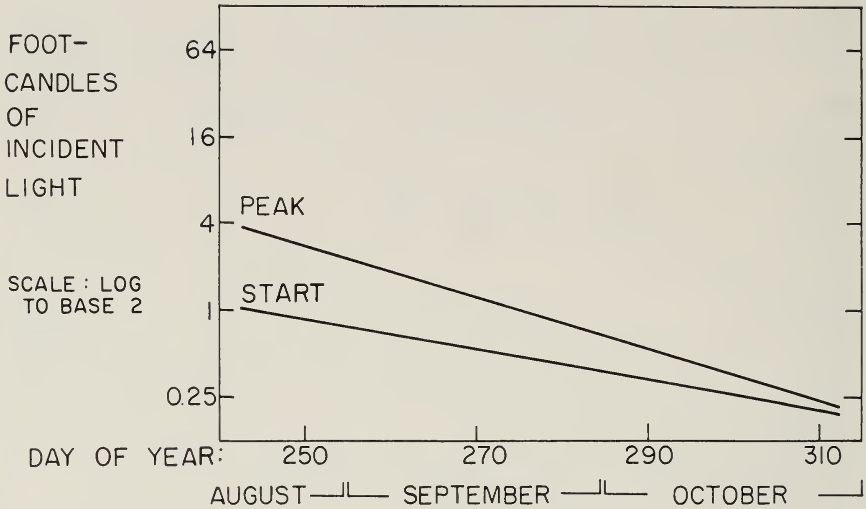

Fig. 3. Seasonal changes of illumination associated with morning roosting flights of Wood Ducks (regression equations are given in Table 2).

the flight. On the other hand, evening flights were prolonged on dark, hazy days, because the start of evening flights tended to be much earlier while the peak and end were only a little earlier on days of poor visibility. This adherence of roosting flights to predictable illumination levels was quite apparent on stormy days. However, exact effects of weather in modifying times of flights could not be stated more explicitly, because "stormy weather" could not be satisfactorily quantified.

DISCUSSION

Wood Duck roosting flights were controlled primarily by light. An illumination threshold near one-half footcandle triggered the morning flights. The stimulus to leave the roost was most likely metabolic, probably hunger since morning flights went directly to feeding areas. Hochbaum (1955) stated that daily feeding flights of waterfowl were governed by metabolic and solar cues. The stimulus to return at evening was probably social. Allee (1958) regarded roosting as a positive social appetite that grew stronger with the approach of darkness. Here the trigger governing response to the stimulus was decreasing illumination with the threshold some value below 200 footcandles.

Seasonal changes in times of flights did not compensate for shorter daylight feeding hours or for greater energy demands as has been postulated for some other birds (Lundin, 1962; Seibert, 1951). Rather, such changes are considered to be responses to changing intensity of the stimuli at a particular

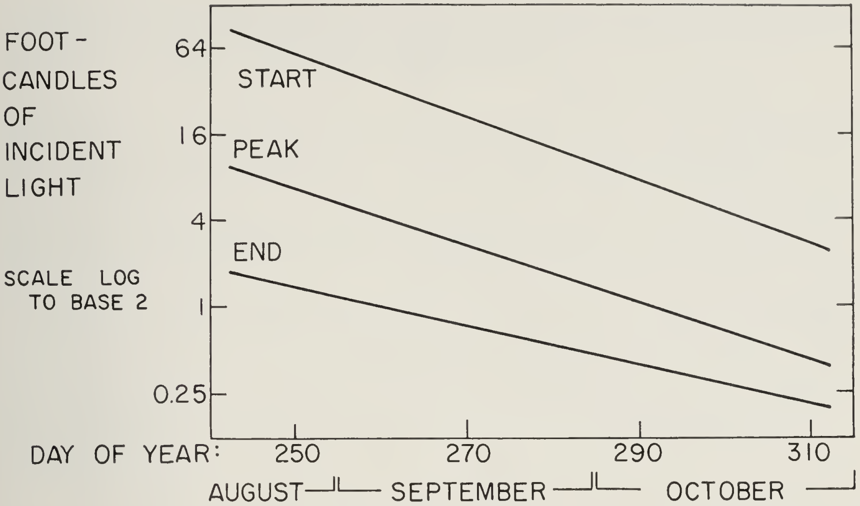

Fig. 4. Seasonal changes of illumination associated with evening roosting flights of Wood Duck (regression equations are given in Table 2).

sun time. That is, as the sun rose later with respect to clock time, the hunger stimulus built up over a longer time and, therefore, became more intense at a given sun time. Thus, the threshold of illumination required to initiate flight became gradually lower as fall advanced. Likewise, evening flights occurred later with respect to sunset because the stimulus to recongregate had less time to build up to an intensity necessary for action after morning dispersal from the roost. Thus, evening flights were triggered by gradually lower light values as the days shortened.

SUMMARY

Roosting flights of Wood Ducks were described as functions of time for convenience. However, they were responses to endogenous stimuli, and they occurred within limits of illumination which changed in a predictable manner as the season advanced.

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IOWA COOPERATIVE WILDLIFE RESEARCH UNIT, IOWA STATE UNIVERSITY, AMES, IOWA, 29 JUNE 1965

RENESTING BEHAVIOR IN THE RING-NECKED PHEASANT

JOHN M. GATES

PERSISTENCY in renesting has long been recognized in Ring-necked Pheasants (*Phasianus colchicus*). Nesting studies almost invariably reveal that the number of nests on a given area is greater than the number of hens known to be nesting there or that the percentage of hens that eventually produces a brood is higher than the percentage of nests successful (Linder et al., 1960; Stokes, 1954; Trautman, 1960; and others). In addition, Seubert (1952) found much evidence of renesting in pheasants under pen conditions. Aside from a single record reported by Warnock and Joselyn (1964), however, no information on renesting behavior is available based on the observation of marked individuals in the wild. This paper describes renesting for backtagged pheasants on a study area in east central Wisconsin.

AREA AND METHODS

This study was conducted in 1959–64 on a 10-mile-square area in southwestern Fond du Lac County and adjacent parts of Dodge and Green Lake counties, Wisconsin.

As part of a long-term study of movements and survival by the Wisconsin Conservation Department, pheasants were captured by bait trapping in winter (January–March) and by nightlighting (Labisky, 1959) in early autumn (September–October). Each hen captured was marked with an individually numbered plastic backtag (Blank and Ash, 1956) and with an aluminum band on each leg. A total of 2,253 hens was marked and released through March 1964. Age determinations were based on bursal depths, with 5 mm used as the separation point between adult and juvenile hens.

Concurrent studies afforded opportunities to find nests and broods of marked hens. Renesting records described in this paper were for birds whose nests were destroyed mainly by natural causes. In order to backdate nest histories to the date of nest establishment, one egg from each active clutch was sacrificed to determine the stage of incubation at nest discovery (Labisky and Opsahl, 1958). A laying rate of 1.3 days per egg (Buss et al., 1951) and an incubation period of 23 days were used in backdating. In instances where information on clutch size was unavailable, backdating was based on an assumed clutch size of 10 eggs.

CASE HISTORIES

Blue HO.—This hen was originally captured as a juvenile on 7 March 1960. On 1 June 1961, she was flushed from a nest concealed in reed–canary grass (*Phalaris arundinacea*) along a drainage ditch 0.36 mile from the trap site. The clutch consisted of seven unincubated eggs. When the nest was checked on 5 July, it still contained six eggs (one egg had been previously removed for age determination). Apparently the hen abandoned the clutch as the result of its discovery.

On 19 June, *Blue HO* was killed by a hay mower on a nest in an alfalfa (*Medicago sativa*) field 0.21 mile from the previous nest. The second clutch consisted of 10 eggs in the fourth day of incubation. Since the starting date of the second clutch was estimated to be 2 June, renesting must have begun the day after the previous clutch was deserted.

White C3.—This hen was trapped as an adult on 30 January 1960. On 1 June 1960, she was flushed from a nest 0.63 mile from the trap site. The nest was concealed in fencerow cover consisting chiefly of quack grass (*Agropyron repens*). It contained 16 eggs in the second day of incubation. The nest was checked on 25 June, when all eggs were found to be missing. No information was available concerning the cause or date of its failure.

On 26 July, this hen was found renesting in another fenceline 0.54 mile from her first nest. The hen was not flushed from the clutch, and when it was checked on 11 August, it had already hatched. The clutch consisted of seven eggs, two of which contained dead embryos. No estimate of its starting date was available.

Yellow N4.—On 26 February 1960, this hen was captured as a juvenile. On 5 June 1961, she was flushed from an unincubated eight-egg clutch concealed in reed–canary grass and goldenrod (*Solidago* sp.) 0.75 mile from the trap site. The clutch still consisted of eight eggs when checked on 1 July, apparently having been deserted at the time of its discovery.

On 21 June, *Yellow N4* was killed on a mowed-over nest in a red clover (*Trifolium pratense)* hayfield 0.14 mile from the previous nest. The clutch consisted of 11 eggs in the third day of incubation. Its calculated starting date was therefore 4 June, indicating that renesting must have begun immediately after the desertion of the first clutch.

Coral X4.—This hen was captured as an adult on 11 March 1960. On 31 May 1960, she was found nesting along a fencerow in quack grass cover 0.50 mile from the trap site. She did not flush from the nest, and no information on clutch size or stage of incubation was obtained. When the nest was checked on 11 June, shell fragments from a minimum of eight eggs were found. The clutch appeared to have been destroyed by a skunk (*Mephitis mephitis*).

On 3 October 1960, *Coral X4* was observed with an 11-week-old brood 0.25 mile south of the nest site. On the assumption that the clutch which produced this brood numbered 10 eggs, renesting must have begun about 12 June.

During the 1961–63 nesting seasons, *Coral X4* was seen several times in the same vicinity; and on 11 May 1963, she was found nesting in roadside cover 0.38 mile northeast of her 1960 nest. Cover at the site consisted chiefly of cordgrass (*Spartina pectinata*). The nest was checked on 14 May, with the hen absent, at which time it contained 13 unincubated eggs. When next visited, on 17 May, it contained 15 eggs which had been destroyed by an unidentified predator, probably on 16 May.

On 19 June, this hen was killed by a hay mower in a red clover hayfield 0.16 mile from the previous nest. The clutch consisted of 10 eggs in the 20th day of incubation. Renesting apparently began on 17 May, the day after the previous clutch was destroyed.

Red 40.—This bird was captured as a juvenile on 3 October 1960. On 5 June 1961, she was flushed from a nest in sedge (*Carex stricta*)-goldenrod cover 0.71 mile from the trap site. The clutch consisted of 11 eggs in the 13th day of incubation. When checked on 11 June, it was found to have been preyed upon, apparently by a skunk. One intact egg with a 17-day embryo placed the date of nest destruction at about 9 June.

On 30 June, leg bands from *Red 40* were found next to a mowed-over nest in a red clover hayfield. This nest was 0.32 mile from the first. It contained eight unincubated eggs, indicating that renesting had started on 20 June, 11 days after the destruction of the first clutch.

Red 11.—On 13 September 1960, this hen was captured as an adult. On 23 May 1961, she was found incubating a clutch concealed in reed–canary grass along a roadside 0.38 mile from the capture site. She was not flushed from the nest. When the nest was checked on 12 June, it was found to contain 14 eggs that had been recently destroyed by an unidentified mammal. Presence of chick feathers adhering to the insides of several eggshells indicated that the clutch was in an advanced stage of incubation when destroyed.

Sometime between 15 and 18 June, this hen was hit and killed by a hay chopper in an alfalfa field 0.24 mile from her previous nest. The eggs were so badly crushed by farm machinery that no information on clutch size or stage of incubation could be obtained.

Light Blue S5.—This hen was caught as a juvenile on 15 March 1962. On 23 May 1962, a hen with an unidentified light blue tag was flushed from an unincubated eight-egg clutch 0.12 mile from the trap site. The nest was located in roadside cover, concealed in quack grass and goldenrod. On 26 May, the identity of this hen was established when she was observed at the nest. When the nest was next checked on 12 June, remains of only two destroyed eggs were found. Neither the cause nor the exact date of nest destruction could be established. Evidence of blood vessels inside the broken eggshells indicated that the clutch had reached at least the early stages of incubation before it was destroyed.

On 20 June, this hen was killed by a hay mower 0.11 mile from the original nest site. The nest was not found until 24 June, and after this lengthy delay it was impossible to determine the size of the clutch and the stage of incubation when destroyed.

Green V8.—This bird was trapped as an adult on 30 January 1962. On 6 June 1962, she was found nesting in sedge–goldenrod cover 0.41 mile from the trap site. The next day the clutch was destroyed when the cover in which it was located was disced and plowed. The clutch comprised 22 eggs, all of which were fertile and in the 13th day of incubation.

On 25 June, this hen was killed by a hay mower in an alfalfa field 0.19 mile from the original nest site. The second clutch consisted of five unincubated eggs, indicating that renesting began about 18 June, 12 days after the destruction of the first clutch.

Green J3.—This bird was trapped as a juvenile on 1 February 1962. On 3 June 1962, she was found on a nest concealed in sedge and bluejoint grass (*Calamagrostis canadensis*) 0.47 mile from the trap site. On 6 June, the nest was destroyed by a marsh fire.

On 17 September, *Green J3* was recaptured by nightlighting 0.23 mile from the nest site. She was accompanied by six chicks, assumed to be her brood, whose wing molts indicated that they were approximately nine weeks old. If it is assumed that this bird's renest clutch consisted of 10 eggs, then she must have started renesting about 10 June.

White 87.—This hen was captured as an adult on 24 September 1962. On 1 June 1963, she was observed incubating a clutch in roadside cover 0.35 mile from the capture site. Nest concealment was furnished by quack grass, sunflower (*Helianthus annuus*), and burdock (*Arctium minus*). On 10 June, the nest was destroyed when it was driven over by farm machinery, at which time it contained 12 eggs in the 20th day of incubation.

On 26 June, this hen was flushed from a nest in an uncut alfalfa hayfield. The clutch consisted of four unincubated eggs and was located 0.09 mile from the previous nesting attempt. Renesting apparently began on 21 June, or 11 days after the destruction of the first clutch.

Yellow 7X.—This hen was caught as a juvenile on 1 March 1963. On 25 May, she was flushed from a nest 0.08 mile from the trap site. The nest was concealed in roadside cover consisting of meadow rue (*Thalictrum dasycarpum*) and wild parsnip (*Pastinaca sativa*). Clutch size was 10 and the eggs were in the sixth day of incubation. When the nest was checked on 9 June, it was found to have been destroyed, probably by a skunk. The date of nest destruction was estimated at 5 June.

On 7 August, this hen was killed by a hay mower in a red clover hayfield 0.42 mile from her previous nest. The eggs were incubated, but the exact clutch size and stage of incubation could not be determined. At the very earliest, this renesting attempt could not have been established before 1 July, whereas the previous nest of this bird was destroyed about 5 June. Thus this hen may have renested unsuccessfully at least one other time.

Yellow 64.—This hen was captured as a juvenile on 1 February 1963. On 12 May 1964, a clutch of five eggs was found in a roadside stand of quack grass and Canada thistle (*Cirsium arvense*) 3.8 miles from the trap site; and on 16 May, *Yellow 64* was observed on this clutch. A later check on 25 May revealed nine unincubated eggs which appeared to have been abandoned, and a final check on 27 May confirmed this fate.

On 1 June, this hen was flushed from a nest located along a ditchbank 0.15 mile from the first nest. The nest was concealed in bluegrass (*Poa pratensis*) and contained 11 unincubated eggs. The hen did not return. Backdating of this clutch indicated that renesting began on 18 May.

On 25 August, *Yellow 64* was observed in the same vicinity with a brood of seven 4-week-old chicks. On the assumption that the clutch which produced this brood comprised 10 eggs, *Yellow 64* must have started another renesting attempt no earlier than 22 June. The 22-day difference between this date and the date that her second nest was deserted indicates that she also may have renested at least one other time. Thus this individual may have made four nesting attempts in 1964.

CONCLUSIONS AND DISCUSSION

The percentage of hens that renest after the desertion or destruction of a clutch is an elusive statistic. In this study, 32 marked hens were found on nests later deserted or destroyed by nest predators. Of these, nest and brood records show that a minimum of 13 renested at least once. One individual (*Yellow 64*) was known to renest twice and may have renested three times. Another hen (*Yellow 7X*) also apparently renested twice. Nest searching in this study involved a sampling procedure in which only about 30 per cent of the available nesting cover was examined, and no attempts were specifically made to search for the renests of marked hens. These data imply a rather high level of renesting activity. Direct evidence obtained by marked individuals thus substantiates the importance of renesting in pheasants as indirectly revealed by numerous nesting studies (e.g., Linder et al., 1960; Stokes, 1954; and Trautman, 1960).

Nesting studies on this area from 1959–64 have revealed an average hatching success of 29 per cent and 1.8 nests per breeding hen (unpublished data). In a hypothetical model based on 100 hens at the start of nesting, for every 71 hens that failed in their first nesting attempts, an average of 80 renesting attempts followed. Under actual conditions, however, some nesting hens were being removed by natural mortality throughout the nesting season. Thus it appeared that nearly all surviving hens whose first nests were broken up must have renested, and that a substantial fraction of those whose renesting efforts were unsuccessful must have renested a second time.

Available evidence, though limited, suggests that adult hens were more persistent renesters than juveniles. The 32 unsuccessful tagged hens in this study included 15 adults and 17 juveniles. Among adults, 10 renesting records for nine individuals were obtained. Among juveniles, only four renesting attempts for four individuals were known. Reproductive superiority in adults is also suggested by results of certain pen studies (Kabat and Thompson, 1963:120–122). In these experiments, adults started egg laying earlier, did less random egg laying, and eventually laid a larger number of clutches than juvenile hens.

Of the 14 renesting records described in this paper, six followed the loss of unincubated clutches, seven followed the loss of incubated clutches, and one followed the loss of a clutch of unknown status. Four of the six hens whose clutches were disrupted before the end of egg laying immediately resumed nesting elsewhere. Continuous laying of this sort has also been reported for ducks where nests are destroyed before egg laying has terminated (Sowls, 1955:134–136).

A different situation exists when clutches are destroyed during incubation. After the start of incubation, the ovaries begin to regress; accordingly, a period of renewed ovarian development, the renesting interval, must take place before egg laying can be resumed. In ducks and pheasants, Sowls (1955: 132–133) and Seubert (1952), respectively, have shown that the renesting interval lengthens as the stage of incubation advances. Renesting intervals could be estimated in only three instances in the present study. One hen required 11 days to renew egg laying after the loss of a clutch in the 17th day of incubation, another required 12 days after the 13th day, and a third required 11 days after the 20th day. Each of these fit into the pattern of renesting intervals observed by Seubert (1952) in penned birds.

Most renesting hens appeared to remain in the vicinity of their original nest sites. The average distance between successive nesting attempts was only 0.23 mile.

A striking difference in cover used for renesting was also evident. For 13 hens that provided renesting records, apparent first nests were distributed as follows: six in roadsides, four in wetlands, two in fencelines, and one in ditchbank cover. But of the 11 renesting attempts located, nine were in hayfields and only two were in other cover types. Early nesting attempts thus were located primarily in permanent cover, whereas renesting occurred mainly in hayfields. A similar trend in cover selection was reported by Buss (1946: 43–45). In the present study, hayfields did not grow to sufficient height to furnish nest concealment (8–10 inches) until mid-May, whereas nesting was usually well under way by early May. Thus hayfields were largely unavailable for early nesting.

The attractiveness of hay for renesting results in a serious drain on reproductive success, since renesting hens usually have too little time to finish incubation before hay mowing takes place. In the present study, hatching success in hay averaged only 15 ± 1.4 per cent ($N = 641$), compared to 35 ± 2.0 per cent ($N = 556$) in permanent cover types. Low rates of hatching in mowed hayfields are, of course, well known from numerous other nesting studies.

SUMMARY

Fourteen records of renesting for backtagged pheasants were obtained in 1959–64 on a study area in east central Wisconsin. These and other nesting data suggest that all unsuccessful hens renested at least once, and that a sizeable fraction must have renested more than once. Adult hens appeared to be more persistent renesters than juvenile hens. Renesting hens remained in the vicinity of their original nest sites. Initial nesting attempts were situated principally in permanent cover types, whereas renesting occurred mainly in hayfields.

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WILDLIFE RESEARCH SECTION, WISCONSIN CONSERVATION DEPARTMENT, WAUPUN, WISCONSIN, 1 JUNE 1965

GENERAL NOTES

Herons leaving the water to defecate.—Watching herons fish in Gwynns Falls, a shallow stream about 25 yards wide, at Woodlawn, Baltimore County, Maryland, I have noticed that when they need to defecate both the Common Egret (*Casmerodius albus*) and the Snowy Egret (*Leucophoyx thula*) leave the water to do so, going onto rocks or mud bars in the stream or onto the bank. Then they reenter the water and resume their fishing.

I have 12 records of Common Egrets leaving the water to defecate, and 9 of the birds then at once reentered the stream and resumed fishing; another returned merely to the brink and fished on from there; 2 stayed ashore. I have 10 records for the Snowy Egret (3 for one bird during a single period of watching); on 9 of the occasions an immediate return into the water was made. In contrast, I have never seen a bird of either species defecate in the stream, although on an 11th occasion a Snowy Egret which went from the water onto a mud bar defecated at its edge, some of the excrement going into the stream. The dates have been 25 July to 16 September 1954 to 1964.

Possibly the Great Blue Heron (*Ardea herodias*) also has this habit. On 5 November a Great Blue that was fishing in or at the edge of an arm of the Falls just a few yards wide—tall weeds blocked my view—went high up on the opposite bank, defecated, then stayed there. The only record of this behavior that I have found for any heron is one by Utley (1942. *Naturalist*, No. 801:104) for the Common Heron (*Ardea cinerea*) of England, the counterpart of our Great Blue.—Hervey Brackbill, *2620 Poplar Drive, Baltimore, Maryland, 20 September 1965.*

Distributional notes on Costa Rican birds.—While associated with the Louisiana State University School of Medicine and its International Center for Medical Research and Training in Costa Rica from September 1964 through August 1965, I obtained significant distributional data on several species of birds. All specimens are on deposit in the Louisiana State University Museum of Zoology.

Ixobrychus exilis. Least Bittern.—Two individuals were repeatedly flushed from a shallow, grassy marsh on the experimental finca of the Ministry of Agriculture and Cattle Industry on Hacienda Taboga, 12 km S of Cañas, province of Guanacaste, on 6 August. There are few records for this species in Costa Rica according to Slud (1964. *Bull. Amer. Mus. Nat. Hist.*, 128:43).

Milvago chimachima. Yellow-headed Caracara.—On 12 June I shot a female (ovaries not enlarged) as it perched in a tree alongside the road 3.2 km E of Golfito, province of Puntarenas. This record is the first for the species north of Panamá.

Amaurolimnas concolor. Uniform Crake.—A female (15-mm ovum in oviduct) was obtained on 13 July in a palm swamp approximately 1.2 km N of Los Chiles de Grecia, province of Alajuela. Slud (op. cit.:82) says that this rail has been taken at only six Costa Rican localities.

Panyptila cayennensis. Lesser Swallow-tailed Swift.—This species is listed by Slud (op. cit.:142) on the basis of sight reports but no specimens. On 1 May I collected two specimens from a flock of swifts (*Chaetura spinicauda* and *C. vauxi*) on the Río Damitas, 14.5 km N of Quepos, province of San José. There were four other individuals of *P. cayennensis* in the flock. The two individuals obtained are a female (ovary enlarged) and a male (testes: left, 9 × 7 mm; right, 7 × 5 mm).

Thryothorus maculipectus. Spot-breasted Wren.—A male (testes: left, 8 × 4 mm; right, 6 × 4 mm) collected on 11 July approximately 1.2 km N of Los Chiles de Grecia, province of Alajuela, represents the first record for Costa Rica. The specimen is assigned to *T. m. umbrinus.*

Agelaius phoeniceus. Red-winged Blackbird.—This blackbird has been known from two restricted regions in the republic. The birds of the Río Frio region, the more northern of the two areas, were tentatively assigned by Slud (op. cit.:343) to *A. p. brevirostris* recently described by Monroe (1963. *Occas. Papers Mus. Zool., Louisiana State Univ.*, No. 26:6–7), while the population around the head of the Gulf of Nicoya is *A. p. costaricensis.* On 25 March Gordon Orians, Paul Cook, and I observed Red-winged Blackbirds in a large marsh known as Laguna de Arenal located approximately 25 km NE of the area known to be populated by *A. p. costaricensis.* I returned to this marsh on 3 August, secured a male (testes, 13 × 8 mm), and located a nest with two eggs near the collection site. This specimen belongs to the race *costaricensis.* On 8 July I shot a pair in wet meadow along the Río Frio; the female specimen was subsequently destroyed. The male (testes: left, 11 × 7 mm; right, 6 × 5 mm) fits the description of *brevirostris.*

The field work was supported in part by Public Health Service Research Grant TW00148 from the Office of International Research of the National Institutes of Health.—KEITH A. ARNOLD, *Museum of Zoology, Louisiana State University, Baton Rouge, Louisiana (Present address: Department of Wildlife Sciences, Texas A&M University, College Station, Texas), 7 October 1965.*

Mallard predation by a Goshawk.—In late afternoon, 15 January 1964, I flushed several Mallards (*Anas platyrhynchos*) from a tree-bordered drainage ditch on the Duck Creek Wildlife Management Area in southeastern Missouri. As they flew down the ditch ahead of me one female veered to pass through the trees and out over an adjacent, ice-covered reservoir. At the edge of the reservoir an adult Goshawk (*Accipiter gentilis*) struck it from behind and brought her down on the ice. For a moment the hawk paused, standing on the duck, then flew up and carried it off. The Mallard, though still alive, made no effort to escape.

The Goshawk flew about 50 yards and landed on the ditch bank. When I moved closer to observe, it flew off and left the duck to which it returned in about 12 minutes. The Mallard was now dead and the hawk quickly plucked some feathers and began feeding. It fed steadily for one-half hour, pausing only to change position or to pluck more feathers. Then it flew off in the gathering darkness.

I examined the remains and found the breast meat on the left side entirely eaten and the underlying sternum clean of flesh. About one-fourth of the right breast and part of the left wing and leg was also eaten. The body cavity was open and one lung plus the left lobe of the liver had been eaten. No other internal organs were touched. Most of the left ribs were gone and pieces of bone were bitten from the sternum. These were probably swallowed with the meat.

The partly eaten Mallard weighed 1.6 pounds. Weights of female Mallards range from 2 to 3 pounds according to Kortright (1942. "The Ducks, Geese and Swans of North America," p. 383). This female was in good flesh but not fat. I believe it was at the lower end of the weight range for females and probably weighed a little over 2 pounds. I estimate that the Goshawk ate about one-half pound of flesh while feeding for one-half hour. In a similar observation, Ammann (1959. *J. Wildl. Mgmt.*, 23:110–111) reported 7 ounces eaten in one-half hour by a Goshawk feeding on a Sharp-tailed Grouse (*Pedioecetes phasianellus*).

Fevold and Craighead (1958. *Auk*, 75:312–317) reported that a captive Goshawk maintained its weight in fall and winter on a daily ration of 124 grams (4.4 ounces) of meat. This is only a little more than half the amounts estimated for the wild birds discussed above. Craighead and Craighead (1956. "Hawks, Owls and Wildlife," pp. 312–313) believe that the food requirements of raptores, adjusted to captivity, closely approximate those of wild raptores. Assuming that this is true, the difference in food intake per meal between wild and captive Goshawks may be due to irregular and less frequent feeding in the wild than in captivity.—John P. Rogers, *University of Missouri, Gaylord Memorial Laboratory, Puxico, Missouri, 23 August 1965.*

An attack and riding of a Red-tailed Hawk.—On 23 June 1965 while driving eastward about 4 miles from Barnsdall, Oklahoma, our attention was attracted to the erratic flight of a Red-tailed Hawk (*Buteo jamaicensis*). Closer scrutiny revealed a Scissor-tailed Flycatcher (*Muscivora forficata*) in close pursuit of the larger bird. As I slowed the automobile, we saw the flycatcher alight on the back of the hawk and ride it down into the roadside vegetation. Both birds became airborne again almost immediately. The flycatcher was still pressing the attack as they flew away.

This observation was made by myself and several of my vertebrate natural history students.—J. Leland Hepworth, *Oklahoma Cooperative Wildlife Research Unit, Department of Zoology, Oklahoma State University, Stillwater, Oklahoma, 23 August 1965.*

Running speed of Bobwhite.—When conducting wildlife research in the spring of 1956 at the Olentangy Wildlife Experiment Station in Delaware County, Ohio, I frequently drove an automobile through a meadow on a road consisting only of two well-worn tracks. The vegetation-free tracks were about 18 inches wide, and there was vegetation on both sides of each track. This vegetation was 6 to 18 inches tall, increasing in height with advance of the season. A male Bobwhite (*Colinus virginianus*), presumably the same bird each time, was often found taking a dust bath or just standing in the track at or near a certain point on this road. When slowly approached, the bird ran down the track ahead of the automobile, so that his running speed was readily clocked with the automobile speedometer. I always followed 5 to 7 yards behind the bird, and it can be assumed his maximum running speed was usually attained. The bird was followed each time until he turned and ran into the adjacent vegetation.

In five observations, this bird was clocked at 8 to 10 (mean, 9.1; standard deviation, ±0.9) miles per hour. Unfortunately, the accuracy of the speedometer was not checked, and speedometers are known to vary in accuracy. In two of the five observations, the bird started staggering as though tired after running 75 to 85 yards; then he soon turned and ran into the vegetation. The assumption of tiredness is, of course, subjective, and the staggering may have resulted from wavering intentions to stop running as the limit of the bird's territorial range was being approached or passed or from some unsuspected cause. The bird always left the road within 10 yards of the same point.

With birds also running ahead of an automobile, C. Cottam, C. S. Williams, and C. A. Sooter (1942. *Wilson Bull.*, 54:130) reported running speeds of 11 and 14 miles per hour for Gambel's Quails (*Lophortyx gambelii*). These birds were observed over distances of 20 and 30 yards, respectively, but no records were made of their behavior in their final stages of running.

The observations reported in this note were made when I was engaged in research supported by the Ohio Cooperative Wildlife Research Unit. The note was prepared when I was an employee of the U.S. Fish and Wildlife Service, and I am indebted to this agency for typing assistance and editorial review.—Paul A. Stewart, *U.S. Department of Agriculture, Agricultural Research Service, Entomology Research Division, Oxford, North Carolina, 9 September 1965.*

Caspian Tern feeding upon carrion.—On 8 June 1964 I observed a Caspian Tern (*Hydroprogne caspia*) standing on a road apparently feeding upon a dead animal. The location was on the main park road at Nine Mile Pond, Everglades National Park, Florida. Closer inspection revealed that the bird was eating a road-killed eastern cottonmouth (*Agkistrodon p. piscivorus*), about 36 inches in length. An automobile had run over the snake near the head and several inches of flesh had been exposed. The tern was observed to pull at and eat the flesh. A second Caspian Tern stood about 20 feet away from the feeding bird but made no attempt to participate. Though several authors have remarked upon the gull-like habit in this tern of occasionally feeding upon the eggs and young of other birds, I am not aware of any previously published remarks concerning the Caspian Tern engaged in the very gull-like habit of feeding upon carrion.—Richard L. Cunningham, *Everglades National Park, Homestead, Florida, 5 August 1965.*

The migration and wintering of the Upland Plover in Surinam.—The Upland Plover (*Bartramia longicauda*) is a regular migrant in Surinam but it cannot be called a numerous bird. It has a restricted habitat which is not particularly attractive to the ornithologist as it is found on open ground, e.g., plowed fields including recently harvested and burnt-over canefields, sandy areas, and open grassland where the vegetation is very short. It is mostly present in small groups of from 6 to 25 birds although solitary birds are also often seen.

Autumn migration starts in late August: the earliest dates being 24 August 1965, when Mr. Th. Renssen shot a specimen on the sugar estate Marienburg (Commewijne Dist.); 25 August 1957 when I flushed a small group of half a dozen birds on an open sandy savanna near Zanderij, about 50 km south of Paramaribo; and 29 August 1957 when six birds were present on a football field at the outskirts of Paramaribo. On this field the birds stayed until 7 November when only a single bird remained. From 11 October onward they were in company with five American Golden Plovers (*Pluvialis dominica*) which were seen for the last time on 8 November. From August and September onward Upland Plovers are regularly present in their favorite habitat. On 16 September 1962 a bird was found killed by a car on the road near Zanderij and on 15 September 1963 I collected a specimen on the strip of short grass bordering the runway of the airfield at Zanderij. Mr. Renssen, who lived for some time at Peperpot Plantation a few miles south of Paramaribo, collected 3 specimens out of a small flock on an open field in the plantation on 27 September 1964 and saw a flock of about 40 birds on a pasture near Moengo on the Cottica River on 25 October 1964.

The Upland Plover is known to winter on the pampas of southern South America from northern Argentina, Uruguay, and extreme southern Brazil south to central Argentina ("Check-List of North American Birds." 5th edition, 1957:185) and Cooke (1910. "Distribution and migration of North American Shorebirds." Washington) remarked that probably no Upland Plover occur in winter north of the pampas of South America. Therefore, it came as a surprise to learn that the Upland Plover spends the whole winter in Surinam where it is regularly present in small flocks from the time of its arrival at the end of August till its departure in the latter half of April.

Mr. Renssen watched daily small flocks of birds on recently harvested and burnt-over canefields at the sugar estate Marienburg on the south bank of the Commewijne River near the place where it joins the Surinam River (at about 5°55′ N 55° W).

Apart from the birds already mentioned on 24 August 1965 at my request he collected from time to time some specimens as a proof of their presence: 25 October 1965, 12 December 1965, 9 January 1965, 30 January 1965, 12 February 1965, 1 March 1965, 24

March 1965, and 4 April 1965. I saw solitary birds on 29 December 1949 and 1 January 1950 and a flock of four birds on an open field near Paramaribo on 26 March 1947 from which I collected a specimen. The latest date during spring migration in Surinam is 29 April 1913 when a specimen was shot near Paramaribo which is preserved in the Thomas E. Penard collection in the Museum of Comparative Zoology at Cambridge, Massachusetts.

The birds that winter in Surinam are in perfect condition and grow very fat as time goes on. The weight of my 16 specimens is: 24 August 1965, ♂—97 g; 15 September 1963, ♀—98 g; 27 September 1964, ♂—134 g, ♂—144 g, ♀—140 g; 25 October 1965, ♀—137 g; 12 December 1965, ♂—118 g; 9 January 1965, ♀—137 g, ♀—140 g, ♀—149 g; 30 January 1965, ♀—132 g; 12 February 1965, ♀—172 g; 1 March 1965, ♀—166 g; 24 March 1965, ♀—149 g; 26 March 1965, ♂—166 g; 4 April 1965, ♀—144 g. The birds feed on insects and the gizzard contents of my specimens were identified by Dr. D. C. Geyskes, Government Biologist at Paramaribo, as: Hemiptera Homoptera; Hemiptera Heteroptera; Coleoptera (Chrysomelidae); Orthoptera (Mantidae); Hymenoptera (Formicidae; Myrmicinae: *Paracryptocerus* sp.); and Lepidoptera (larvae).—F. HAVERSCHMIDT, *P. O. Box 644, Paramaribo, Surinam, 12 July 1965.*

Ancient Murrelet in Michigan.—On 7 July 1965 an Ancient Murrelet (*Synthliboramphus antiquum*) was collected on the Lake Michigan shore by W. R. Arendshorst and E. D. Greij. The bird was found on the beach about 4 miles north of the Lake Macatawa channel near Holland, Ottawa County, Michigan (Section 9, T5N, R16W). This is the first record of the species in Michigan.

The bird, which was in adult breeding plumage, had been dead for an estimated 3 to 6 weeks and was badly decomposed. The specimen was injected with formalin and allowed to dry. It (HCMZ No. 520) has been deposited in the Hope College Museum. Identification was confirmed by comparison with a series at the UMMZ, Ann Arbor, Michigan.—ELDON D. GREIJ, *Department of Biology, Hope College, Holland, Michigan, 5 August 1965.*

The nestling period of the Great Crested Flycatcher.—A. C. Bent (1942. *U.S. Natl. Mus. Bull.*, 179:113) cited various observers who had reported the nestling period of the Great Crested Flycatcher (*Myiarchus crinitus*) to vary from 12 days to 3 weeks. Although the nestling period for any given passerine species may vary somewhat from nest to nest, it seems doubtful that young Crested Flycatchers normally leave the nest at 12 days of age, or that they remain in the nest as long as 18 or 21 days.

During 1957 and 1958 I made observations at two nests built in birdhouses in Barton Hills, Ann Arbor, Michigan. Five young fledged from each nest. In both instances all of the young left the nest box on the same day. Three of the young left the nest when 15 days old, whereas their two nest mates left when 14 days old. The young were banded when the oldest birds were 7 days old; they were not handled after that date. The young in the 1957 nest were fed by both the male and female. At the 1958 nest, the male disappeared during the incubation period so that only the female fed the nestlings.

On 26 July 1958 the nest box was under constant observation from 4:50 AM EST (still dark) until 7:05 PM, so that either my wife or I saw each of the five young flycatchers leave the nest box. The young left the nest at 12:10, 12:42, 6:00, 6:30, and 7:05 PM. The first three birds to leave the nest box flew distances of 20 to 44 feet, each bird gaining elevation in flight. The last two birds flew over 40 feet but each bird lost elevation during its first flight.—ANDREW J. BERGER, *Department of Zoology, University of Hawaii, Honolulu, Hawaii, 9 September 1965.*

Pilot black snake predation on the Long-billed Marsh Wren.—On 6 June 1965 we observed a juvenile pilot black snake in a Long-billed Marsh Wren (*Telmatodytes palustris*) nest in a marsh along the Potomac River 4 miles south of Washington, D.C. The snake was collected and two fresh Long-billed Marsh Wren eggs were found in its stomach.

The nest containing the snake and several nearby nests were built in narrowleaf cattail (*Typha angustifolia*) at a height of about 4 feet above high tide and at a distance of about 15 yards from the river. The snake, 38.25 cm in total length and 0.75 cm in diameter, was identified as *Elaphe o. obsoleta* by Dr. James A. Peters of the U.S. National Museum.

According to Wright (1957. "Handbook of Snakes," pp. 230–235) this snake is one of the most arboreal of northeastern snakes and is found mostly in hilly, rocky, or scrubby mountainous regions. It lives upland, away from lakes and swamps, and is not generally considered an aquatic or semiaquatic snake. However, Kilham (1959. *Wilson Bull.*, 71:191) observed a pilot black snake near a Pileated Woodpecker (*Dryocopus pileatus*) nest in a swamp over a period of 5 days.

Uhler et al. (1939. *Trans. Fourth N. Amer. Wildl. Conf.*, pp. 608, 612–613), in a study of pilot black snake food habits in Virginia, reported that birds and their eggs constituted 13.31 per cent by volume of this snake's diet. No marsh wrens were reported as food items but this is to be expected since the study area did not contain marsh wren habitat. Apparently this is the first record of snake predation on the Long-billed Marsh Wren and is certainly the first record for the pilot black snake.—Roger Clapp and Tina C. Abbott, *U.S. National Museum, Washington, D.C., 7 September 1965.*

Nesting record of the Hermit Thrush in the Black Hills.—On 19 June 1965, while attending the Wilson Ornithological Society meeting in the South Dakota Black Hills, we observed a Hermit Thrush (*Hylocichla guttata*) nest in the vicinity of Sylvan Lake. Recorded sightings of the Hermit Thrush in the Black Hills are few and no nesting records have been recorded, according to Pettingill and Whitney (1965. "Birds of the Black Hills").

The nest site was approximately 1 mile northwest of Sylvan Lake near the top of the western slope of the canyon below the dam. The nest was about 35 feet from the ground in a birch (*Betula papyrifera*). About 15 feet north of the tree was a sheer granite uprising estimated to be at least 100 feet in height. South of the tree was a smaller rock about 30 feet in height from which we stepped into the tree to observe the nest. Pine (*Pinus ponderosa*), spruce (*Picea glauca*), and birch were the dominant trees in this moderately wooded area.

We first sighted the nest at 6:30 AM and a bird, presumably the female, was sitting on the nest. After observing no conspicuous eye ring we flushed the bird and immediately saw the reddish tail. The nest held four unmarked blue eggs.

We returned to the nest site at 7:30 AM with Dr. George M. Sutton, who verified our finding after observing the incubating bird and one of the eggs.

We carefully observed the nest from 9:00 AM to 11:30 AM, during which time the female remained on the nest. At 9:30 AM a second bird, presumably the male, flew to the large lateral branch supporting the nest. The male, approximately 8 feet from the nest, stayed in this position for 1½ hours, during which time the only movements observed were several head twists, one seemingly in response to the call of a Western Flycatcher (*Empidonax difficilis*). At 11:00 AM he moved down the branch and stood on the edge of the nest. No interactions were noted between him and the incubating bird. The male then dropped to the ground and was not observed again. He did not sing during this period.

At 5:00 PM we returned to the nest site briefly with Dr. Olin Sewall Pettingill, Jr. and Dr. Nathaniel R. Whitney, Jr. The incubating bird flushed when we were within 20 feet of the nest.

On 20 June we returned to the nest site at 4:30 AM and again inspected the nest and four eggs. The female was incubating and did not leave until we were only a few feet from her. Several times she flew in close during our brief visit.

The nest was attached to a loose, dead branch, about 1½ inches in diameter and 1½ feet long, that lay in a crotch where a somewhat larger live branch extended laterally from the main trunk. The outside of the nest was constructed of dry grass, small spruce twigs, a few pine needles, and some pieces of lichen (*Usnea* sp.) and moss (*Hypnum* sp.). It was lined with dry grass and fine rootlets. The inside diameter of the nest was about 3¾ inches and the total diameter was about 5 inches.—DALE W. GREINER AND BOB NEILL, *Kansas State Teachers College, Emporia, Kansas, 9 August 1965.*

Returns of Kirtland's Warblers banded as nestlings.—Mayfield (1960. "The Kirtland's Warbler." Cranbrook Inst. of Science, Bull. 40, p. 206) states that of 222 Kirtland's Warblers (*Dendroica kirtlandii*) banded as nestlings, three have been seen as adults. During the 1963, 1964, and 1965 seasons we have been doing field work on the Kirtland's Warbler Management Area, Huron National Forest, Oscoda County, Michigan. During the 1963 and 1964 seasons 31 warblers were banded as nestlings by us and by Andrew J. Berger. Two of these have been seen as adults, both during the 1965 season.

The list below gives the data on these latter two birds as well as data on the first three, which Mr. Mayfield has kindly sent me from his files. All five were females.

41-97295 banded by Josselyn Van Tyne, 12 June 1946, Sec. 12, T27N, R1E, Oscoda County. Recovery by Harold Mayfield 14 June 1947, Sec. 19, T25N, R4E, Oscoda County (30.6 km SE of nest where banded).

49-30955 banded by Josselyn Van Tyne, 23 June 1953, Sec. 34, T26N, R2W, Crawford County. Recovery by Andrew J. Berger, 18 June 1955, Sec. 4, T25N, R2W, Crawford County (1.1 km SW of nest where banded).

49-30961 banded by Josselyn Van Tyne, 21 June 1953, Sec. 33, T26N, R2W, Crawford County. Recovery by Andrew J. Berger, 23 June 1956, Sec. 8, T25N, R3E, Oscoda County (37 km E of nest where banded).

50-28080 banded by Andrew J. Berger, 24 June 1963, Sec. 10, T25N, R3E, Oscoda County. This bird was first sighted, as an adult, by Nicholas and Mabel Cuthbert on 14 July 1965. Following their directions we relocated this female on 15 July. We found her nest and recovered the female in Sec. 28, T33N, R2E, Presque Isle County (73 km N of nest where banded).

107-76121 banded by us on 19 July 1964, Sec. 11, T25N, R3E, Oscoda County. Recovery by us 29 June 1965, Sec. 2, T25N, R3E, Oscoda County (1.6 km WNW from nest where banded).

Only the gradual accumulation of occasional sightings will reveal the movements and distribution of Kirtland's Warblers banded as nestlings and fledglings. It is hoped that this list of records known to date will make interested people more alert to future sightings.—BRUCE E. RADABAUGH, FLOYD E. RADABAUGH, AND CLARICE A. RADABAUGH, *1208 East 12-Mile Road, Royal Oak, Michigan, 7 September 1965.*

THE PRESIDENT'S PAGE

On page 341 you will find the names of those persons who are charged with the various details of operating our Society during 1966–67. If I may speak for the Vice-Presidents, I am sure they would join me in saying that the real work of making the Wilson Ornithological Society function efficiently is done by the Secretary, the Treasurer, the Editor, the members of the Executive Council, the Trustees, the Editorial Staff of *The Wilson Bulletin* and by the several Committees, whose Chairmen are listed. The Wilson Society exists because of the individual and collective dedication of these officials. But the Society's existence also depends, obviously, on the interest of all our members. If we call upon you for financial support of the Society, for the suggesting of new members, and for your attendance at Annual Meetings, it is reasonable that you, in turn, should feel that there is an avenue of communication by which each member can make his wishes, criticisms, and helpful suggestions known to the officers.

A principal duty of the President should be to provide just such an avenue of communication by which a member may realize that the Society is interested in him. Therefore, I shall welcome any communication on any aspect of the Wilson Society. For example, at the invitation of the Audubon Society of New Hampshire, our 1967 Annual Meeting will be held during 15–18 June at the Crawford House, Crawford Notch, in the White Mountains of New Hampshire. The major field trips will be to breeding areas of various northern warblers and finches. If a member has any questions about the 1967 Meeting, or wishes to see any particular species of birds in northern New Hampshire next June, he should feel free to write to me. Working with the Local Committee, I will do my best to see that his questions are answered, and that he may be enabled to see the birds he mentions, either on the scheduled field trips, or before or after the Meeting.

AARON M. BAGG

ORNITHOLOGICAL NEWS

It is a pleasure to mention that Albert F. Ganier, Harold M. Holland, and Herbert L. Stoddard have in the last two years joined that small group of members who have belonged to the Wilson Society for 50 years. The other members of our "Half Century Club" are: George E. Ekblaw, Ira N. Gabrielson, Charles R. Rogers, W. E. C. Todd, and Alexander Wetmore.

By action of its Council, the Wilson Ornithological Society has authorized the creation of 25 student memberships to be offered during the year 1967. These memberships will be awarded to worthy undergraduate students with special interest in ornithology, will be on a yearly basis, and will carry full privileges of the Society.

Through the kindness of a donor who wishes to be anonymous, the full cost of these memberships, $125, has been provided at no expense to the Society.

There will be further announcement as to these memberships later in the present calendar year.

President Aaron Bagg has announced the formation of two special committees for the next year: a Committee on Student Memberships whose Chairman is Maurice Brooks; and a Committee for the Fiftieth Annual Meeting, 1969, to be chaired by O. S. Pettingill, Jr.

One of the features of the 1967 Annual Meeting in New Hampshire will be a Symposium on Nocturnal Migration and Orientation (with considerable emphasis on radar investigations). This symposium is being organized by William W. H. Gunn.

The XV International Ornithological Congress will be held in the late summer of 1970 in The Netherlands. The President of the Congress will be Dr. Niko Tinbergen.

ORNITHOLOGICAL LITERATURE

Water, Prey, and Game Birds of North America. By Alexander Wetmore and other eminent ornithologists. National Geographic Society, Washington, D.C., 1965: 7 × 10¼ in., 464 pp., 643 illus. (600 in color), 6 phono. records in back-cover pocket, 6¼ in., 33⅓ rpm, 2 sides. $11.95.

Whether we have few or many bird books, most of us want in our collection at least one popular work that treats *all* the birds from coast to coast and shows a recognizable picture of each in color. If buying such a work today, we may well choose this volume and its 1964 companion, "Song and Garden Birds of North America" (the two in cloth box for $25.00). The only approximate alternative is T. Gilbert Pearson's "Birds of America" (presently $8.95), which is still widely sold in bookstores although it was first published almost 50 years ago and betrays its vintage in both text and illustration.

This new book treats 329 species from the loons through the swifts in the AOU Check-list. (It was obviously a challenge to find a title to embrace such diverse groups, including the cuckoos, goatsuckers, and swifts, which are not by any stretch of the imagination water, prey, or game birds.) The illustrations, the majority of them color photographs and some of them truly spectacular, have been rounded up from many sources. The principal photographers, Frederick Kent Truslow, Arthur A. Allen, Eliot Porter, G. Ronald Austing, and Karl W. Kenyon, and the painters, Walter A. Weber and Allan Brooks, are men of established reputations, but many photographs were gathered also from comparatively unknown people. The fact that the paintings by Brooks were used earlier, with different arrangements and plates, in the National Geographic Society's long-out-of-print "Book of Birds" (2 vols., 1932 to 1939), does not detract from their value here, in my opinion.

The printing, the paper, and the binding are excellent. No effort was spared to produce a book that will be an attractive item on your library shelf for many years. If the two volumes had been bound as one, the resulting book would have been too heavy for convenient handling.

Next after the pictures among the attractions of this book, I believe, are the phonograph records by Peter Paul Kellogg of the Cornell Laboratory of Ornithology. These are six small vinyl disks (12 sides) presenting the voices of 97 species of birds. The sound quality is excellent. The records are played by placing on the turntable the entire booklet opened to the desired page. By ingenious use of the transparency of the disks, the needle can be placed directly at the song wanted, without playing the whole record to find it. Each side, presenting about eight voices, plays a little over 5 minutes. The system works well except that, if the tone arm is not positioned accurately at the start, it may slide off the disk and cause the square corners of the booklet to hit the stylus alarmingly.

Each chapter in the book, with a few exceptions, is devoted to one family of birds. There is a general account of the family, often by a recognized authority, and then some comments about each species. The signed accounts are mostly short, narrative, and personal. The statements about the species are necessarily brief, ranging from less than 100 to more than 700 words (typically 200 to 300), concluding with a short paragraph on the range and "characteristics" (field marks). Three chapters scattered through the book are of a different kind, treating broadly the history of birds, migration, and conservation. The opening chapter by Wetmore on the development of birds through the ages is of particular interest. Other authors writing in the fields of their special competence are John W. Aldrich, Robert Porter Allen, Dean Amadon, Frank C. Craighead, Jr., John J. Craighead, Philip S. Humphrey, George H. Lowery, Jr., Robert M. McClung, Alden H. Miller, Robert Cushman Murphy, Robert J. Newman, Roger Tory Peterson, Olin Sewall Pettingill, Jr., Austin L. Rand, S. Dillon Ripley, Alexander Sprunt, Jr., George Miksch Sutton, Frederick Kent Truslow, and Paul A. Zahl.

In regarding this work primarily as a "picture book," perhaps inevitably I place the text in a secondary position among its attractions. Could any words compete with such bright colors? Should we expect the text to be more than a mere appendage to the illustrations? Yet I believe the "National Geographic formula" tends further to downgrade the word content in the eyes of ornithologists.

Although the stated authors of portions are prestigious, the reader senses a pattern of treatment (chatty, anecdotal, and sometimes inconsequential) that bespeaks an anonymous staff writer (or perhaps an army of them) that does not know birds but uses a practiced method for popularizing subjects of all kinds. Even in the signed portions, one suspects that the distinguished authors served more importantly to assure factual accuracy than to determine the content and style. The dominant role of anonymous staff authors is suggested further by the circumstance that the writers are not identified in 23 of the 50 chapters and all of the species accounts.

The account of the Common Goldeneye, for example, begins, "A March snowstorm drops a blanket of white across a New England estuary. Ice cakes litter the surface, but the bleak setting fails to dampen the fervid courting by goldeneye drakes." The point of this leisurely flight of rhetoric, I think, is that goldeneyes court in early spring. I would not object to it in a lengthy treatment of the species or in a nature-is-beautiful essay. But I wonder what was in the author's mind who devoted a tenth of the species account to a fact that is unremarkable and in no sense unique to the goldeneye. Presumably he believes that his imagery is more interesting than anything informative that could be said about the bird. The person searching this book for information will find such passages frothy.

Again, the matter of authorship will not worry the majority of the 300,000 buyers of the first printing of this book, but it will perplex ornithologists. When one opens the book, he is likely to assume at first glance that the distinguished Alexander Wetmore is the principal author, and I suspect that bibliographers and librarians will so list it. Yet, a turn of the page raises a question about how much this means. Two of 50 chapters were signed by Wetmore (one of these an edited version of a chapter on owls he wrote in the thirties for the "Book of Birds"); and therefore, presumably, the unsigned portions were not his work. Next we notice that his name does not appear on the spine of the book. Thus alerted (and puzzled), we eye other parts more critically. Immediately our attention is arrested at the table of contents by a mislabeled owl that Wetmore, not even in an inattentive moment, would have called a Great Horned Owl. A few other pictures cause us to wrinkle our brows. The long-dead mammal in the talons of the Golden Eagle (p. 27) takes some of the drama from what otherwise might have been a view of this magnificent bird at the moment of kill. The frayed tail of the Swainson's Hawk (p. 230) suggests a caged bird, and the eyes of the Spotted Owl (p. 443) are not those of a bird in health. The Golden Plover (p. 323) seems to be the European species, *Pluvialis apricaria.*

The vague handling of authorship leads to some other minor annoyances. The table of contents lists the subjects of chapters but not the authors, whose names are among the book's genuine attractions in many instances. "The author" in a picture caption on page 36 means Wetmore and on page 211 seems to mean Miller.

In spite of my criticisms, I want to emphasize that this book is attractive and, except for a few slips, accurate. These are strong virtues. The book deserves a wide popular audience, and I hope this audience will not be severely reduced because the volume is obtainable only from the publisher and not through bookstores. The issuance of a work of this scope is a major event in ornithology, for it is books like this that foster the interest from which scientists grow.—HAROLD MAYFIELD.

TOP FLIGHT: SPEED INDEX TO WATERFOWL OF NORTH AMERICA. By John A. Ruthven and William Zimmerman. Moebius Printing Company, Milwaukee, Wisconsin, 1965: 4½ × 11¼ in., 112 pp., 260 col. illus. $6.95.

"Top Flight" is an interesting new approach to a sort of "Slim Jim" (dimensions, 4½ by 11¼ inches), pocket-adapted field guide. Its slender format with plastic-coated board binding adapts it rather well to deep hunting coat pockets. The illustrating of molting birds as encountered by the hunters in fall as well as the spring nesting plumages is an excellent idea. The simplified classification of the waterfowl by marginal color bars on the pages, as ready reference to the colors of the birds, suggests that here is a simple and easy solution to a difficult identification problem. However, I do not feel that the problems of waterfowl recognition can be pigeonholed in quite such an easy fashion. The colors, especially of females and various molting plumages of male ducks, are too near the border line of gray and brown to be readily called one or the other. I feel this simplified keying of color will break down completely when one attempts to use such criteria for grouping unknown birds.

In my field experiences I have found that many species identifications depend on differentiating very faint and indistinct characters. After one becomes thoroughly acquainted with the degree of variation in both color and form that exists in certain characters, and not until then, can one be reasonably sure of whether a duck's neck is longer and more slender or shorter and thicker than another. To the uninitiated, these descriptive terms mean little until he knows within what limits these descriptions apply. Because of this necessity for making fine distinctions, it follows that these fine distinctions must appear in any illustrations that are to be of value in pointing them out. For instance, the winter plumages of the Horned and Eared Grebes are actually so similar as to be difficult to distinguish, yet the gray-and-white Horned Grebe on page 30 is vastly different from the brown Eared Grebe on page 32, at least in the copy of the book I examined. Likewise, the Gadwalls swimming, page 96, are far darker birds than the same birds in flight, page 97, and the gray Black Brant, page 64, differs markedly from the brown bird in flight, page 65. These errors may well be not the artists' fault but the color reproducer's. Other color errors appear, such as the Pintail and merganser heads, pages 82 and 83, are far too reddish.

The proportions of several figures seem incorrect. The artists did not make careful enough measurements of the heads and bills as compared with the tails, the feet, or the wings in several plates. The Ruddy's head on page 62, for instance, is too large, while among others the head of the flying Green-winged Teal on page 25 and that of the swan on page 107 are too small. The necks of the swan and goose in the silhouettes on page 9 would be found to be longer if photographs were carefully measured. Furthermore, the attitude of the merganser does not show the tendency for the bill to be carried above the horizontal. The loon in flight, page 9, also lacks the upcurved neck characteristic of that species while the swimming loon's bill, page 64, is far too thin.

The highly abbreviated text contains many relatively meaningless words. On page 83, "a flock of Pintails, with their pointed wings and tails and their long, forward-poised, white necks, form a beautiful and distinctive pattern." The words "flight pattern" are used repeatedly, apparently referring to the flock formation whereas it usually would be understood to mean the color pattern of the wings in flight. Descripions of "voice" are mostly of doubtful value—e.g., "strange clucking sounds" (p. 58)! The newly coined word "featheration" is a bit startling but perhaps is well chosen.

I realize that, from a sales standpoint, a so-called "easy method" of waterfowl recognition may sell a lot of books, and it is true that future waterfowl management is going to require much more sophisticated knowledge of field recognition of species on the part of hunters. My reaction to this book is that it follows a modern trend to seek ways and means of avoiding hard work and long study in mastering difficult problems. Instead of admitting that to tell a female Blue-winged Teal from a female Cinammon Teal is next to impossible and that many a female Gadwall has been field-identified as a female Pintail or Mallard, I'm afraid these authors have tried not too successfully to point out that this is really fairly simple if one just observes certain obvious characters.—W. J. Breckenridge.

Birds of the Niagara Frontier Region. An Annotated Check-list. By Clark S. Beardslee and Harold D. Mitchell. Bulletin of the Buffalo Society of Natural Sciences, Vol. 22, Buffalo, New York, 1965: 6½ × 9¾ in., xix + 478 pp., 38 bl. and wh. photos, 1 map. $9.00 paper; $10.00 boards.

In 1930, two indefatigable compilers of records for the Buffalo Ornithological Society set out to gather the data for a checklist of the birds of the Niagara Frontier, and this excellent volume is the result. The senior author, Clark Beardslee, died in 1957, and Harold Mitchell carried the work to completion. The territory covered includes all of western New York west of the vicinity of the Genesee River Valley and much of the Niagara Peninsula of Ontario. A two-color altitudinal map depicts the exact boundaries of this diversified study area.

Introductory chapters include an ornithological history of the region, the observers, previous works, and a discussion of the faunal zones. Were I a resident or a prospective visitor, I would find much useful information in the 33 pages devoted to "Territorial Localities of Special Ornithological Interest." The 109 localities described are keyed by number to the regional map mentioned above.

A section entitled "Seasonal Status" places the birds in 12 arbitrary and of course debatable categories—permanent residents, introduced permanent residents, summer residents, summer visitants, winter visitants, transient visitants, introduced rare transient visitants, rare and very rare visitants, casual and sporadic visitants, accidental visitants, hypothetical, and extinct or extirpated. There is an interesting month-by-month chronology of weather and regularly expected occurrences.

A chapter, "The Authenticity of Records," gives the authors' criteria for the acceptance of records. They say that their "sole criterion has been the question of certainty." I cannot feel as certain as the authors are about some of them, but this is only natural when specimens are not involved. Chapters on "Nomenclature and Classification" and "Dates" describe the treatment of these subjects in the annotated list which follows and comprises the bulk of the work. There is an excellent and thorough bibliography, an appendix of questionable value, and an index of scientific and vernacular names.

In a book which is primarily based upon field observations, I dislike the use of trinomials in the annotated accounts. The authors explain (p. 71) that "where locally taken specimens are not available to us, we have assigned the birds—to those subspecies which, according to the ranges given in the 'A.O.U. Check-list,' Fifth Edition, are most apt to occur here." I would much prefer binomials with additional remarks under those headings when subspecies are deemed worthy of comment. There are at least a dozen species listed under one trinomial which I feel sure are represented at one time or another in this area by one or more additional subspecies.

The treatment of hypotheticals is always a thorny problem. It is especially one in a work such as this where so many data are based upon sight records. The Razorbill appears in the list of hypotheticals (p. 57), but is the only bird in that list which doesn't appear in the main text. When such a highly improbable occurrence as a Golden-cheeked Warbler is dignified with even a listing in the hypothetical category, it makes one wonder if any other "far out" observations have made their way into these pages in the attempt to be certain that nothing in the literature has been excluded.

The book is remarkably free of typographical errors, and the proofreaders are to be highly congratulated. I found a few errors in scientific and vernacular names: *Pleadis* (p. 104) should be *Plegadis*, Hawk-Owl (p. 280) should be Hawk Owl, *garrula* (p. 351) should be *garrulus*, *brachydactylus* (p. 391) should be *brachidactylus*, and Gmelin (p. 428) should be enclosed in parentheses.

Every ornithologist in the Niagara Frontier Region will welcome this work and find it most useful in his field studies.—PHILLIPS B. STREET.

A COMPARATIVE STUDY OF SOME SOCIAL COMMUNICATION PATTERNS IN THE PELECANIFORMES. By G. F. van Tets. American Ornithologists' Union, Ornithological Monographs No. 2, 1965: 88 pp., 49 figs. $2.00 ($1.60 to members of the AOU).

Slightly more than half of this work is devoted to a descriptive cataloguing of visual and vocal communication signals in a wide variety of pelecaniform species. The author personally observed and photographed 14 of these: Pelecanidae, 4 species; Sulidae, 2 species; Anhingidae, 1 species; Phalacrocoracidae, 6 species; and Fregatidae, 1 species. Pertinent information on 40 additional species has been gleaned from the literature, and the various terminologies employed by others to describe displays have been listed and equated to those used by van Tets.

Displays are treated in four categories: (1) locomotion and its derivatives; (2) fighting and its derivatives; (3) nest-building and its derivatives; and (4) begging and its derivatives. Comparative descriptions of each display are given for each species in which it is known, and quantitative measures of display duration and frequency and of tail angle are provided for those displays recorded on film. Associated vocalizations are presented but lack quantification because field recording equipment was not available. The possible origins and functions of displays are discussed, with the author's full acknowledgment that any attempt to understand the motivation of these displays is premature. Finally, the organization of displays in behavioral sequences is included in tabular form but unfortunately without statistical analysis or discussion.

In general, it is not possible to judge the accuracy of van Tets' descriptions, but his accounts of the Red-footed Booby (*Sula sula*) are, with a single exception, in complete agreement with my admittedly superficial experience with the behavior of this species. On page 23, van Tets writes that "*Sula sula* are silent during the post-landing display." While I may misinterpret van Tets' delimitation of the post-landing display, certainly one of the most prominent vocal signals of the Red-footed Booby is a raucous call repeated many times, beginning shortly before landing and usually continuing for a few seconds after. So common is this call that a colony is rarely quiet during the daytime.

The presumed relationships of displays in different species have been employed to erect phylogenetic trees of the various basic body movements and their derivative displays. In most instances these are based entirely upon speculation and are thus of questionable value. More to the point, however, is a comparative analysis of display types as they relate to current phylogenetic considerations of the Pelecaniformes. The conclusion is reached that behavioral data support the phylogeny of Lanham (1947. *Auk*, 64:65–70), particularly in relating the Sulidae more closely to Anhingidae and Phalacrocoracidae than to Pelecanidae and in maintaining the Anhingidae as a family separate from Phalacrocoracidae. Both of these points differ from those of Sibley (1960. *Ibis*, 102:215–284).

While the speculative aspects of van Tets' paper are the most interesting, limitations in our understanding of the evolution and motivation of visual signals preclude definite conclusions. Certainly the most significant contribution of this paper lies in its detailed descriptions of a multiplicity of displays.—JARED VERNER.

THE GOLDEN EAGLE. By Robert Murphy. E. P. Dutton & Co., Inc., New York, 1965: 5½ × 8¼ in., 157 pp., 10 figs. $3.95.

This book is not an account of the Golden Eagle, but an imaginative story of the vicissitudes of an eaglet, from its precipitous flight from the nest to avoid capture by a falconer, through many harrowing adventures (The "father" is shot by a rifleman; a companion eagle is shot from the air by a hunter–pilot.) until she herself dies, still only months old, after eating from a poisoned carcass set out by a sheep rancher as bait for coyotes. The general pattern of the story is much like the author's previous book devoted to a young Peregrine Falcon, in which a lively, entertaining, and always sympathetic picture is given of the surroundings and life of a bird of prey.

At a time when man's exploding population, coupled with an ingenious but misguided technocracy, increasingly threatens the very existence of his fellow vertebrates, hope for some protection to threatened animals comes more from education and esthetic appreciation than from legal restraints. Books such as this. aimed at younger readers, result in gaining more effective protection for the Golden Eagle than do reams of reports of scholarly investigations of food habits and behavior of eagles.

The author takes free license in giving human thoughts and traits to his eagle subject, but these are easily overlooked in the story which deals intimately and colorfully with mountain ranges and mountain birds and mammals of central Colorado. For the sake of accuracy, however, it may be noted that Mr. Murphy's eagles appear to resemble and behave more like the large falcons with which the author has had experience as a falconer, than like eagles. Thus his eagles "scream" in alarm as a falconer ropes into the nest, and the air is frequently filled with the roar of wings in headlong stoops.

On the contrary. Golden Eagles are quiet and retiring in the presence of man, usually disappearing soundlessly well before the observer appears. I have never heard eagles screaming in alarm, or for that matter emitting any call that I think could really be called a scream. The yelping call ("kiah-kiah-kiah" of Bendire, 1892. "Life Histories of North American Birds") is usually given in the presence of another eagle. Again, eagles do make spectacular tumbles and cartwheels in display or perhaps in sheer exuberance, but during hunting, long plunging stoops are far from the normal pattern of the eagle which, instead, spends hours coursing and contouring only yards above his anticipated prey. Again, the list of kills of the young eaglet within a few weeks of leaving the nest include a coyote, doe deer, and a young bobcat, as well as ducks and a Canada Goose taken in full flight. This makes for exciting reading, and if this were the true picture of the hunting of eagles there might be more grounds to support the contention of some sportsmen and sheep ranchers that eagles threaten their sport and livelihood. I believe Mr. Murphy has been misled by the published accounts of spectacular kills in which the eagle must do exhausting battle for his dinner. These are, of course, more newsworthy than the regular daily fare of rabbits, ground squirrels, and marmots. Eagles take a large prey only when pressed by severe hunger, and an eagle that eats a ptarmigan on one day (p. 133) is certainly not going to be hungry enough to tackle a doe the next.

There are other details of eagles and eagle life which seem not true or which are inaccurately presented (the white at the bases of tail and middle wing feathers of the young eagle [p. 14] do not gradually darken . . . on the contrary they are gradually replaced during molt by feathers with less [tail] or no [wing] white. Male eagles are not "tiercels," one-third smaller than their mates, but rather, female eagles average bigger and heavier than males with sizes and weights actually overlapping.) However, the value of this book is not in its account of details of eagles and their lives, but rather in its appeal to man to give a fellow vertebrate a chance to survive in a world which is ever more rapidly becoming man-made and for man alone.—Walter R. Spofford.

PROCEEDINGS OF THE FORTY-SEVENTH ANNUAL MEETING

PERSHING B. HOFSLUND, SECRETARY

The Forty-Seventh Annual Meeting of the Wilson Ornithological Society was held Thursday, 28 April to Sunday, 1 May 1965 at The Pennsylvania State University, University Park, Pennsylvania. Sponsoring organizations were the Penn State Center of Continuing Education, the College of Science, and the Carnegie Museum of Pittsburgh. The local committee was under the chairmanship of Merrill Wood, Associate Professor of Biology at Penn State. The meeting was attended by 187 registered members and guests.

The meeting opened on Thursday night with a social hour at the J. Orvis Keller Conference Center and the Executive Council meeting held in the same building. On Friday the first of four papers sessions followed the welcoming address given by Dr. Clarence I. Noll, Dean of the College of Science, the response by the President of the Society, Roger Tory Peterson, and the first business session. In the evening a reception followed a showing of slides of some of England's Nature Trusts by Richard Fitter of Oxford, England, and of raptores along the Anderson River in northern Canada by Richard Fyfe. There also was an opportunity to view a particularly fine art exhibit featuring proofs from the "Birds of Colorado" and four water colors of hawks and eagles done by Earl L. Poole, drawings of baby ducks from a forthcoming book on the day-old Anatidae of North America by Colleen Nelson, field studies of members of the Cracidae by Albert E. Gilbert, four oil paintings of Leonard J. Hue, and a number of bird etchings done on aluminum trays by Dorothy L. Bordner. The annual dinner held in the Holiday Inn Motel was handled adroitly by Master of Ceremonies Kenneth Parkes. The program was presented by President Roger Tory Peterson who, after the Presidential address, gave a slide-illustrated program, "Penguin Peregrinations," a story of Dr. Peterson's field trips from the Galápagos to the Antarctic in quest of the various species of penguins.

The papers sessions featured two symposia, one on the arbovirus studies at Penn State and the second on the present status of our birds of prey. The arbovirus symposium was arranged by Dr. David E. Davis of Penn State and the birds of prey symposium by Sally and Walter Spofford.

Cool and rainy weather interfered with the field trips, but early morning trips on Friday and Saturday and the Sunday trips were held. On Sunday, there were four trips available: (1) to visit the netting project where the arbovirus study is being made, (2) Centre County Barrens for warblers, (3) Black Moshannon Lake for migrating waterfowl, and (4) the research station at Powdermill Nature Reserve. At Powdermill it was reported that among the first birds netted were a Brewster's and a Lawrence's warbler. The Lawrence's Warbler, rarely taken in western Pennsylvania, was the first record for Powdermill.

FIRST BUSINESS SESSION

The meeting was presided over by President Roger Tory Peterson. The secretary, Pershing B. Hofslund, summarized the principal actions of the Executive Council meeting from the previous evening as follows:

1. The Council reaffirmed the 1965 decision to hold the 1967 meeting in New Hampshire. Present plans call for the meeting site to be at Crawford House in Crawford Notch among the White Mountains. Robert Smart was named local chairman.
2. Tentatively, the 1968 site will be at Carbondale, Illinois with Southern Illinois University being the host institution.

3. No decisions were made for the 1969 and 1970 sites but Council members suggested that the 1969 site be in the southeastern United States and the 1970 site be in the north-central area.
4. A resolution was passed establishing a committee (to be chosen by the president) whose obligation was to explore various means of promoting the Wilson Ornithological Society. This committee was empowered by the Council to establish 25 complimentary Wilson Ornithological Society memberships for undergraduate students showing an interest and promise in ornithology. The procedure for selection was to be determined by the appointed committee.
5. George A. Hall was reappointed editor.
6. After acceptance of the report of the Research Committee, two Louis Agassiz Fuertes Research grants were awarded. Recipients were Douglas D. Dow, Department of Zoology, University of Western Ontario, London, Ontario for his study entitled "Habitat Selection by the Cardinal *(Richmondena cardinalis)*" and to Ralph W. Schreiber, University of Maine, Orono, Maine for his study "Nonbreeding Behavior of Herring Gulls."
7. The following delegates were named: C. Chandler Ross to the XIV International Ornithological Congress, Pershing B. Hofslund to the 84th Stated Meeting of the American Ornithologists' Union, and Jeff Swinebroad to the 200th anniversary of Rutgers University.

The following committee reports were summarized by the Secretary, or where indicated, given by the Chairman of the committee.

Treasurer's Report

REPORT FOR THE TREASURER FOR 1965

GENERAL FUND

Balance as shown by last report dated 31 December 1964		$5,265.43
RECEIPTS		
Dues		
Active Memberships	$ 6,939.00	
Sustaining Memberships	710.00	
Subscriptions to *The Wilson Bulletin*	1,800.00	
Sales of back issues of *The Wilson Bulletin*	618.99	
Interest and Dividends on savings and investments	1,831.73	
Gifts	12.00	
Royalties from microfilming back issues of *The Wilson Bulletin*	6.05	
Society's share of Income from the Christian J. Goetz Estate	1,216.50	
Total Receipts	$13,134.27	
DISBURSEMENTS		
The Wilson Bulletin (printing and engraving)	$ 8,566.50	
The Wilson Bulletin (mailing and maintenance of list)	1,049.02	
Editor's Expense	118.33	
Secretary's Expense	22.45	
Treasurer's Expense	405.92	
Canadian Discount and Transfer Fees	14.99	
Annual Meeting Expense	69.50	
Committee Expense	27.11	

International Council for Bird Protection (1965 dues)	25.00	
Transfer to Research Fund	63.00	
Cost of Establishing Zip Code Numbers on mailing list	159.62	
Total Disbursements	$10,521.44	
Excess of Receipts over Disbursements for Year 1965		$2,612.83

GENERAL FUND CASH ACCOUNTS

Checking Account	$2,752.61
Savings Account	5,125.65
Balance in Girard Trust Bank, Philadelphia, Pennsylvania, 31 December 1965	$7,878.26

Josselyn Van Tyne Memorial Library Book Fund

Balance as shown by last report dated 31 December 1964	$ 482.78
RECEIPTS	
Sale of duplicates and gifts	134.60
Total Balance and Receipts	$ 617.38
DISBURSEMENTS	
Purchase of books and postage	293.43
Balance in Girard Trust Bank, Philadelphia, Pennsylvania, 31 December 1965	$ 323.95

Louis Agassiz Fuertes Research Fund

Balance as shown by last report dated 31 December 1964	$ 36.00
RECEIPTS	
Contributions	133.00
Transfer from General Fund	63.00
Total	$ 232.00
DISBURSEMENTS	
Award to J. O. Sullivan	100.00
Balance in Girard Trust Bank, Philadelphia, Pennsylvania, 31 December 1965	$ 132.00

Endowment Fund

Balance in Endowment Fund Savings Account as shown by last report 31 December 1964		$ 3,330.28
RECEIPTS		
Life Membership payments		
Cash	$1,325.00	
Patronship payments		
Cash	1,650.00	
3 shares Standard Oil of California (included below)		
Stock dividends received (included below)		
4 shares Massachusetts Investor's Trust		
Sale of 70 shares M. A. Hanna Co.	3,208.87	
Total Receipts		6,183.87
		$ 9,514.15

DISBURSEMENTS

Common Stocks Purchased		
100 Shares Savannah Electric & Power Co.	$2,700.00	
35 Shares General Motors	3,613.64	
50 Shares Niagara Mohawk Power Co.	2,975.00	
Total Disbursements		9,288.64

Balance in Endowment Fund Saving Account Girard Trust Bank, Philadelphia, Pennsylvania, 31 December 1965	$ 225.51

SECURITIES OWNED (listed at closing prices 31 December 1965)

$5000	U.S. Treasury 4% Bonds due 1 October 1969 at $96\frac{18}{32}$	$4,828.12	
5000	U.S. Treasury 4% Bonds due 15 August 1972 at $95\frac{30}{32}$	4,791.88	
5000	Bankers Trust Co. 4½% Capital Notes due 15 December 1988 at 95½	4,775.00	
3000	Phillips Petroleum Co. 4½% cvt. bonds due 15 February 1987 at 121½	3,645.00	
15	shares Kaiser Aluminum & Chemical Co. 4¾% cum. cvt. Pfd. (1957 Series at 100)	1,500.00	
25	shares Owens-Illinois Glass Co. 4% cum. Pfd. at 93½	2,337.50	
210	shares Fireman's Fund Insurance at 39	8,190.00	
35	shares General Motors at 103½	3,622.50	
428	shares Massachusetts Investors Trust at 18.28	7,823.84	
50	shares Niagara Mohawk Power Corp. at 26⅝	2,662.50	
75	shares Phillips Petroleum Co. at 56¼	4,218.75	
100	shares Savannah Electric & Power Co. at 26⅜	2,637.50	
3	shares Standard Oil Co. of California at 79⅞	239.63	
	Total Securities Owned		51,272.22
Total Endowment Fund, 31 December 1965			$51,497.73

Respectfully submitted,

C. Chandler Ross
Treasurer

Research Grant Committee Report

Chairman Harrison B. Tordoff reported: we received a total of nine complete applications for the Louis Agassiz Fuertes Grant for ornithological research. An additional seven persons made preliminary inquiries but did not file formal applications.

The applicants are a strong lot, but our committee is in close agreement this year. If funds are available for two awards, we recommend that they be given to:

Douglas D. Dow, Department of Zoology, University of Western Ontario, London, Ontario, for his study entitled "Habitat Selection by the Cardinal (*Richmondena cardinalis*)." and

Ralph W. Schreiber, 9 Coburn Hall, University of Maine, Orono, Maine, for his study "Non-breeding Behavior of Herring Gulls."

In the event the Council accepts our recommendations, the winner or winners should be notified by the Secretary, who should also send a letter to each unsuccessful applicant.

Conservation Committee Report

Roland Clement, Chairman of the Conservation Committee, summarized the report for the attending audience. A complete report will appear in the next issue of *The Bulletin.*

Membership Committee Report

Chairwoman Hazel Bradley Lory reports that this committee consisted of 15 members and herself this year. One new member was added in June and two dropped out in the fall. Two of these 15 members are in Canada and the rest are fairly well distributed over the U.S.

Supplies were sent out to all who indicated a need for them. The committee as a whole secured 30 new members, while 26 other people joined under the sponsorship of 12 W.O.S. members not on the committee.

Application cards for 123 new members are on hand and a list of these is being submitted to the Secretary with this report. This is 30 fewer than last year, reflecting both the need of more and better mailing lists of prospects and the relative inactivity of the chairman.

Last year about 25 per cent of our new members were students. This year we added 36 students, which is 29 per cent of the new membership. Most of these are on the college or postgraduate level. Twenty other new members are professors, teachers, or other school employees. These facts suggest good quality in the society for the future.

We have asked the Treasurer to display brochures and application cards at the meeting and have requested the local committee on arrangements to obtain the names and complete addresses of all persons attending it. As usual, this list will be used to obtain new prospects for membership.

Library Committee Report

Chairman William A. Lunk reported (report read by the Secretary): the year passed smoothly, so far as the Josselyn Van Tyne Memorial Library was concerned. No formal meeting of the committee was held, nor deemed necessary for such routine transactions as were carried on.

Since critical storage problems have been alleviated, the library materials can be more effectively handled and used. Norman Ford, of the Museum of Zoology Bird Division, continues competently to carry on all of our administrative details.

The current increment of the gift from Mrs. Josselyn Van Tyne comprised a group of 3,300 reprints from her late husband's library.

Including this, 40 gifts were received during the year from 34 individuals. Included were 26 books, 233 journals, 4 pamphlets, 5 translations, and 3,660 reprints.

Sixty-eight loans (149 items) went out of town to 44 individuals, to maintain about the level shown on recent reports, this, as always, being in addition to constant on-the-spot use by numerous members.

A slight increase is noted in the number of journals received, 117 in all, of which 91 are by exchange.

It is hoped that member-participation will continue at its present high level, and increase, through use of the growing collections, through contributions of books and separates, and through cash donations to the New Book Fund.

Endowment Committee Report

Chairman Stephen Eaton reported no action for the past year.

Temporary Committees

The following committees were appointed by President Peterson:

Auditing Committee
Edward L. Altemus
John H. Foster
Allan Crawford, Jr., Chairman
Nominating Committee
Maurice Brooks
Phillips B. Street
O. S. Pettingill, Jr., Chairman
Resolutions Committee
Donald Borror
William W. H. Gunn
Phillips B. Street, Chairman

SECOND BUSINESS SESSSION

Report of the Auditing Committee

The Secretary read the following report:

We have examined the accounts, books and balance sheet of the Wilson Ornithological Society as prepared and maintained by the Treasurer, Mr. C. Chandler Ross. We find same to be entirely in order and again compliment the Treasurer on the capable dispatch of his office. We also were pleased to note the excellent financial condition of the Society.

Report of the Resolutions Committee

Chairman Phillips B. Street gave the following resolutions:

WHEREAS the Forty-seventh Annual Meeting of The Wilson Ornithological Society has convened on the beautiful campus of The Pennsylvania State University at University Park, Pennsylvania, in the newly completed J. Orvis Keller Conference Center and

WHEREAS the members of the Society have been privileged to enjoy the unsurpassed facilities of this Center and the unstinting hospitality of those in charge of the arrangements for this meeting

THEREFORE BE IT RESOLVED that the Society expresses its grateful appreciation to the host organizations, The Pennsylvania State University College of Science and Continuing Education and the Carnegie Museum of Pittsburgh.

BE IT FURTHER RESOLVED that the Society give warm thanks to Dr. Merrill Wood, Chairman of the Committee on Arrangements, his fellow Committee members, and to Richard Grubb, Deputy Director of the Conference Center and his staff, all of whom have contributed so much to the enjoyment of our stay here.

Because the raptorial birds represent an end link in the pyramid of life and are thus indicators of the health of the environments they occupy, and because several species of North American raptores are currently in serious decline,

THEREFORE BE IT RESOLVED that the Bureau of Sports Fisheries and Wildlife be urged to enlarge its concern for all aspects of the biology of these birds, and that provision be made to establish reliable indices of population size; to this end increased emphasis on the banding of these birds should be encouraged.

The report of the Resolutions' Committee was accepted.

Election of Officers

The nominating committee proposed the following officers for the coming year: President, Aaron M. Bagg; First Vice-President, H. Lewis Batts, Jr.; Second Vice-President, William W. H. Gunn; Secretary, Pershing B. Hofslund; Treasurer, C. Chandler Ross: Elective Member of the Council to fill the unexpired term of William W. H. Gunn, Stephen W. Eaton (term expires 1967); Elective Member of the Council, Kenneth C. Parkes (term expires 1969).

The report of the Nominating Committee was accepted and there being no nominations from the floor, President Peterson called for a vote of the members present. The officers were elected with no dissenting votes.

PAPERS SESSIONS

Friday, 28 April

1. *The Arbovirus Grant at Penn State*—Symposium.
   Moderator: David E. Davis
   Participants: C. R. Houseknecht, I. R. Savidge, J. E. Applegate, F. W. Peak.
   Summary: E. C. Franks
2. Albert E. Gilbert, Ridgeview, Connecticut. *Observations on the Horned Guan and Black Chachalaca in Chiapas.*
3. Ralph W. Schreiber, University of Maine. *Herring Gull Population Fluctuations in Penobscot County, Maine.*
4. Aaron M. Bagg, Dover, Massachusetts. *Factors Affecting the Occurrence of the Lapwing* (Vanellus vanellus) *in Eastern North America.*
5. Ralph W. Dexter, Kent State University. *Incursions of the Evening Grosbeak in Northeastern Ohio, 1860–1966.*
6. Maurice L. Giltz, Ohio Agriculture Research and Development Center. *Red-winged Blackbirds Disappear Over Lake Erie.*
7. David B. Peakall, Cornell Laboratory of Ornithology. *An Analysis of Nest Record Cards of the Bluebird.*
8. Charles M. Weise, University of Wisconsin–Milwaukee. *Castration and Spring Migration in the White-throated Sparrow.*
9. Deborah V. Howard, Massachusetts Audubon Society. *Variation in the Clutch-size and Breeding Season of the Robin* (Turdus migratorius) *in the Northeastern United States and the Maritime Provinces of Canada.*
10. Glen E. Woolfenden, University of South Florida, Tampa. *The Timing of the Remigial Molt in Loons.*
11. *The Status of Our Birds of Prey*—Symposium.
    Moderator: Roger Tory Peterson, Old Lyme, Connecticut.
    Accipiters: Heinz Meng, New Paltz State College.
    Broadwings: Joseph Archie Hagar, Marshfield Hills, Massachusetts.
    Golden Eagle: Walter Spofford, New York State University, Syracuse.
    Bald Eagle: Alexander Sprunt IV, Tavernier, Florida.
    Common Harrier: David Peakall, Cornell University, and Francis Hamerstrom, Waushara, Wisconsin.
    Kites: William Robertson, Everglades National Park.

Osprey: Roger Tory Peterson, Old Lyme, Connecticut, and Sergej Postupalsky, Detroit Audubon Society.

Peregrine: Joseph J. Hickey, University of Wisconsin.

Kestrel: John Haugh, Syracuse University.

Northern Raptores: Richard Fyfe, Sackville, New Brunswick.

Annual Hawk Counts at Hawk Mountain: Maurice Broun, Hawk Mountain Sanctuary.

Summarization: Roland Clement, National Audubon Society.

12. Maurice Broun, Hawk Mountain Sanctuary. *Can We Save Our Birds of Prey?*
13. Robert G. Wolk, Adelphi University. *Functional Morphology of the Eye and Bill of the Black Skimmer.*
14. Ralph W. Schreiber, University of Maine. *Herring Gull Roosting and Environmental Factors.*
15. Harold D. Mitchell, Buffalo Museum of Science. *Need for Banding Birds in Zoos and Aviaries.*
16. Lawrence I. Grinnell, Cornell Laboratory of Ornithology. *Bird Habitats of Venezuela.*
17. Douglas H. Morse, University of Maryland. *Post-fledging Activities of Some Wood Warblers.*
18. John L. George, The Pennsylvania State University. *Land Use Trends and Wildlife Populations.*

ATTENDANCE

Members and guests who registered totaled 187 persons. Twenty-three states, plus the District of Columbia, three Canadian provinces, and England were represented.

From **Arizona**: 1—*Phoenix*, Jacob B. Gier.

From **Colorado**: 2—*Denver*, Joseph Leonard Guarino, Donald M. Thatcher.

From **Connecticut**: 4—*Norwalk*, Roland C. Clement: *Old Lyme*, Dr. and Mrs. Roger Tory Peterson; *Ridgefield*, Albert Earl Gilbert.

From **Delaware**: 2—*Wilmington*, Mr. and Mrs. Rodman Ward.

From **Florida**: 1—*Tampa*, Glen E. Woolfenden.

From **Hawaii**: 1—*Honolulu*, Charles A. Ely.

From **Iowa**: 3—*Grinnell*, Helen T. Stewart, Mildred Stewart; *West Union*, Arlo J. Raim.

From **Maryland**: 11—*Baltimore*, Burton J. Alexander; *Bethesda*, Shirley A. Briggs; *Chestertown*, Mr. and Mrs. Edward Mendinhall; *College Park*, Robert H. Horwich; *Ellicott City*, Earl B. Baysinger; *Hillcrest Heights*, Jan Gunby Reese; *Laurel*, Chandler S. Robbins, William C. Russell; *Towson*, Mrs. R. D. Cole; *West Hyattsville*, Douglass H. Morse.

From **Massachusetts**: 7—*Amherst*, Lawrence M. Bartlett, Lillian Bartlett; *Dover*, Mr. and Mrs. Aaron M. Bagg; *Lincoln*, James Baird; *Marshfield Hills*, Joseph A. Hagar; *West Newton*, Deborah V. Howard.

From **Michigan**: 7—*Ann Arbor*, Mrs. Reuben L. Kahn, Harrison B. Tordoff; *Holland*, Eldon D. Greij; *Kalamazoo*, Jerome D. Robins; *Muskegon*, James Ponshair, George Wickstrom; *Royal Oak*, Sergej Postupalsky.

From **Minnesota**: 1—*Duluth*, Pershing B. Hofslund.

From **New Hampshire**: 1—*New Hampton*, Vera H. Hebert.

From **New Jersey**: 10—*Bridgeton*, Herbert E. Mills; *Jamesburg*, Mildred Miskimen, Jeff Swinebroad; *Morristown*, Jack Stewart, Robert Stewart; *Pennington*, Kenneth W. Prescott; *Piscataway*. Jon S. Greenlaw, Violet Greenlaw; *Tenafly*, Dr. and Mrs. Dean Amadon.

From **New York**: 22—*Allegany*, Stephen W. Eaton; *Buffalo*, Mr. and Mrs. Edward C. Ulrich; *Etna*, Sally F. Hoyt Spofford, Walter R. Spofford; *Far Rockaway*, John Bull; *Hamburg*, Mr. and Mrs. Fred T. Hall; *Hempstead*, Robert G. Wolk; *Ithaca*, Lawrence I. Grinnell, Dr. and Mrs. Olin Sewall Pettingill, Jr.; *Jamestown*, Lewis F. Kibler, Priscilla Kibler, Robert A. Sundell; *Liverpool*, David B. Peakall; *New Paltz*, Heinz Meng; *North Syracuse*, John R. Haugh; *Sayville*, V. N. Rimsky-Korsakoff; *Syracuse*, Margaret S. Rusk; *Williamsville*, Mr. and Mrs. Harold D. Mitchell.

From **Ohio**: 31—*Ashtabula*, Howard E. Blakeslee; *Athens*, Henri C. Seibert, Peter W. Whar; *Bowling Green*, Elden W. Martin, Stanton C. Southward; *Burton*, Robert McCullough; *Canfield*, Mr. and Mrs. G. William Richter; *Chardon*, Marjorie Ramisch; *Columbus*, Dr. and Mrs. Donald Borror, Maurice L. Giltz, Thomas C. Rambo, David I. Richard; *Delaware*, Dr. and Mrs. William D. Stull; *East Liverpool*, Mr. and Mrs. John T. Laitsch; *Gambier*, Robert D. Burns, E. Ray Heithaus; *Kent*, Dr. and Mrs. Ralph W. Dexter; *Lakewood*, William A. Klamm, Nancy Klamm; *Massillon*, Arnold Warren Fritz; *Oxford*, Curtis S. Adkisson; *Steubenville*, Mr. and Mrs. Clinton S. Banks; *Toledo*, John M. McCormick; *Wooster*, Ralph W. Schreiber; *Worthington*, L. S. Putnam.

From **Pennsylvania**: 48—*Allentown*, Donald S. Heintzelman; *Boyertown*, Samuel R. Rockey; *Butler*, Mr. and Mrs. F. W. Preston; *Chalfont*, Dorothy H. Noll, Edward M. Noll; *Chester Springs*, Phillips B. Street; *Coraopolis*, Earl C. Schriver, Jr.; *Dunmore*, Elizabeth A. Taft; *Harrisburg*, Mrs. Harold B. Wood; *Jonestown*, Fred E. Hartman; *Kempton*, Maurice Broun; *Lancaster*, Kenneth B. Corbett; *Lemont*, Frank W. Peak; *Mechanicsburg*, Winslow M. Shaughnessy; *Orwigsburg*, Dr. and Mrs. Franklin McCamey; *Philadelphia*, C. Chandler Ross; *Pittsburgh*, Carsten Ahrens, Mary Anne Heimerdinger, Kenneth C. Parkes; *Ridgeway*, Glenn R. Andrews, Sara Andrews; *Sheffield*, Charles A. Neel, Martha Neel; *Shippensburg*, Herbert Eugene Hays, Jr.; *State College*, Dorothy L. Bordner, Mrs. Earl R. Bordner, William Sloan Clarke, Jr., Ralph W. Condee, Arthur Joseph Crist, Haskell B. Curry, David E. Davis, Edwin C. Franks, Evelyn C. Franks, John L. George, Sam B. Guss, Leon J. Hue, James S. Lindzey, Mrs. Phillip B. Lovett, Marie McDonald, Helen C. Wood, Merrill Wood; *Trout Run*, Mr. and Mrs. Walter K. Bigger; *University Park*, Stephen L. Billeb; *West Chester*, Frank B. Moody; *West Reading*, Earl L. Poole.

From **South Carolina**: 2—*Chester*. Mrs. Clyde B. Carter, Mrs. W. Cornwell Stone.

From **South Dakota**: 2—*Watertown*, Dr. and Mrs. L. J. Moriarty.

From **Tennessee**: 1—*Maryville*, Ralph J. Zaenglein.

From **Vermont**: 1—*South Londonderry*, Mrs. James R. Downs.

From **Virginia**: 5—*Arlington*, Dr. and Mrs. Phillip S. Humphrey; *Ashburn*, Mrs. Herbert M. Church, Jr.; *Winchester*, Lee W. Braunschweig, Ralph Braunschweig.

From **West Virginia**: 8—*Kingwood*, Larry Schwab; *Morgantown*, Mr. and Mrs. Maurice Brooks, Dr. and Mrs. George A. Hall, Earl N. McCue, Robert Leo Smith; *St. Albans*, George F. Hurley.

From **Wisconsin**: 5—*Madison*, J. J. Hickey; *Milwaukee*, Daniel D. Berger, Charles M. Weise; *Viroqua*, Margarette E. Morse; *Waushara*, Frances Hamerstrom.

From **Washington, D.C.**: 2—Orville W. Crowder, Adrian C. Fox.

From **Manitoba, Canada**: 1—*Winnipeg*, Colleen Helgeson Nelson.

From **New Brunswick, Canada**: 1—*Sackville*, Richard William Fyfe.

From **Ontario, Canada**: 6—*Clarkson*, Dr. and Mrs. William W. H. Gunn; *Fort William*, Dr. and Mrs. A. E. Allin; *Hamilton*, Eric W. Bastin, James S. Pringle.

From **England**: 1—*Oxford*, Richard S. R. Fitter.

THE WILSON ORNITHOLOGICAL SOCIETY

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President	Aaron M. Bagg
First Vice-President	H. Lewis Batts, Jr.
Second Vice-President	William W. H. Gunn
Secretary	Pershing B. Hofslund
Treasurer	C. Chandler Ross
Editor	George A. Hall

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Bagg, Aaron Moore, Farm St., Dover, Mass. 02023	1948
Batts, H(enry) Lewis, Jr., 2315 Angling Rd., Kalamazoo, Mich. 49001	1946
Booth, Mrs. Robert V. D., 1085 Bank St., Painesville, Ohio 44077	1949
Carnes, Mrs. Herbert E., 11801 Sundown Ave., Scottsdale, Ariz. 85251	1944
Desmond, Thomas C(harles), Box 670, Newburgh, New York 12553	1942
Goelet, Robert G., 425 Park Ave., New York, N.Y. 10022	1953
Mills, Herbert H., Arrowhead Farms, R.F.D. 3, Bridgeton, N.J. 08302	1951
Peterson, Roger Tory, Neck Rd., Old Lyme, Conn. 06371	1942
Root, Oscar M(itchell), Brooks School, North Andover, Mass. 01845	1940
Speirs, Mrs. Doris Huestis, "Cobble Hill," R.R. 2, Pickering, Ont., Canada	1936
Stettenheim, Peter, U.S.D.A. Avian Anatomy Project, Dept. of Poultry Science, Michigan State Univ., East Lansing, Mich. 48823	1951
Stokes, Allen W., Dept. of Wildlife Management U.S.A.C., Logan, Utah 84321	1950
Stoner, Mrs. Lillian C., 399 State St., Albany, N.Y. 12210	1945
Strong, Reuben M.	Founder, Deceased
Swetland, David W., Daisy Hill, Chagrin Falls, Ohio 44022	1953
Tucker, Mrs. Carll, Penwood, Mt. Kisco, N.Y. 10549	1928
Van Tyne, Josselyn	Deceased

†Life Member *Sustaining Member Others—Active Members

Abbott, Waldo G., Museum of Natural History, Santa Barbara, Calif. 93101	1963
Able, Kenneth P(aul), 4106 Winchester Rd., Louisville, Ky. 40207	1965
Abraitys, Vincent, Sergeantsville, N.J. 08557	1956
Adams, C(lyde) Bruce, 40 Summit Rd., Riverside, Conn. 06878	1959
Adams, Heman P(urdy), 7 Highland Ave., Maplewood, N.J. 07040	1959
Adams, Mrs. L. T., Box 2124, Austin, Texas 78767	1965
Adams, William Hensley, Jr., 3904 Ivydale Dr., Annandale, Va. 22003	1951
Adelson, Richard Henry, Remsen's Lane, R.D. 1, Oyster Bay, L. I., N.Y. 11771	1938
Adkisson, Curtis S(amuel), Rt. 3, Morrilton, Ark. 72110	1963
Agey, H. Norton, 908 Ave. H, N.E., Winter Haven, Fla. 33880	1960
Ahlquist, Jon Edward, 2014 West 16 St., Ashtabula, Ohio 44005	1959
Aiholzer, John R., Jr., 4138 So. 51st St., Milwaukee, Wisc. 53220	1965
Aldrich, John Warren, 6324 Lakeview Drive, Falls Church, Va. 22041	1930
Alexander, Burton J(erome), 2712 Southern Ave., Baltimore, Md. 21214	1966
*Alexander, Donald C(hild), 16 Pleasant St., Nahant, Mass. 01908	1937
Alexander, Gordon, Dept. of Biology, Univ. of Colorado, Boulder, Colo. 80304	1936
Allen, Arthur W(esley), 561 Eastern Blvd., Watertown, N.Y. 13601	1959
Allen, Ted T(ipton), Dept. of Biology, Jacksonville Univ., Jacksonville, Fla. 32201	1958
†Allin, A(lbert) E(llis), Provincial Laboratory, Fort William, Ont., Canada	1943
Allyn, (Paul) Richard, 709 Myers Bldg., Springfield, Ill. 62706	1944
Almon, Lois, Miles College, Birmingham, Ala. 35064	1958
†Altemus, Edward Lee, Lafayette Ave., Fort Washington, Pa. 19034	1954
Altsheler, Mrs. Yancey R(oberts), 2412 Dundee Rd., Louisville, Ky. 40205	1954
Amadon, Dean, Am. Mus. of Natural History, Central Park West at 79th St., New York, N.Y. 10024	1935
†Ames, Peter L., 6 Washington Lane, Orinda, Calif. 94563	1963
Ammon, Walter L., 2607 Kessler, Midland, Texas 79702	1958
Anaka, William, Spirit Lake, Saskatchewan, Canada	1957
*Andersen, Elmer L(ee), 2230 W. Hoyt Ave., St. Paul, Minn. 55108	1965
Anderson, Bertin W(alter), Mus. of Natural History, Univ. of Minn., Minneapolis, Minn. 55455	1966
Anderson, Donald L., 4529 Spruce St., Philadelphia, Pa. 19139	1965
Anderson, Eugene N(ewton), Jr., Dept. of Anthropology, Kroeber Hall, Univ. of California, Berkeley, Calif. 94704	1964
Anderson, John M., R.R. 4, Winous Point Club, Box 359, Port Clinton, Ohio 43452	1938

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* Correct to 31 May 1966

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Anderson, R. K., Conservation Dept. Wisconsin State Univ., Stevens Point, Wisc. 54481 1962
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Anderson, William L(eno), 279 Natural Resources Bldg., Urbana, Ill. 61801 1965
Andrews, Glenn R(obert), 307 Cook Ave., Ridgeway, Pa. 15853 1966
†Annan, Ormsby, 744 Hinman Ave., Evanston, Ill. 60202 1956
Anthes, Clarence A(lvin), 707 North Moreland Blvd., Waukesha, Wisc. 53186 1939
Arbib, Robert S(imeon), Jr., 226 Guion Drive, Mamaroneck, N.Y. 10543 1947
Armington, Sven, Blanchegatan 18, Stockholm, Sweden 1948
Arner, Dale H., Mississippi State Univ., Dept. of Zoology, State College, Miss. 39762 1964
†Arnold, Elting, 4914 Dorset Ave., Chevy Chase, Md. 20015 1941
Arnold, Keith A(lan), 826 Steward Ave., Jackson, Mich. 49202 1960
Arny, Samuel A., 7608 Hamlet St., Springfield, Va. 22151 1947
Atkeson, Thomas Zephaniah, P.O. Box 1643, Decatur, Ala. 35602 1953
Austin, George T(rout), 6004 W. Washington Ave., Las Vegas, Nev. 89106 1966
Austin, Mrs. Harold C., 1116 Mandana Rd., Oakland, Calif. 94610 1950
Austin, Oliver L(uther), Jr., Florida State Museum, Gainesville, Fla. 32603 1930
Avent, Carrie Pillow, Minter City, Miss. 38944 1959
Axtell, Harold H., Buffalo Museum of Science, Humboldt Park, Buffalo, N.Y. 14211 1950

Babcock, Charles D., 127 Jefferson St., Cattaraugus, N.Y. 14719 1959
Bachmann, Gertrude, 3304 Cottonwood St., Rapid City, S.D. 57701 1965
Baepler, Donald H(enry), Dept. of Biology, Central Washington State College, Ellensburg, Wash. 98926 1955
Bailey, Alfred Marshall, Denver Museum of Natural History, City Park, Denver, Colo. 80206 1928
Bailey, Mrs. Harold H(arris), Rockbridge Alum Springs Biological Laboratory, Route 2, Goshen, Va. 24439 1963
Bailey, Karl D., 5275 Adams Rd., Bloomfield Hills, Mich. 48013 1963
Bailey, W. Wallace, Director, Wellfleet Bay Wildlife Sanctuary, Box 236, South Wellfleet, Mass. 02663 1959
Baillie, James Little, Royal Ontario Mus., Dept. of Ornithology, 100 Queen's Park, Toronto, Ont., Canada 1939
Baird, James, 69 Hartwell Ave., Littleton, Mass. 01460 1954
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Baker, John H(opkinson), 169 East 78 St., New York, N.Y. 10021 1930
Baker, Paul S(eaman), 502 Newport Ave., Williamsburg, Va. 23185 1946
Baker, Rollin Harold, The Museum, Michigan State Univ., East Lansing, Mich. 48823 1938
Baker, William C(alvin), 559 Euclid St., Salem, Ohio 44460 1931
Baldwin, Paul H., Dept. of Zoology, Colorado State Univ., Fort Collins, Colo. 80521 1956
Ball, Kathleen E., 11719 133rd St., Edmonton, Alberta, Canada 1946
Ball, W(illiam) Howard, 4322 Sheridan St., University Park, Hyattsville, Md. 20782 1961
Ballentine, George L., 268 Oakwood Rd., Charleston, W. Va. 25314 1963
Balson, Mrs. Amos Parker, 2209 E. Stratford Court, Milwaukee, Wisc. 53211 1949
Banks, Clinton S(eeger), 202 Wilma Ave., Steubenville, Ohio 43952 1945
Banks, Richard C(harles), Natural History Museum, P.O. Box 1390, San Diego, Calif. 92112 1959
Banta, Edna, R.R. 1, Nashville, Ind. 47448 1945
Barbour, Llewellyn, P(helps), 4780 Wood St., Willoughby, Ohio 44094 1948
Barker, Paul R(aymond), 18 Ridgeway, Ann Arbor, Mich. 48104 1962
Barlow, Jon Charles, Dept. of Ornithology, Royal Ontario Museum, 100 Queen's Park, Toronto 5, Ont., Canada 1959
†Bartel, Karl E(mil) Edgar, 2528 West Collins St., Blue Island, Ill. 60406 1934
Bartleson, Fred D(urant), Jr., H.Q. 315 Air Division, C.M.R. Box 1608, A.P.O. San Francisco, Calif. 96323 1952
Bartlett, Guy, 1053 Parkwood Blvd., Schenectady, N.Y. 12308 1938
†Bartlett, L(awrence) M(atthews), 83 Springs St., Amherst, Mass. 01002 1957
Bartlett, Wesley H., 122 South Ridgley Ave., Algona, Iowa 50511 1936

Barton, Roger, Mt. Salem Farm, R.D. 1, Pittstown, N.J. 08867 1960
Bartonek, James C., Dept. of Wildlife Mgmt., Univ. of Wisconsin, 226 Russel Labs., Madison, Wisc. 53706 1965
Bastin, Eric W(alter), 175 Catherine St. South, Apt. 55, Hamilton, Ont., Canada 1951
Batchelder, Edgar M(arden), 56 Orchard St., Marblehead, Mass. 01947 1941
Bauer, Kurt M(ax), Natural History Museum, P.O. Box 417, A 1014, Vienna, Austria 1966
†Baum, William W., 1257 Cranford Ave., Lakewood, Ohio 44107 1963
Baylor, L(eslie) M(ilton), Dept. of Languages, S.D. School of Mines, Rapid City, S.D. 57701 1954
Beardsley, M(argaret) Hortense, 330 North Chestnut St., Ravenna, Ohio 44266 1941
Bebb, Forrest, 1300 Boston Ave., Muskogee, Okla. 74401 1955
Beck, Robert E(dwin), Jr., Route 6, Hagerstown, Md. 21741 1964
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Beddall, Mrs. Barbara G(ould), 2502 Bronson Rd., Fairfield, Conn. 06431 1958
Beecher, William J(ohn), Chicago Academy of Sciences, 2001 North Clark St., Chicago, Ill. 60614 1948
Beer, James R(obert), Dept. of Ent., Fishery & Wildlife, Univ. of Minnesota, St. Paul, Minn. 55101 1957
†Behle, William H(arroun), Dept. of Biology, Univ. of Utah, Salt Lake City, Utah 84110 1935
Behrens, Harry Carl, Box 1055, Rapid City, S.D. 57702 1950
†Belcher, Paul Eugene, 230 Mineola Ave., Akron, Ohio 44313 1938
Belknap, John B(alcom), 92 Clinton St., Gouverneur, N.Y. 13642 1959
*Bell, Henry III, Dept. Geology, Univ. of North Carolina, Chapel Hill, N.C. 27515 1946
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Bell, Ralph K(ennedy), R.D. 1, Box 142, Clarksville, Pa. 15322 1963
Bellrose, Frank G., Jr., Illinois Natural History Survey, Havana, Ill. 62644 1963
Bender, Charles R(ichard), 364 Alex Hamilton, San Antonio, Texas 78228 1960
Bennett, Esther V(orena), 600 S. 33rd St., Lincoln, Neb. 68510 1954
Bennett, Holly Reed, 2457 Orchard St., Chicago, Ill. 60614 1949
Benson, Seth Bertram, 645 Coventry Rd., Berkeley, Calif. 94707 1930
Bent, Mrs. M. V., 275 Monroe Ave., Rochester, N.Y. 14607 1955
Benton, Allen H(aydon), Dept. of Biology, State College, Fredonia, N.Y. 14063 1953
†Berger, Andrew J(ohn), Dept. of Zoology, Univ. of Hawaii, Honolulu, Hawaii 96822 1940
Berger, Daniel D(avid), 510 E. MacArthur Rd., Milwaukee, Wisc. 53217 1953
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*Berkowitz, Albert Clarence, P.O. Box 1341, Des Moines, Iowa 50305 1946
Berrett, Delwyn Green, Box 1071, Laie, Oahu, Hawaii 96762 1959
Betts, Amelia J(eannette), Baldwin City, Kan. 66006 1953
Biaggi, Virgilio, Jr., College of Agriculture, Mayaguez, Puerto Rico, West Indies 00708 1945
†Bibbee, P. C., Dept. of Biology, Davis & Elkins College, Elkins, W. Va. 26241 1958
†Biddle, E. Turner, Leiters Ford, Ind. 46945 1960
Bierly, Michael L(ee), 3826 Bedford Ave., Nashville, Tenn. 37215 1966
Bigger, Walter K., Star Route, Trout Run, Pa. 17771 1963
Billeb, Stephen L., Dept. of Zoology, 212 Frear Laboratory, Pennsylvania State Univ., University Park, Pa. 16802 1962
Binford, L(aurie) C(harles), Museum of Zoology, Louisiana State Univ., Baton Rouge, La. 70803 1954
Birch, Robert Lee, Dept. of Biology, West Virginia Univ., Morgantown, W. Va. 26506 1950
Birkenholz, Dale E(ugene), Dept. of Biological Science, Illinois State Univ., Normal, Ill. 61761 1957
Bishop, Earl, Dept. of Botany, Univ. of Hawaii, 2550 Campus Rd., Honolulu, Hawaii 96822 1962
Black, Charles T(heodore), Route 1, Box 480, East Lansing, Mich. 48823 1935
Black, Gladys B., 608 DeWitt, Pleasantville, Iowa 50225 1963
Black, W. F., 16 Anworth Rd., Westmont, P.Q., Canada 1962
Blades, Herbert, 1708 West Gilpin Drive, Willow Run, Wilmington, Del. 19805 1962
Blake, Charles H(enry), P.O. Box 613, Hillsboro, N.C. 27278 1950

Blake, Emmet R., Chicago Natural History Museum, Roosevelt Rd. & Lake Shore Drive, Chicago, Ill. 60605 1939
Blakeslee, Howard E., 1722 East 45th St., Ashtabula, Ohio 44004 1959
Blakeslee, William P., 40 Montclair Ave., Roslindale, Mass. 02131 1965
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Blount, Elisabeth R(ose), 741 Ruiz St., San Antonio, Texas 78207 1961
Bock, Walter (Joseph), Dept. of Zoology, Columbia Univ., New York, N.Y. 10027 1953
Bodsworth, Fred, 294 Beech Ave., Toronto 13, Ont., Canada 1956
Bolen, Eric G(eorge), Texas A & I College, Kingsville, Texas 78363 1964
Bomm, Mrs. J. Henry, 674 Pascack Rd., Washington Twp., P.O. Westwood, N.J. 07675 1965
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Bond, Richard M(arshall), Kingshill, St. Croix, U.S. Virgin Islands 00850 1936
Bondi, Joseph, 349 North Fulton Ave., Mt. Vernon, N.Y. 10552 1960
Boone, George C., Biology Dept., Susquehanna Univ., Selinsgrove, Pa. 17870 1961
Bordley, James III, 13 Main St., Cooperstown, N.Y. 13326 1957
Bordner, Dorothy L., 926 West Beaver Ave., State College, Pa. 16801 1959
Borell, Adrey Edwin, Soil Conservation Service, 3140 Wadsworth Blvd., Denver, Colo. 80215 1936
†Borror, Donald J(oyce), Dept. of Zoology & Entomology, Ohio State Univ., Columbus, Ohio 43210 1927
†Boulton, Rudyerd, Box 8305 Causeway, Salisbury, South Rhodesia 1957
Bourdo, Eric Albert, Jr., Ford Forestry Center, L'Anse, Mich. 49946 1951
Bowman, Robert I., Dept. of Biology, San Francisco State College, 1600 Holloway Ave., San Francisco, Calif. 94132 1962
Boyd, Elizabeth M(argaret), Mount Holyoke College, South Hadley, Mass. 01075 1941
Boyd, Ivan L., Dept. of Biology, Baker Univ., Baldwin, Kan. 66006 1951
Brackbill, Hervey G(roff), 2620 Poplar Drive, Baltimore, Md. 21207 1942
*Bradburn, Donald Muir, 465 Audubon St., New Orleans, La. 70118 1950
Brady, Alan, Box 103, Wycombe, Pa. 18960 1959
Branch, Mrs. Margaret G(amble), 1324 Wells St., Ann Arbor, Mich. 48104 1952
Branum, Florence (Pauline), 727 Rutter Ave., Lancaster, Ohio 43130 1946
Brauner, Joseph, Apt. 19, 18645 Collins St., Tarzana, Calif. 91356 1942
Braunschweig, Mrs. Lee W(elsh), Box 514, Winchester, Va. 22601 1953
†Brecher, Leonard C(harles), 1900 Spring Drive, Louisville, Ky. 40205 1939
†Breckenridge, Walter J(ohn), Museum of Nat. History, Univ. of Minnesota, Minneapolis, Minn. 55414 1929
Breitweiser, Mrs. Alberta P(auline), 1002 Chestnut St., Anderson, Ind. 46012 1964
Brenner, Frederick J(ames), 214 South Oakland Ave., Sharon, Pa. 16147 1965
Brewer, Richard Dean, Dept. of Biology, Western Michigan Univ., Kalamazoo, Mich. 49007 1949
Brierley, Frances, 26 Crandall St., Adams, Mass. 01220 1963
Briggs, Shirley A(nn), 7605 Honeywell Lane, Bethesda, Md. 20014 1965
Brigham, Edward M(orris), Jr., Kingman Memorial Museum, Battle Creek, Mich. 49107 1931
Brigham, Edward M(orris) III, Box 125, Atlas, Mich. 48411 1960
Broadbooks, Harold E(ugene), Southern Illinois Univ., Alton Residence Center, Alton, Ill. 62002 1948
Brodkorb, Pierce, Dept. of Biology, University of Florida, Gainesville, Fla. 32603 1951
Brooke, Mrs. Margaret, 126 51st St., Des Moines, Iowa 50312 1958
†Brooks, Maurice Graham, Div. of Forestry, Morgantown, W. Va. 26506 1927
Brooks, William S(tewart), Dept. of Biochemistry, College of Med. Sciences, Univ. of Minnesota, Minneapolis, Minn. 55455 1966
Broun, Maurice, Route 1, New Ringgold, Pa. 17960 1935
Brown, Jerram L., Dept. of Biology, Univ. of Rochester, Rochester, N.Y. 14627 1950
Brown, John Warner, Oatka Farm, Scottsville, N.Y. 14546 1959
†Brown, Laurence A(llyn), Jr., 434 Marlborough St., Boston, Mass. 02115 1958
Brown, N(orman) Rae, Faculty of Forestry, Univ. of New Brunswick, Fredericton, N.B., Canada 1945
*Brown, Woodward H(art), 4815 Ingersoll Ave., Des Moines, Iowa 50312 1949

Browne, Micou M(etcalf), 2728 Cambridge Rd., Raleigh, N.C. 27608 1966
Brownstein, Richard, 41 Sargent Drive, Amherst, N.Y. 14226 1966
Bruce, James A(ddison), 565 Spring St., Wooster, Ohio 44691 1952
Bryan, Burton Donald, Box 2, Adamsville, R.I. 02801 1949
Bryant, Mrs. Paula S., 640 35th St., Sacramento, Calif. 95816 1957
*Bryens, Oscar McKinley, Route 1, White Pigeon, Mich. 49099 1924
Buchheister, Carl W., 1130 Fifth Ave., New York, N.Y. 10028 1943
Buckley, P(aul) A(nthony), Laboratory of Ornithology, Cornell Univ., Ithaca, N.Y. 14850 1966
†Bucknell, Donald N(eedham), 134 Wonham, Ingersoll, Ont., Canada 1953
Bull, John L., Dept. of Ornithology, Am. Mus. Nat. History, Central Park West at 79th St., New York, N.Y. 10024 1952
Burger, Joanna, State University College at Buffalo, 1300 Elmwood Ave., Buffalo, N.Y. 14222 1962
Burgett, Thomas Ray, R.F.D. 3, Rt. 534, Geneva, Ohio 44041 1966
Burk, Myrle M., R.R. 2, Waterloo, Iowa 50701 1960
Burnham, Gladys L(ou), Howard County Junior College, Big Spring, Texas 79720 1954
†Burns, James Henry, 800 Lowerline St., New Orleans, La. 70118 1942
Burns, R. K., Bridgewater College, Bridgewater, Va. 22812 1963
Burns, Robert David, Dept. of Biology, Kenyon College, Gambier, Ohio 43022 1948
Burr, Irving W(ingate), 1141 Glenway, West Lafayette, Ind. 47906 1945
Burrell, Helen E., 1523 Orchard Drive, Kalamazoo, Mich. 49002 1962
Burt, William Henry, Museum of Zoology, Univ. of Michigan, Ann Arbor, Mich. 48104 1928
Burtt, Benjamin P., 109 Haffenden Rd., Syracuse, N.Y. 13210 1956
Burtt, Harold E., 2163 North Starr Ave., Columbus, Ohio 43221 1953
Bushman, John, Desert Test Center, Ft. Douglas, Salt Lake City, Utah 84113 1951
Butsch, Robert Stearns, Exhibit Museum, Univ. of Michigan, Ann Arbor, Mich. 48104 1947
Byrd, Mitchell A(gee), Dept. of Biology, College of William and Mary, Williamsburg, Va. 23185 1965

Cadbury, Joseph M., 108 W. Phil-Ellena St., Philadelphia, Pa. 19118 1963
Cade, Tom, Dept. of Zoology, Syracuse Univ., Syracuse, N.Y. 13210 1950
Cahalane, Victor H(arrison), Derbyshire Rd., Clarksville, N.Y. 12041 1933
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Calef, Robert, 929 Woodlawn Park, Flint, Mich. 48503 1954
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Calvin, Robert L(eal), R.D. 3, Pulaski Rd., Newcastle, Pa. 16101 1951
Campbell, Louis W(alter), 4531 Walker Ave., Toledo, Ohio 43612 1926
Campbell, Marylyn F., R.R. 7, Box 423 K, Terre Haute, Ind. 47803 1964
Campbell, Mildred F(lorence), 29 North Hawthorne Lane, Indianapolis, Ind. 46219 1938
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Carpenter, Charles C., Dept. of Zoology, Univ. of Oklahoma, Norman, Okla. 73069 1951
Carpenter, Floyd S., 2402 Longest Ave., Louisville, Ky. 40204 1934
Carrick, W(illiam) H(enesey), Niska Waterfowl Research Station, R.R. 6, Guelph, Ont., Canada 1960
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Carson, L(enwood) B(allard), 1306 Lincoln St., Topeka, Kan. 66604 1948
Carter, Charles E(dward), 1339 30th St., Orlando, Fla. 32805 1958
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Censer, Mrs. Ruth B(landing), 12 Whitehall Rd., East Chester, N.Y. 10709 1966
†Chalif, Edward Louis, 37 Barnsdale Rd., Short Hills, N.J. 07078 1947

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Chamberlain, Dwight R., Draper's Meadow Terrace Apts., Apt. Q 12, Blacksburg, Va. 24060	1965
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Chapman, Blanche Hammond, 1325 So. 19th St., Birmingham, Ala. 35205	1953
Chapman, Herman Floraine, 712 South Dakota Ave., Sioux Falls, S.D. 57104	1947
Chase, Charles Greenough, Mere Place R.D., Brunswick, Me. 04011	1959
Chase, Theodore, Jr., 1618 Milvia St., Apt. 2, Berkeley, Calif. 94709	1960
Chilson, Herman P., 505 Main St., Webster, S.D. 57274	1965
Choate, Ernest A., Cape May Point, N.J. 08212	1954
Christie, David S., 13 Spruce St., Saint John, N.B., Canada	1962
Christy, James Edward, 9226 Phillips Ave., Chicago, Ill. 60617	1966
Church, Mrs. Herbert M., Jr., Janelia Farms, Ashburn, Va. 22011	1963
Clapp, Roger B., Research Curator, Pacific Program, Smithsonian Institution, Washington, D.C. 20560	1966
Clark, George A(lfred), Jr., Dept. of Zoology & Entomology, Univ. of Connecticut, Storrs, Conn. 06268	1955
Clark, George C(lifford), Toivo St., R.R. 2, Port Arthur, Ont., Canada	1961
Clark, Robert A., Lewis St., Petersham, Mass. 01366	1964
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Clement, Roland C(harles), Weed Ave., R.F.D., Norwalk, Conn. 06850	1941
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Clyde, E(dward) C(alvin), Jr., Box 495, Effingham, S.C. 29541	1963
Cochran, William W., 279 Natural Resources Bldg., Illinois Natural History Survey, Urbana, Ill. 61803	1964
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*Coffey, Lulu C(ooper), 672 N. Belvedere, Memphis, Tenn. 38107	1952
Coggeshall, Robert D., Chair Factory Rd., Elma, N.Y. 14059	1956
Cogswell, Howard L(yman), Dept. of Biological Science, California State College at Hayward, Hayward, Calif. 94542	1944
Cohn, Mrs. Jean W., 4787 Beaumont Drive, La Mesa, Calif. 92041	1954
†Cole, Mrs. Richard D., 625 Valley Lane, Towson, Md. 21204	1955
Cole, William W(alter), Jr., R.D. 3, Box 316, Apollo, Pa. 15613	1964
Collier, Gerald, Dept. of Zoology, San Diego State College, San Diego, Calif. 92115	1956
Collins, Charles T(hompson), Dept. of Zoology, Univ. of Florida, Gainesville, Fla. 32603	1959
Compton, Mrs. L. E., 2745 So. Genessee Rd., Waukesha, Wisc. 53186	1957
Compton, Lawrence Verlyn, Biology Division, Soil Conservation Service, Washington, D.C. 20251	1923
†Conboy, Mrs. John Williams, 417 Studebaker St., Mishawaka, Ind. 46544	1954
Condee, Ralph W., 443 East Waring Ave., State College, Pa. 16801	1966
Conn, Robert Carland, 755 Ross Lane, Bound Brook, N.J., 08805	1945
Conrad, Charles L(ouis), 137 North 11th St., Wheeling, W. Va. 26001	1937
Conway, C(harles) Abbott, R.R. 1, Puslinch, Ont., Canada	1962
Conway, Mrs. Isabella Anderson, R.R. 1, Puslinch, Ont., Canada	1962
Conway, William G., New York Zoological Park, 185th St. & Southern Blvd., New York, N.Y. 10460	1959
Cooper, Kenneth K(ing), Dunster Rd., Stanwood, Mount Kisco, N.Y. 10549	1958
Cope, James B(onwill), Earlham College, Richmond, Ind. 47374	1949
Coppinger, Raymond P., Chestnut Hill Rd., R.F.D., Montague, Mass. 01351	1964
Corbett, Kenneth B., 3129 Marietta Ave., Lancaster, Pa. 17601	1957
Cornwell, George W(illiam), Dept. of Forestry and Wildlife, Virginia Polytechnic Institute, Blacksburg, Va. 24061	1962
*Cors, Paul B(eaumont), 514 E. 23rd St., Cheyenne, Wyo. 82001	1952
*Cottam, Clarence, Welder Wildlife Foundation, P.O. Box 1396, Sinton, Texas 78387	1929
Cottrell, George William, Jr., Route 2, Hillsboro, N.H. 03244	1941
Cottrille, W. P., 6075 Brown's Lake, Jackson, Mich. 49203	1964
Cottrille, Mrs. W. Powell, 6075 Brown's Lake, Jackson, Mich. 49203	1950

Coutlee, Ellen L(orraine), Dept. of Zoology, Univ. of California, Los Angeles, Calif. 90024 1961
Cox, Geraldine H(ollon), Route 1, Box 26, Bayboro, N.C. 28515 1963
Coy, Roy E., St. Joseph Museum, St. Joseph, Mo. 64501 1953
Cracraft, Joel Lester, Museum of Zoology, Louisiana State Univ., Baton Rouge, La. 70803 1961
Craighead, William M., George School, Bucks County, Pa. 18940 1962
*Crawford, Alan, Jr., White Horse Rd., Devon, Pa. 19333 1949
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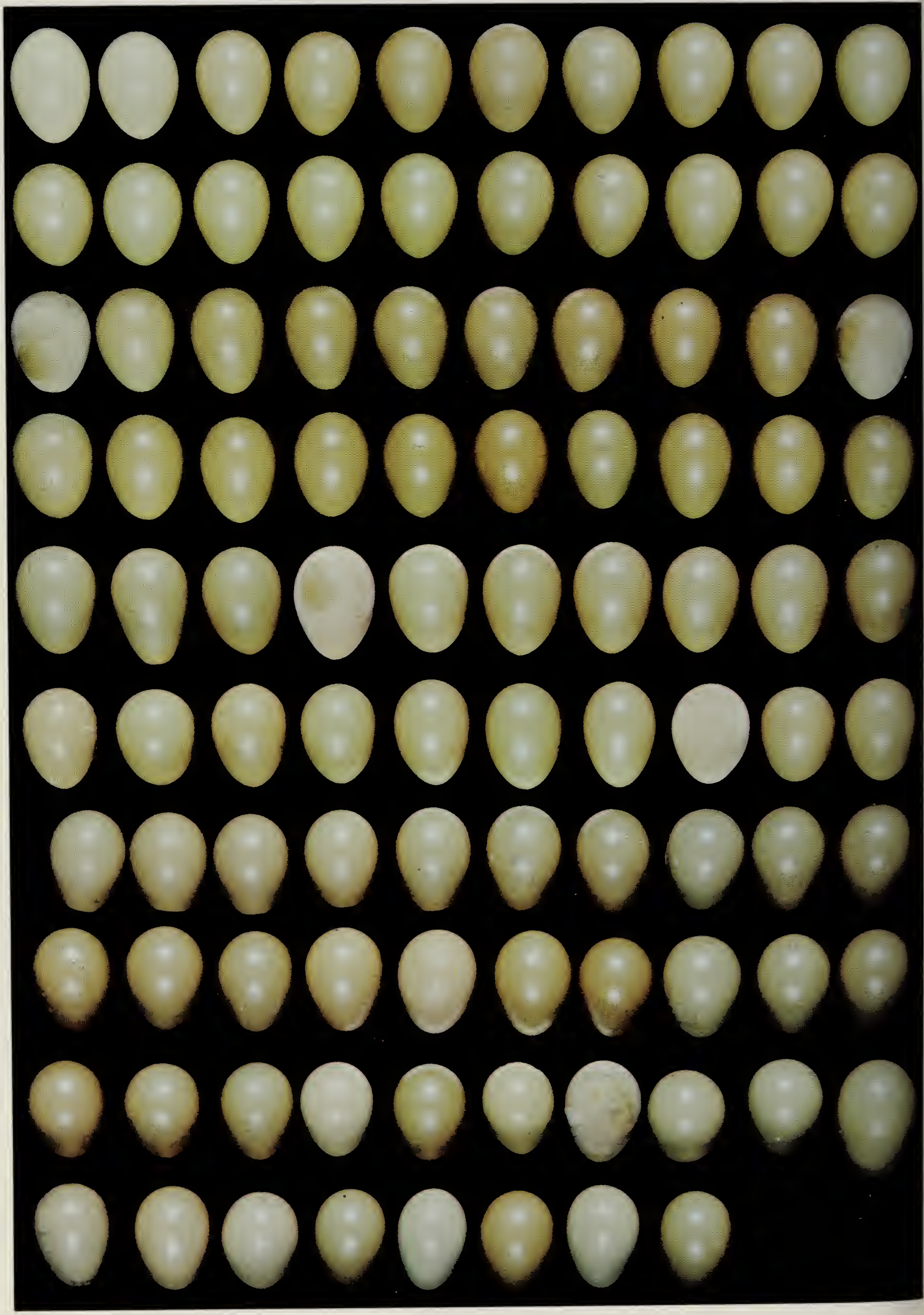

Plate 1

CHARACTERISTICS OF EGG-LAYING AND EGGS OF YEARLING PHEASANTS

Ronald F. Labisky and Gary L. Jackson

Among populations of wild pheasants (*Phasianus colchicus*) which have become established in the United States it is not uncommon for two or more females to deposit eggs in the same nest. These communal nests, commonly called "dump nests," may contain from 20 to 50 eggs (Baskett, 1947:10; Stokes, 1954:27; Dale, 1956:23). A communal nest is ordinarily identified as such by measuring the rate of egg deposition in the nest. It is impossible to determine whether two or more hens are laying in the same nest if the nest is not under surveillance during the egg-laying period.

Usually, dump nests are abandoned voluntarily by the hens; Stokes (1954:33) reported that less than 25 per cent of clutches of 20 eggs or more were incubated, whereas about 60 per cent of clutches containing between 5 and 16 eggs were incubated. Investigations of the nesting ecology of wild pheasants in east-central Illinois during 1957–61 revealed that 57 of 127 nests (45 per cent) that were voluntarily abandoned by the hen, or hens, and 37 of 133 nests (28 per cent) that had hatched, contained eggs of at least two distinctly different colors (R. F. Labisky, unpublished data). These findings of differently colored eggs in nests suggested to us that (1) communal laying might be a factor causing the abandonment of many nests other than the obvious dump nests and (2) two or more hens might be contributing to successful clutches that are normally attributed to single pheasant hens.

The objective of this research was to examine egg-laying and egg characteristics of pheasants, and to determine whether the stability of shell color or size of eggs (or both) laid by individual pheasants was a satisfactory criterion for identifying the number of hens contributing eggs to single nests in the wild.

METHODS

Nine pen-reared hen pheasants, approximately 10 months old, were obtained from the Illinois State Game Farm, Mt. Vernon, and transported to Urbana on 20 March 1964. These hens will be referred to as yearlings in this paper. The hens were held as a group in a large outdoor pen until they were individually caged, prior to the onset of laying, on 10 April. The individual cages, 51 × 56

←

PLATE 1. Shell color of 98 of the 107 eggs laid by hen 334 (Fig. 3), 1964. Eggs presented in the chronological order in which they were laid, with the first egg shown at the left of the top row. Eggs No. 52, 69, 88, 92, 98, 101, 104, 105 (third from last egg), and 107 (last egg) not photographed. This color plate sponsored by the Illinois Natural History Survey.

× 33 cm in size, were situated in an outdoor battery. Between 20 March and 9 April the hens were fed a ration of mixed grain, supplemented with oyster shells; prior to 20 March the hens had been fed a commercial maintenance ration. From 10 April through the conclusion of the experiment each hen was fed an exclusive diet of Purina Game Bird Layena and water ad libitum. The weight of the nine hens averaged 1,026 ± 23(SE)g on 27 April 1964.

The eggs were collected each evening and measured within 48 hours. All eggs were weighed on a Shadowgraph balance to the nearest 0.1 g and measured (maximum length and width) to the nearest 0.1 mm with vernier calipers. Shell color was determined by matching each egg with the most similar color as presented by Maerz and Paul (1950). All color determinations were made under uniform fluorescent lighting.

In discussing color according to the system of Maerz and Paul (1950), the following terms must be defined. *Hue* is the name of the color. *Purity* represents the amount of gray added to a color to reduce its reflective ability, i.e., as increasing amounts of gray are added, the color will approach black. *Strength* refers to the intensity of color; the full strength of a hue at each level of purity is reduced in strength (or neutralized) to no hue by adding increasing amounts of white or gray.

Maerz and Paul divided color, consistent with the spectrum, into seven major groups: red to orange; orange to yellow; yellow to green; green to blue-green; blue-green to blue; blue to red; and purple to red. Each group is represented by eight successive color plates. The first plate of each group is presented in full purity, whereas the following seven plates show decreasing purity, i.e., progressively increasing amounts of gray. Plates 1 through 8, for each major color group, reflected 86, 74, 67, 48, 38, 28, 20, and 10 per cent of light, respectively; the eight plates are numbered 9–16 for the orange to yellow group, 17–24 for the yellow to green group, and 25–32 for the green to blue-green group. Each plate is divided into 12 rows (numbered 1–12) and 12 columns (lettered A to L). Each group has a total of 23 analogous hues corresponding to the squares in the far right column (L) and in the bottom row (12); in the orange to yellow group, for example, the hues grade from orange in the lower left corner of the plate, to yellow-orange in the lower right corner, and to yellow in the upper right corner of the plate. Each hue, at a specific level of purity, is expressed in 12 degrees of strength, grading from full strength at the terminal position to no hue at the upper left corner of the plate. Thus, on the first plate of each group (full purity) the hues reduce to white (no hue), whereas on the other seven plates of the group the hues reduce to neutral grays (no hue). Each color group is, descriptively, a 3-dimensional color model.

In order to express eggshell color, we have described it according to the number, letter, and plate system of Maerz and Paul. The use of this system will allow the reader, with the aid of Maerz and Paul (1950), to observe the actual variations in shell color that occurred among the eggs. A numerical system was derived so that variations in shell color could also be expressed mathematically.

In this paper, the shell color of all eggs laid by each individual hen is presented in a 3-axis model, consisting of x, y, and z axes centered on a midpoint which represents the mean shell color. The x axis represents the horizontal variation (rows) and the y axis, the vertical variation (columns) in egg color according to the Maerz and Paul system; thus, both the x and y axes correspond essentially to strength of hues. The z axis represents variation from plate to plate of a particular color group, corresponding to purity. A fourth parameter, the c axis, is used to describe the variations in shell color of those eggs of individual hens that fell into two or more major color groups. All eggs laid by hens in this experiment were included within three major color groups: orange to yellow; yellow to green; and green to blue-green.

Our designation of egg color refers to any detectable color difference among different eggs, whether this difference be in hue, strength, purity, or color group.

RESULTS

The egg-laying cycle.—The few published findings on the reproductive physiology of the pheasant, an indeterminate egg-layer according to the criterion of Cole (1917:505), suggest that the mechanisms of ovulation and oviposition are similar, although not identical, to those of the domestic fowl (*Gallus gallus*). The reader is referred to Nalbandov (1959*a* and 1961) and Fraps (1961) for discussions of the physiological mechanisms controlling ovulation and oviposition in birds, particularly domestic fowl. The domestic hen, subjected to optimal photoperiods (12–14 hours of light), typically lays an egg on each of 2 or more consecutive days, does not lay on 1 day, and lays again on 2 or more consecutive days (Fraps, 1961:134). The egg, following ovulation, usually spends about 25–26 hours in the oviduct (mostly in the shell gland) prior to oviposition, and ovulation of the subsequent egg does not occur until 30–60 minutes after oviposition of the previous egg. Usually a hen does not ovulate after 3 PM. Thus, each day, ovulation among a series of consecutive eggs becomes successively later until a scheduled ovulation falls late in the afternoon and is held in abeyance, which accounts for failure of the hen to lay the next day (Nalbandov, 1958:116). In this paper, the number of eggs laid by a hen on consecutive days is termed a *sequence*, and the number of days between oviposition of the terminal egg in one sequence and the initial egg in the following sequence is termed a *lapse*.

The first egg of the laying season from the nine yearling pheasants studied at Urbana (Lat. 40°N) was laid between 7–10 April, the last on 24 August (Table 1). Kabat and Thompson (1963:121) reported that yearling hens confined in pens near Madison, Wisconsin (Lat. 43°N) commenced laying on 13 April in 1949. The initiation of egg-laying by yearling, or first-year, pheasant hens usually lags several days behind that of old, or adult, hens (Kabat and Thompson, 1963:121; Westerskov, 1956:56).

TABLE 1

CHARACTERISTICS OF EGG-LAYING OF NINE YEARLING PHEASANTS, URBANA, ILLINOIS, 1964

Hen	Date of		Total number of eggs laid	Days in laying period	Rate of laying		Sequences			Lapses		
							Total num-ber	Eggs per sequence		Total number	Days per lapse	
	First egg*	Last egg			Days per egg	Per cent		Mean	Range		Mean	Range
334	12 April	24 Aug.	107†	135	1.26	79	18	5.9	1–49	17	1.7	1–4
335	11 April	11 June	47	62	1.31	76	15	3.1	1–7	14	1.1	1–2
336	12 May	24 June	19	44	2.32	43	10	1.9	1–7	9	2.8	1–6
337	11 April	8 July	78	89	1.14	88	9	8.7	1–41	8	1.4	1–2
340	11 April	16 July	84	97	1.15	87	14	6.0	1–23	13	1.0	0
342	11 April	16 Aug.	104	128	1.23	81	22	4.7	1–11	21	1.1	1–3
343	12 April	8 July	65	88	1.35	74	22	3.0	1–7	21	1.1	1–2
344	13 April	24 July	88	103	1.17	85	14	6.3	1–24	13	1.2	1–2
345	18 April	24 June	43	68	1.58	63	21	2.1	1–5	20	1.3	1–3
Total			635	814			145			136		
Mean	16 April	11 July	70.6 (9.8)‡	90.4 (9.9)	1.28	78	16.1 (1.6)	4.4 (0.5)		15.1 (1.6)	1.3 (0.1)	

* Three eggs were laid by the nine hens between 7–10 April. The first egg of the season was laid on 5 April by a yearling hen not included in this experiment.

† Egg breakage occurred in the cage of hen 334; shell color was determined on only 102 eggs, shell measurements on 99 eggs, and weights on 98 eggs.

‡ Numbers in parentheses are standard errors of means.

Egg production by the nine yearlings averaged 70.6 eggs for the season, with extremes of 19 and 107 eggs; the laying period averaged 90.4 days in length, with extremes of 44 and 135 days (Table 1). These findings substantiated those of Westerskov (1956:77), who reported that 37 yearling Ring-necked Pheasants (*Phasianus colchicus torquatus*), confined at Ngongotha, New Zealand (Lat. 38°S) averaged 67.3 eggs during a single laying season. The age of the hen apparently affects egg production, as Kabat and Thompson (1963:121) and Westerskov (1956:77) observed yearling pheasant hens to lay fewer eggs than older hens. However, among domestic fowl, Romanoff and Romanoff (1941:11) reported that egg production is heaviest among pullets and then declines throughout the life of the hen. Evidence obtained by Buss, Meyer, and Kabat (1951:41) in Wisconsin indicated that wild pheasant hens often laid as many as 55 per season, and that hens from wild populations and from artificially propagated stock commenced laying at about the same time in April. Thus, the average pheasant hen in a wild population retains egg-laying capabilities for a period of at least 3 months each breeding season, which explains its persistent ability

TABLE 2

FREQUENCY OF SEQUENCES CONTAINING DIFFERENT NUMBERS OF EGGS LAID BY NINE YEARLING PHEASANTS, URBANA, ILLINOIS, 1964

Number of eggs per sequence	Frequency of sequences			Eggs contributed	
	Number	Per cent		Number	Per cent
1	42	29		42	7
2	23	16		46	7
3	23	16		69	11
4	16	11		64	10
5	14	10		70	11
6	5	3		30	5
7	6	4		42	7
8	2	1		16	3
9	2	1		18	3
10	3	2		30	5
11	2	1		22	3
12	1	<1	6	12	2
18	1	<1		18	3
19	1	<1		19	3
23	1	<1		23	4
24	1	<1		24	4
41	1	<1		41	6
49	1	<1		49	8
Total	145	100		635	102

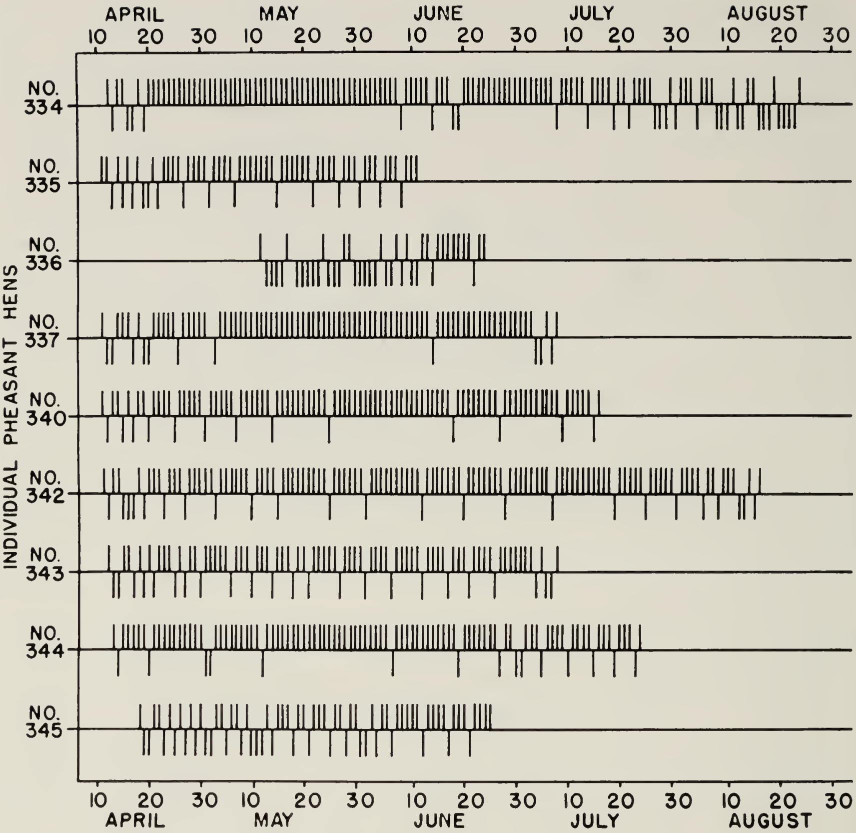

FIG. 1. Distribution of egg sequences and days of lapse during the complete seasonal laying cycle of nine yearling pheasants, 1964. Bars above the lines indicate number of eggs laid on consecutive days (sequence); bars below the lines indicate number of days "skipped" between successive eggs (lapse).

to renest following the disruption of one or more previously established, but not hatched, nests (Seubert, 1952; Warnock and Joselyn, 1964).

The seasonal rate of laying for the nine hens ranged from a low of 43 per cent (2.32 days per egg) to a high of 88 per cent (1.14 days per egg), and averaged 78 per cent (1.28 days per egg) (Table 1). A similar mean rate of laying among captive pheasants, 1.3 days per egg, was reported by Buss et al. (1951:35). Greeley (1962:188) also found a rate of laying of 1.3 days per egg among pheasants on diets containing at least 2 per cent calcium; Greeley's study was terminated on 5 June, prior to the end of the laying season. Monthly rates of laying for the yearlings in this study averaged 70 per cent in April, 81 per cent in May, 84 per cent in June, 78 per cent in July, and 58 per cent in August. The occurrence of the best rates of laying, in May and June, coincided well with the major period of nest establishment of wild pheasants in east-central Illinois (R. F. Labisky, unpublished data).

The numbers of sequences of eggs laid by the nine yearlings averaged 16.1, with an average of 4.4 eggs per sequence (Table 1). The longest sequence contained 49 eggs. Sequences containing 1 to 5 eggs comprised 81 per cent of all sequences and contributed 46 per cent of all eggs (Table 2).

The average lapse between successive sequences was 1.3 days, with extremes of 1 and 6 days (Table 1). Single-day lapses comprised 81 per cent of all lapses. Hen 340 exhibited single-day lapses throughout her laying period (Fig. 1). Many of the deviations from single-day lapses, particularly for certain hens, occurred either early or late in the egg-laying period.

An egg-laying *rhythm* comprised of irregular sequences and irregular lapses was most common, occurring among eight of the nine hens; sequences were characteristically longer than lapses (Fig. 1). The egg laying of hen 340 was, however, characterized by irregular sequences and regular lapses (single-day lapses). The long sequences of hens 334 and 337, 49 and 41 eggs, respectively, indicated that successive ovulations occurred regularly at approximately 24-hour intervals. The variability of rhythm between sequences and lapses for these young hens evinces an irregularity in timing of successive ovulations which may be associated with all pheasant hens, or associated predominantly with yearling hens, or may be caused by the experimental conditions.

Eggshell characteristics and color.—Shell color of bird eggs, the physiology of which is largely under genetic control, is due to a combination of porphyrins and bile pigments; the bile pigments (biliverdin and bilirubin) arise as products of the catabolism of the porphyrin of hemoglobin. The red-brown pigment of the eggshell is oöporphyrin (protoporphyrin), which is present in the brown eggshells of domestic fowl and in the eggshells of many other species, including the pheasant (*Phasianus* [*colchicus*] *torquatus*) and some passerine birds (Fisher and Kögl, 1923:261; Völker, 1942:279). Oöcyan, a blue or blue-green pigment considered identical to biliverdin, has been extracted from the eggshells of gulls and other wild birds (Lemberg, 1931:90). Tixier (1945:631) extracted two bilin pigments from the green egg of the Emu (*Dromiceius novaehollandiae*); one pigment was biliverdin (or oöcyan), and the other very likely bilirubin.

According to the classic concept of the mechanisms of eggshell coloration, the bile pigments are transported by the blood to the uterus (shell gland), from which they are excreted by glands of the uterine mucosa into the lumen of

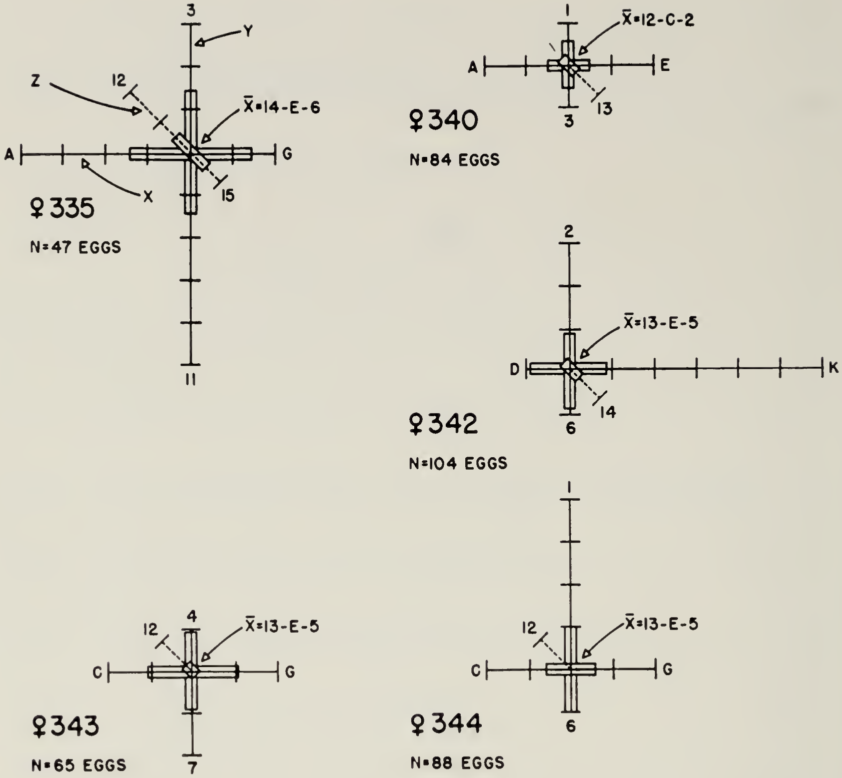

Fig. 2. Individual variations in shell color of eggs laid by yearling pheasants, 1964. Shell color of all eggs fall within the orange to yellow color group. Means, ranges, and standard deviations (open bars) are expressed in units corresponding to Maerz and Paul (1950): *z* axis corresponds to plate numbers, *y* axis to columns on plates, and *x* axis to rows on plates. Example: mean shell color for 47 eggs of hen 335 is 14-E-6, which refers to Plate 14 (28 per cent light reflection), column E, and row 6 in the orange to yellow color group.

the uterus and are deposited on the eggshell (Romanoff and Romanoff, 1949: 227). This hemoglobin degradation cycle has not been proved. nor does it explain the presence of porphyrins in the shell (Polin. 1957:278). Polin (1957:277) reported that the uterus of the domestic hen was capable of forming porphyrins in vitro from delta-aminolevulenic acid, a known intermediate in porphyrin synthesis. He also found that uterine tissue from domestic hens that laid white eggs was as capable of in vitro porphyrin synthesis as the uterine tissue from hens that laid brown eggs. Polin (1957:278) thus suggested that eggshell color might be more dependent on the amount of

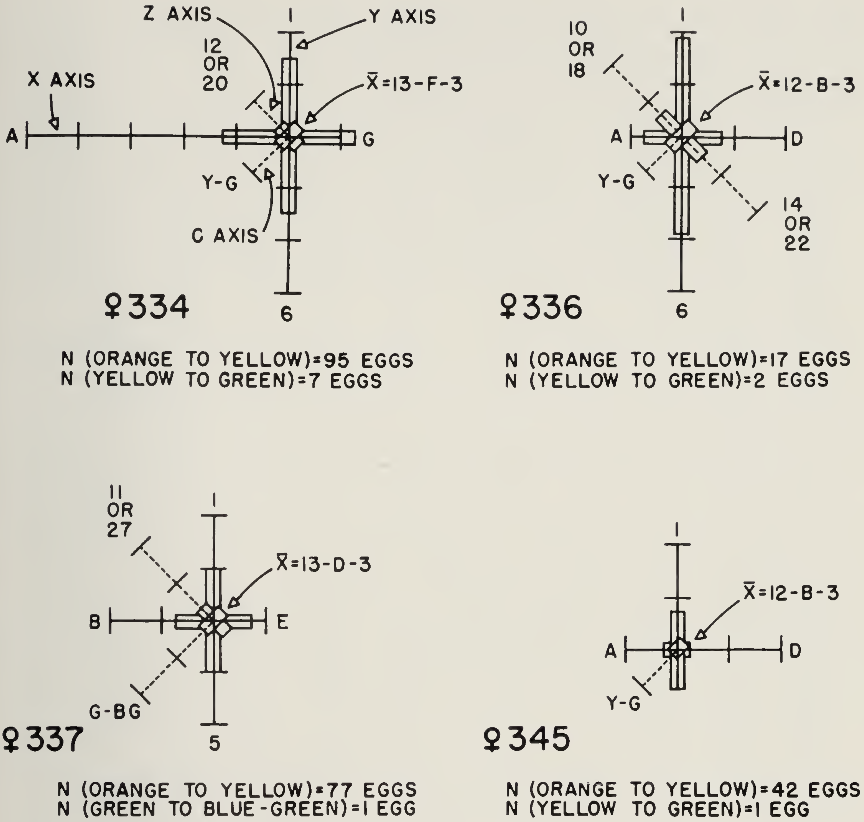

FIG. 3. Individual variations in shell color of eggs laid by yearling pheasants, 1964. Shell color of eggs of each hen is distributed between two color groups; the mean shell color for each hen falls within the orange to yellow color group. Means, ranges, and standard deviations (open bars) are expressed in units corresponding to Maerz and Paul (1950). *c* axis corresponds to color groups, *z* axis to plate numbers, *y* axis to columns on plates, and *x* axis to rows on plates. Example: mean shell color for 102 eggs of hen 334 is 13-F-3, which refers to Plate 13 (38 per cent light reflection), column F, and row 3 in the orange to yellow color group. See Plate 1 (frontispiece) for color photograph of eggs of hen 334.

aminolevulenic acid in the system of the hen than on the porphyrin-synthesizing ability of the uterus.

Among the nine yearling pheasants, eggshell color was found to be a variable characteristic among eggs laid by individual hens as well as among eggs laid by different hens (Plate 1 and Figs. 2 and 3). Shell color was most variable among eggs laid by hens 334 and 336 and least variable among eggs laid by hen 340. Typically, the coloration of eggshells of pheasants consisted of a ground color without superficial markings (Plate 1), although occasional flecks of color, differing from the ground color, appeared on some eggs, particularly at the small end. Most of the eggs laid by these young hens were characterized by shells of a "smooth," glossy texture, indicating the presence of a uniformly deposited cuticle on the shell. However, five of the eggs laid by hen 334, all members of a 49-egg sequence, possessed shells with a rough or sandy texture (Plate 1). The penultimate egg in the 49-egg sequence of hen 334 was soft-shelled; this hen also laid a second soft-shelled egg near the completion of laying.

Among the 630 pheasant eggs for which shell color was determined, 619 (98 per cent) were confined to the orange to yellow color group, 10 to the yellow to green group, and 1 to the green to blue-green group. Shell color of the eggs laid by five of the nine hens remained exclusively within the yellow to orange color group (Fig. 2). No hens laid eggs whose shell color fell into more than two color groups (Fig. 3, c axis). Even among those hens whose eggs fell into two color groups, the majority of the eggshells were contained within the orange to yellow color group. One hen (not included in this experiment) laid eggs whose shell color was confined exclusively to the green to blue-green color group. The shell color of eggs laid by wild pheasants is probably most commonly, though not exclusively, associated with the orange to yellow color group.

The color values along the x and y axes (Figs. 2 and 3) yielded a combined measure of hue, and its strength; hue represented the pigment responsible for eggshell "color" within any specific color group. The mean values of the x and y axes for the 630 eggs were represented by E and 4, respectively, which revealed that hue was expressed at about 75 per cent of full strength.

Purity of color, along the z axis, measured the concentration of the eggshell pigment in terms of reflected light. Among the 630 eggs, 422 (67 per cent) and 161 eggs (26 per cent) were grouped at levels of purity with light-reflecting capabilities of 38 and 48 per cent, respectively.

Changes occurred in the shell color of eggs laid throughout the laying cycle, but were most obvious at the beginning and end of laying (Fig. 4). The shells of the first two, perhaps three, eggs were "lighter" in color than sub-

→

FIG. 4. Comparisons of shell color, irrespective of color group, of the first five and last five eggs (N = 9) with interim eggs (N = 540) laid by nine yearling pheasants, 1964. The x and y axes represent hue, and its strength, and the z axis represents purity. Eggshell colors become "darker" as the unit values of all axes increase. Horizontal lines indicate means; vertical lines, ranges; and open bars, standard deviations.

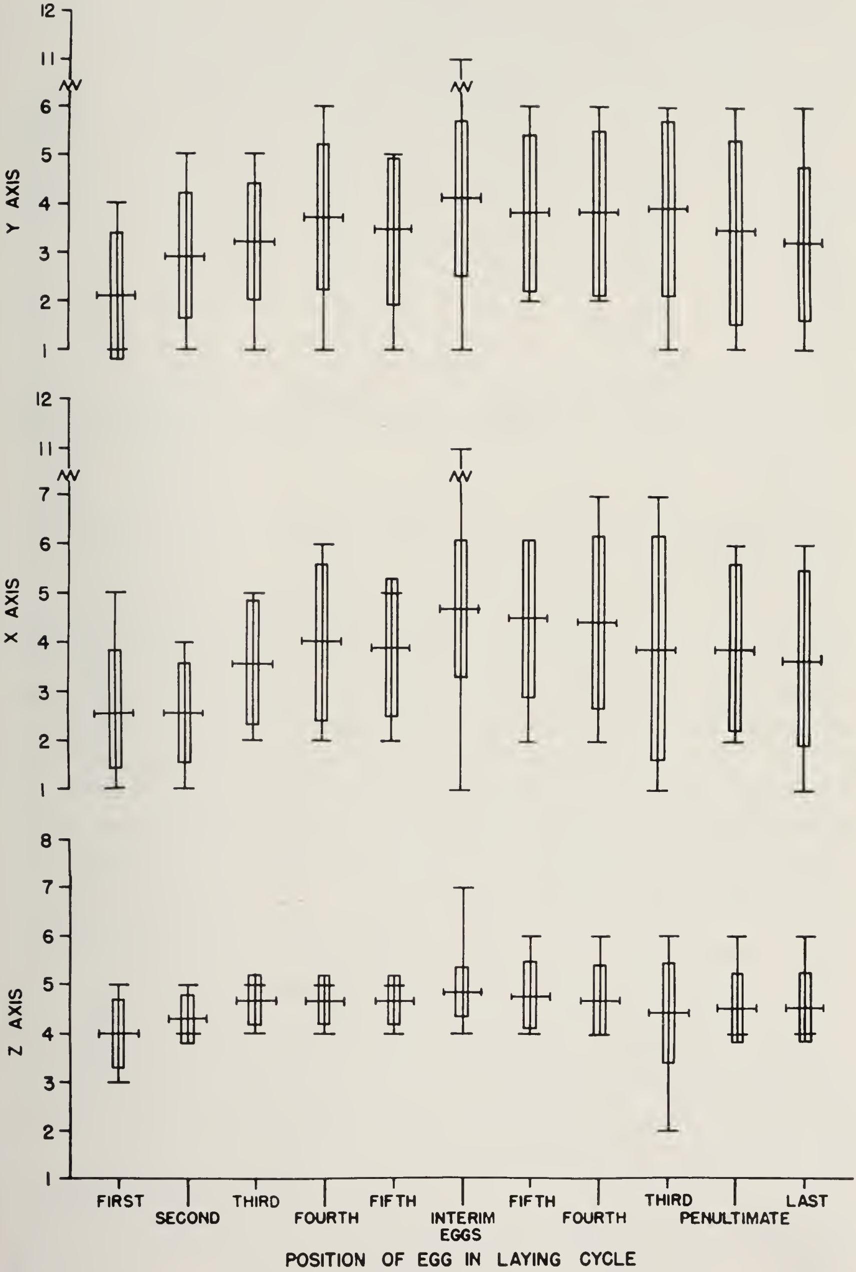
Y AXIS
X AXIS
Z AXIS
12
11
6
5
4
3
2
1
12
11
7
6
5
4
3
2
1
8
7
6
5
4
3
2
1
FIRST
SECOND
THIRD
FOURTH
FIFTH
INTERIM EGGS
FIFTH
FOURTH
THIRD
PENULTIMATE
LAST
POSITION OF EGG IN LAYING CYCLE

TABLE 3
FREQUENCY OF OCCURRENCE OF EGGS WITH IDENTICAL SHELL COLOR LAID SUCCESSIVELY BY NINE YEARLING PHEASANTS DURING THEIR LAYING CYCLES, 1964

Hen	Occurrence of groups of consecutively laid eggs of identical shell color*											Total number of eggs laid
	Number of eggs per group											
	1	2	3	4	5	6	7	8	9	10	11+	
334	55	7	3	1	0	0	0	0	0	0	1†	102
335	24	7	3	0	0	0	0	0	0	0	0	47
336	10	3	1	0	0	0	0	0	0	0	0	19
337	31	8	6	2	1	0	0	0	0	0	0	78
340	34	8	1	3	0	0	0	0	1	1	0	84
342	52	12	3	3	0	0	1	0	0	0	0	104
343	29	7	3	2	1	0	0	0	0	0	0	65
344	38	15	3	0	1	1	0	0	0	0	0	88
345	12	5	2	0	1	0	0	0	0	1	0	43
Total eggs	285	144	75	44	20	6	7	0	9	20	20	630
Per cent	45.2	22.9	11.9	6.9	3.2	1.0	1.1	0.0	1.4	3.2	3.2	100.0

* Irrespective of sequences
† 20 eggs in group.

sequent eggs. In contrast, domestic pullets produced their darkest eggs at the onset of laying (Axelsson, 1932:164). Also, the last two or three eggs laid by yearling pheasant hens were slightly "lighter" in color than the preceding eggs, exclusive of the first two or three eggs of the cycle. There was some evidence that a sufficient degree of variability existed in the shell color of the third from the last egg in the laying cycle to render it a positional indicator marking the approaching end of laying. Much of the overall variability in shell color of eggs laid by individual hens was attributed to variations in shell color that occurred early and late in the laying cycle.

There was no stability of shell color among eggs of sequences, regardless of the number of eggs per sequence. In fact, among all sequences of two or more eggs (Table 2), eggs of identical color were recorded for only four two-egg sequences, two three-egg sequences, and one ten-egg sequence.

Axelsson (1932:190) reported that domestic hens laid eggs with darker shells immediately following a pause in laying or during periods of infrequent laying. These characteristics of pigment deposition were not detectable among the eggs laid by yearling pheasants.

An examination of the shell color of eggs laid consecutively by the yearlings, irrespective of sequences, indicated that it was most unlikely that the hens could lay a clutch of 9–12 eggs (normally expected in wild populations; Stokes, 1954:27) of identical color (Table 3). Only three of the nine yearlings could

TABLE 4

WEIGHTS (G) OF EGGS LAID BY NINE YEARLING PHEASANTS, 1964

Hen	Number of eggs	Mean weight (g)*	Standard deviation (g)	Standard error (g)	Coefficient of variation (per cent)
334	98	23.9	2.0	0.2	8.5
335	47	26.9	1.7	0.8	6.5
336	19	21.0	4.1	0.9	19.7
337	78	25.6	1.3	0.1	4.9
340	84	27.3	0.9	0.1	3.3
342	104	29.7	1.5	0.2	5.1
343	65	30.3	1.1	0.1	3.5
344	88	28.1	1.6	0.2	5.7
345	43	28.8	1.3	0.2	4.4
Total	626	27.3	2.9	0.1	10.5

* An analysis of variance of the differences among mean weights of eggs laid by individual hens yielded an *F* value of 163.76, which was statistically significant at the 0.01 level of probability; the reference *F* was 2.55 at 8 and 617 df.

have possibly, but not probably, deposited nine or more eggs of the same color in a nest during the laying season. Thus, because of its instability, shell color among eggs laid by individual hens (at least yearling hens) cannot be considered a reliable criterion for identifying the number of hens contributing to single nests in the wild.

The effect of environmental exposure on eggshell color was measured by placing 12 eggs of various known colors in each of four nests, two of which were placed in shaded sites and two in sites exposed directly to the sun. Shell color of these eggs was redetermined after periods of 10 and 20 days of natural exposure during June and July, 1964. Changes in shell color were negligible among eggs exposed in shaded sites. Shell color faded among eggs exposed directly to the sun, i.e., color was reduced in strength of hue and in purity; the fading of shell color was greater after 20 days than after 10 days of exposure and greater among the darker-colored than among the lighter-colored eggs. These findings suggest that shell color measured from eggs exposed in nests of birds in the wild may not be representative of true eggshell color.

Egg weights and dimensions.—The weights of eggs laid by individual yearlings were relatively stable, but statistically significant differences occurred among the mean weights of eggs laid by different hens (Table 4). There was no correlation between the total number and the mean weight of eggs laid by individual hens.

The mean weight of 626 eggs laid by the yearling pheasants was 27.3 g (Table 4). The heaviest egg recorded was 33.5 g and the lightest, 5.4 g; the latter egg did not contain a yolk. Romanoff and Romanoff (1949:62) re-

TABLE 5

COMPARISON OF THE MEAN WEIGHTS (G) OF THE FIRST TEN EGGS LAID WITH ALL SUBSEQUENT EGGS, AND OF THE LAST TEN EGGS LAID WITH THE INTERIM EGGS. ALL EGGS LAID BY YEARLING PHEASANTS, 1964

Hen	Number of eggs	(μ_1) Mean weight of eggs 1–10	(μ_2) Mean weight of subsequent eggs	Test of significance: $\mu_1 < \mu_2$*	(μ_1') Mean weight of last 10 eggs	(μ_2') Mean weight of interim eggs†	Test of significance: $\mu_1' < \mu_2'$*
334	98	24.3	23.9	ns	22.9	24.0	ns
335	47	24.3	27.6	s	28.2	27.3	ns
337	78	24.3	25.8	s	24.9	26.0	s
340	84	26.7	27.4	s	27.3	27.4	ns
342	104	26.3	30.1	s	30.3	30.1	ns
343	65	29.4	30.5	s	30.3	30.6	ns
344	88	24.8	28.5	s	29.4	28.3	ns
345	43	27.4	29.3	s	29.8	29.1	ns

* Data tested by a one-tailed *t* test; s indicates statistical significance and ns indicates the lack of significance at the 0.05 level of probability.

† Interim eggs include all eggs except the first ten and last ten eggs laid by individual hens.

ported 32 g as a characteristic egg weight for pheasants, but did not specify the age or strain of the hens. Westerskov (1956:96) reported that 66 fresh eggs from a stock of pure Ring-necked Pheasants (*P. c. torquatus*) at the Urbana Game Farm, Ohio, averaged 32.1 g. Westerskov (1956:90) also found that among *P. c. torquatus* hens, artificially propagated in New Zealand, first-year breeders (yearlings) laid heavier eggs (32.9 g) than second-year breeders (31.0 g); the reverse was true among "Black-necked" Pheasants (*Phasianus c. colchicus*). The egg weights of pheasants recorded in this study are about 4–5 g per egg less than those reported by other workers. The influence of the small cages used to house the pheasants in this experiment seems inadequate to explain the smaller eggs, as Bailey, Quisenberry, and Taylor (1959:568) found that individually caged chickens produced heavier eggs than did floor-housed birds. Very likely, the reported differences in egg weights can be attributed to the genetic variability of the various stocks of pheasants.

In chickens, the first few eggs that a pullet lays are normally smaller than those laid subsequently in the laying period (Romanoff and Romanoff, 1949:73). The weights of eggs produced by the pheasants in this study followed a similar pattern. Among seven of eight hens (hen 336 excluded because of small sample), the mean weights of the first ten eggs of the laying period were significantly less than the mean weights of the eggs laid subsequently (Table 5). The mean weights of the last ten eggs were significantly less than the mean weights of the interim eggs for only one of the eight hens; in four hens, the mean weights of the terminal ten eggs were greater than those of the

TABLE 6

COMPARISON OF MEAN WEIGHTS (G) OF EGGS RELATIVE TO THEIR POSITION IN SEQUENCES OF ONE TO SIX EGGS. ALL EGGS LAID BY YEARLING PHEASANTS, 1964

Number of eggs in sequence	Number of sequences	Position of egg in sequence						Test of significance*
		1	2	3	4	5	6	
1	41	25.6						
2	21	26.7	26.8					$t = 1.06$ ns
3	21	28.2	28.1	28.0				$F = < 1$ ns
4	14	28.8	29.7	28.9	28.8			$F = < 1$ ns
5	13	27.4	27.6	27.5	27.8	27.2		$F = < 1$ ns
6	5	27.7	28.7	29.0	28.0	27.6	27.7	$F = < 1$ ns

* Test level was at 0.05 level of probability; ns indicates the lack of statistical significance.

interim eggs (Table 5). (Interim eggs include all eggs except the first ten and last ten laid by a hen.) Thus, among yearling pheasants, eggs apparently do not decrease in weight toward the end of the laying period.

Bennion and Warren (1933:363) concluded that in chickens, the first egg in a sequence was usually the largest, and that weights of succeeding eggs in the sequence decreased progressively. However, Tyler and Geake (1961:275) found this conclusion to be only partially applicable among two- and three-egg sequences, and not at all applicable among four- and five-egg sequences. In the Japanese Quail (*Coturnix c. japonica*), the first egg of the sequence was usually smaller, but not significantly so, than subsequent eggs (Woodard and Wilson, 1963:545). Kendeigh, Kramer, and Hamerstrom (1956:46) reported that the first egg of the clutch of the House Wren (*Troglodytes aedon*) was the smallest, but that a gradual increase in weight occurred among subsequent eggs of the clutch. Westerskov (1956:91) found that the first egg was lightest in clutches containing 12 or more pheasant eggs, and that each of the first six or seven eggs laid tended to be heavier than the preceding egg.

In this study, there were no significant differences in the mean weights of eggs at different positions in the sequences (Table 6). However, in the two-, four-, five-, and six-egg sequences, the first egg was lighter than the second egg.

There was no significant difference in the mean weight of eggs from sequences of different lengths laid by the yearling hens (Table 7), nor was there any apparent linear relationship between length of sequence and mean weight of eggs. This lack of relationship between sequence length and egg weight also exists in chickens (Tyler and Geake, 1961:275). However, in the House Wren, larger clutches contained heavier eggs (Kendeigh et al., 1956:64).

Mean width and mean length of 627 eggs laid by the yearling pheasants were 34.0 mm and 43.4 mm, respectively (Table 8). Romanoff and Romanoff

TABLE 7

MEAN ADJUSTED WEIGHTS (G) OF EGGS AS RELATED TO THE NUMBER OF EGGS PER SEQUENCE.* ALL EGGS LAID BY YEARLING PHEASANTS, 1964

Number of eggs per sequence	Number of sequences	Mean adjusted weights (g)†
1	41	20.0
2	21	20.2
3	21	20.1
4	14	20.6
5	13	20.7
6	5	21.3
7	6	21.4
8	2	21.8
9	2	21.1
10	3	20.7
11	2	21.2
12	1	21.5
19	1	20.8
23	1	21.0
24	1	21.0
41	1	21.5

* Weights were adjusted to eliminate bias among sequences of certain lengths that were not randomly distributed among the hens.

† An analysis of variance of the differences in the mean adjusted weights of eggs among different sequences yielded an *F* value of 1.16, which was not statistically significant at the 0.05 level of probability; the reference *F* was 1.67 at 15 and 528 df.

(1949:106) reported 35 × 44 mm as average dimensions for eggs from pheasants for which age and strain were not given. Westerskov (1956:90) reported that among *P. c. torquatus* hens, the eggs laid by first-year breeders averaged 35.8 × 45.9 mm, being very slightly larger than those laid by second-year breeders; however, among *P. c. colchicus* stock, yearling hens laid slightly smaller eggs than second-year hens. Both age and genetic constitution apparently influence egg size.

Although the variability among widths and among lengths of eggs laid by the yearlings was not great, statistically significant differences did exist among the mean widths and among the mean lengths of eggs laid by different hens (Table 8). In pheasants, as in domestic fowl (Romanoff and Romanoff. 1949:91), egg width was less variable than egg length.

Among the yearling pheasants, the first few eggs of the laying cycle were generally smaller than subsequent eggs. In seven of eight hens (hen 336 excluded because of small sample), either the mean width or the mean length of the first ten eggs laid was significantly less than of all subsequent eggs (Table 9). In three hens, both the mean width and mean length of the first ten eggs were significantly less than in subsequent eggs.

TABLE 8

MEAN MAXIMUM WIDTH (MM) AND MEAN MAXIMUM LENGTH (MM) OF EGGS LAID BY NINE YEARLING PHEASANTS, 1964

Hen	Number of eggs	Width (mm)				Length (mm)			
		Mean*	Standard deviation	Standard error	Coefficient of variation (per cent)	Mean*	Standard deviation	Standard error	Coefficient of variation (per cent)
334	99	32.6	0.97	0.10	3.0	45.5	1.57	0.16	3.4
335	47	33.9	0.74	0.11	2.2	42.4	1.33	0.19	3.1
336	19	30.9	3.12	0.72	10.1	38.7	4.25	0.97	11.0
337	78	33.6	1.15	0.13	3.4	42.0	1.03	0.01	2.5
340	84	33.9	0.37	0.04	1.1	44.0	0.88	0.10	2.0
342	104	34.8	0.53	0.05	1.5	45.5	1.56	0.15	3.4
343	65	35.4	0.49	0.06	1.4	44.3	0.82	0.10	1.9
344	88	34.7	0.62	0.06	1.8	42.9	1.21	0.13	2.8
345	43	34.7	0.63	0.10	1.8	44.7	1.05	0.16	2.3
Total	627	34.0	1.42	0.06	4.2	43.4	2.03	0.08	4.7

* An analysis of variance of the differences among mean diameters and among mean lengths of eggs laid by individual hens yielded *F* values of 126.03 and 80.90, respectively, which were statistically significant at the 0.01 level of probability; the reference *F* was 2.51 at 8 and 618 df.

A comparison of the three measurements of pheasant egg-size—weight, width, and length—revealed that egg-weight had the greatest coefficient of variation (10.5 per cent) and egg-width the lowest coefficient of variation (4.2 per cent). Yet, even variability among egg-widths was of sufficient magnitude to preclude egg-width as a criterion for accurately identifying the eggs laid by different yearling hens.

TABLE 9

COMPARISON OF MEAN MAXIMUM WIDTHS (MM) AND LENGTHS (MM) OF FIRST TEN EGGS LAID WITH ALL SUBSEQUENT EGGS LAID BY YEARLING PHEASANTS, 1964

Hen	(μ_1) Mean diameter of eggs 1–10	(μ_2) Mean width of subsequent eggs	Test of significance: $\mu_1 < \mu_2$*	(μ_1') Mean length of eggs 1–10	(μ_2') Mean length of subsequent eggs	Test of significance: $\mu_1' < \mu_2'$*
334	32.5	32.2	ns	42.9	42.5	ns
335	33.0	34.1	s	41.0	42.8	s
337	33.2	33.6	ns	41.1	42.2	s
340	34.1	33.9	ns	43.3	44.1	s
342	33.6	34.9	s	43.2	45.8	s
343	35.0	35.5	s	44.0	44.4	ns
344	33.9	34.9	s	41.0	43.2	s
345	34.0	34.9	s	44.8	44.7	ns

* Data tested by a one-tailed *t* test; s indicates statistical significance and ns indicates the lack of significance at the 0.05 level of probability.

DISCUSSION

Pheasants are "long-day" breeders, that is, their breeding activity is initiated by increasing photoperiods (Bissonnette and Csech, 1936:109). Among cock pheasants, the increasing day-length in spring causes a gradual rise in the gonadotrophin content of the pituitary, which is accompanied by an increase in testis weights and the attainment of spermatogenesis (Greeley and Meyer, 1953:353–354). Hen pheasants also show a gradual physiological achievement of full reproductive capacity in spring, but lag about a month behind cocks in attaining complete gametogenesis (Hiatt and Fisher, 1947: 538, 543).

Among domestic pullets, an increase in the size of the yolk (or ovum) is paralleled by an increase in total egg weight; the greatest gains in yolk size occur among eggs laid at the beginning of the laying season, after which time yolk size stabilizes (Romanoff and Romanoff, 1949:117–118). Assuming a parallelism between pheasants and pullets, the smallness of the first several eggs laid by yearling pheasants at the onset of laying, in contrast to eggs laid later in the cycle, may be partially the result of small yolks. Because the pituitary gonadotrophins, which govern follicular growth and ovulation among avian species (Nalbandov, 1958:117), strongly influence the size of the ova, we speculate that the gonadotrophins of yearling pheasants do not attain a level of maximum effectiveness until several eggs have been laid.

It seems plausible that the anatomical and glandular development of the oviduct, being dependent on estrogens, and progesterone or androgen (Nalbandov, 1959*b*:531), is also a gradual process. We postulate for yearling pheasants that the oviduct functions at a submaximal level at the time of the first ovulation in spring, and that it functions maximally only after the hen has experienced several ovulations. This postulate would serve to explain the gradual change from the lighter-colored eggs laid by yearling pheasant hens early in the laying cycle to the darker-colored eggs laid after the oviduct, particularly the shell gland, becomes "experienced." Apparently the secretory function of the shell gland of the oviduct of pheasants diminishes slightly near the termination of laying, i.e., onset of the refractory period, as evidenced by the reappearance of eggs with lighter-colored shells. That "inexperienced" oviducts, as well as small yolk sizes, may also contribute to the small size of the first several eggs laid by yearling pheasants is evidenced by our observations that eggs did not decrease in size at the end of the laying cycle.

SUMMARY

Egg production by nine yearling pheasants, maintained in captivity in 1964, averaged 70.6 eggs for the laying season, with extremes of 19 and 107; the laying season averaged 90.4 days in length, with extremes of 44 and 135. Rate of laying averaged 1.28 days per

egg per hen. The number of eggs laid by a hen on consecutive days (sequence) averaged 4.4. The lapse between successive sequences averaged 1.3 days; single-day lapses comprised 81 per cent of all lapses.

Shell color, a variable characteristic of eggs laid by and among individual hens, was confined predominantly to the orange to yellow color group. At least the first and last three eggs laid by yearling hens exhibited a "lighter" shell color than did the interim eggs.

The mean weight of eggs laid by yearling hens was 27.3 g, with average dimensions of 34.0 × 43.4 mm. Although the variability among weights and dimensions of eggs laid by individual hens was not great, significant variability in size did occur among eggs laid by different hens. Generally, the first ten eggs laid by yearlings were significantly smaller than subsequent eggs.

The variability in weight, width, length, and shell color of eggs laid by yearling pheasants was great enough to render these criteria insufficient for reliably segregating eggs laid by different hens in single nests in the wild.

The seasonal pattern of variations in shell color and size of eggs laid by yearling pheasants suggested that the level (or balance) of pituitary gonadotrophins and the function of the oviducts are submaximal at the time of first ovulation and that they become maximal only after the hens have experienced several ovulations.

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WEATHER AND LATE SPRING MIGRATION OF BIRDS INTO SOUTHERN ONTARIO

W. John Richardson

Many studies of the correlations between bird migration and various aspects of weather have been published. These were reviewed by Lack (1960*b*). Recent North American authors believe that spring migration occurs with following winds (Bagg et al., 1950; Raynor, 1956; Graber and Cochran, 1960; Drury and Keith, 1962). Major spring influxes of migrants usually occur with high pressure areas to the east and/or low pressure areas to the west (Bagg et al., op. cit.). No recent study has proposed that barometric pressure, per se, has an important influence on migration (Lack, 1960*b*). It is generally believed that light winds are more favorable to migration than are strong winds (Lack, 1960*a*, *b*). Major waves of vernal migrants usually move through after the passage of a warm front and they usually stop migrating when they encounter a cold front (Bagg et al., op. cit.: Raynor, op. cit.). Temperature has been considered by some, especially in Europe, to have a great deal of influence on the timing of migration. Heavy cloud or rain is commonly believed to reduce the volume of migration (Lack, 1960*a*, *b*).

The present paper is an analysis of the late spring migrations into southern Ontario in the years 1961, 1962 and 1963.

METHODS

It is generally accepted that late spring influxes are less dependent on warm weather with southerly winds than are earlier ones (Bagg et al., op. cit.: Lack, 1960*a*). Thus the period of study was restricted to the months of May in 1961 and 1963 and to the period of 24 April to 24 May, 1962. The 1962 period was advanced by one week because a major wave of late spring migrants arrived unusually early, but in weather conditions similar to those which were prevalent on most other days with major waves.

The flights recorded in southern Ontario were assumed to have originated south of Lakes Erie and Ontario. Accordingly, correlations were made with the weather conditions both in Ontario and south of the lower Great Lakes.

Selection of data.—All of the meteorological data used were taken from the U.S. Weather Bureau daily surface maps. The data used included the temperature, dew point, wind direction, wind velocity and cloud cover at 0100 EST at Toronto, Ontario and the means of these at Cleveland, Ohio, Columbus, Ohio, and Pittsburgh, Pennsylvania. Areas of rain and locations of pressure systems and fronts at 0100 were noted. Since most late spring migrants move at night, the conveniently obtained 0100 conditions were considered suitable.

The averages of the 0100 wind directions at Cleveland, Columbus, Pittsburgh and Toronto were placed into 3 categories. Winds between SSE and WSW were classified as *following*. Those between WNW through N to ESE were *opposing*. Winds between WNW and WSW and between ESE and SSE were called *side* winds. These categories were decided upon after consideration of the flight directions of nocturnal migrants during May near Hamilton, Ontario, as revealed by my lunar observations. In some cases, the combined category *not following* was used for side and opposing winds.

When considering humidity, the number of degrees in the difference between the actual temperature and the dew point temperature was taken as a reflection of relative humidity. A small difference indicates a high relative humidity. While not exact, this measure is convenient and reasonably accurate within the fairly narrow range of temperatures present during the period of study.

Ornithological data were assembled from the spring migration reports in *Audubon Field Notes* (August issues) and from those in the Federation of Ontario Naturalists' *Bulletin* and in its successor, *The Ontario Naturalist* (Sept. issues). In addition, my observations of nocturnal migrants passing in front of the moon (5 nights during the period of study; 19 in May of 1964 and 1965) and the results of a daily census made in 1962 were used.

Each day was classified as type A, a major-wave day; type B, a minor-wave day; or type C, a little-movement day. This was done by assigning numbers of points to stations in Ontario south of latitude 46°30′ which made regular observations of migration. The number of points assigned varied from 0 for reports of no movement to 5 for very heavy movement. Points were not assigned for concentrations of migrants believed to be grounded. The totals were weighted by doubling the number of points assigned to Long Point and Point Pelee. These two stations were better studied and the extent of migration was, because of concentration effects, considered easier to estimate accurately there. Days with a total of 20 or more points were type A, of 10 to 19, type B and of 0 to 9, type C.

Of the 93 days studied, there were 14 type-A days (7, 13, and 14 May, 1961; 28 and 29 April, 1962; 5, 6, 13, 14, 15, 16, 17, and 19 May, 1962; 9 May, 1963), 7 type-B days (1 and 28 May, 1961; 26, 27, and 30 April, 1962; 18 May, 1962; 3 May, 1963), and 72 type-C days.

It was recognized that the diurnal observations which exerted the dominant influence on the classification of days as A, B, or C might not give a true idea of the volume of migration. In particular, grounded waves of migrants might be mistaken for onrushing waves and migrants, especially nocturnal ones, might pass over undetected. However, in view of the good results of others who used diurnal data (Bagg et al., op. cit.; Raynor, op. cit.), the classical wave pattern obtained, and the agreement between lunar and diurnal observations, useful results were expected. In the present study, major waves were isolated satisfactorily, but very few minor waves were recorded. Since lunar observations show some movement almost every hour of observation, many minor waves must have been missed. Since the averages of weather parameters on type-B days are based on only 7 days' data, they are not considered to be very reliable. This paper considers primarily the differing relationships between type-A days, type-C days, and the weather.

TABLE 1

MIGRATION CORRELATED WITH AIR MASSES, WIND, FRONTS, AND RAIN

0100 weather conditions in southern Ontario	Days weather present	No. days weather at left and various types migration expected together if no correlation (± standard deviation)*		
		Type A	Type B	Type C
H to E	39	5.9 ± 1.9	2.9 ± 1.3	30 ± 4.2
H to E; wind following	27	4.1 ± 1.7	2.0 ± 1.2	21 ± 3.9
H to E; wind not following	12	1.8 ± 1.3	0.90 ± 0.89	9.3 ± 2.9
L to W	28	4.2 ± 1.7	2.1 ± 1.2	22 ± 3.9
L to W; wind following	21	3.2 ± 1.6	1.6 ± 1.1	16 ± 3.6
L to W; wind not following	7	1.1 ± 0.99	0.53 ± 0.70	5.4 ± 2.2
H to E; L to W	23	3.5 ± 1.6	1.7 ± 1.1	18 ± 3.7
H to E; L to W; wind following	17	2.6 ± 1.5	1.3 ± 1.0	13 ± 3.3
H. to E; L to W; wind not following	6	0.90 ± 0.92	0.45 ± 0.65	4.6 ± 2.1
H to E and/or L to W	44	6.6 ± 1.9	3.3 ± 1.3	34 ± 4.2
H to E and/or L to W; wind following	31	4.7 ± 1.8	2.3 ± 1.3	24 ± 4.0
H to E and/or L to W; wind not following	13	2.0 ± 1.3	0.98 ± 0.92	10 ± 2.9
Neither H to E nor L to W	49	7.4 ± 1.9	3.7 ± 1.3	38 ± 4.2
Neither H to E nor L to W; wind following	1	0.15 ± 0.39	0.08 ± 0.27	0.76 ± 0.88
Neither H to E nor L to W; wind not following	48	7.2 ± 1.9	3.6 ± 1.3	37 ± 4.2
Following winds	25	3.8 ± 1.7	1.9 ± 1.2	19 ± 3.8
Side winds	25	3.8 ± 1.7	1.9 ± 1.2	19 ± 3.8
Opposing winds	41	6.2 ± 1.9	3.1 ± 1.3	32 ± 4.2
Calm winds	2	0.30 ± 0.54	0.15 ± 0.38	1.6 ± 1.2
Cold front to S or E	28	4.2 ± 1.7	2.1 ± 1.2	22 ± 3.9
Cold front to N or W	30	4.5 ± 1.8	2.3 ± 1.2	23 ± 4.0
No cold fronts near	35	5.3 ± 1.8	2.6 ± 1.3	27 ± 4.1
Warm front to S or W	6	0.90 ± 0.92	0.45 ± 0.65	4.6 ± 2.1
Warm front to N or E	20	3.0 ± 1.5	1.5 ± 1.1	16 ± 3.5
No warm fronts near	67	10 ± 1.7	5.0 ± 1.2	52 ± 3.8
Warm sector	15	2.3 ± 1.4	1.1 ± 0.97	12 ± 3.1
Rain present	25	3.8 ± 1.7	1.9 ± 1.2	19 ± 3.8

* See "Methods" for explanation.

† The symbols + and − indicate positive and negative correlations between the type of weather at the left and the type of migration at the top of the column. IS, S, and HS indicate insignificant ($P > 0.05$), significant ($0.05 \geqslant P > 0.003$), and highly significant ($P \leqslant 0.003$) correlations.

TABLE 1 (*cont.*)

	Days weather and various types migration occurred together*			Occurred-expected difference as a multiple of the standard deviation*			Significance of difference between observed and expected numbers of days†		
	A	B	C	A	B	C	A	B	C
H to E	13	6	20	3.9	2.4	–2.4	+HS	+S	–S
H to E; wind following	12	5	10	4.7	2.5	–3.5	+HS	+S	–HS
H to E; wind not following	1	1	10	–0.64	–0.10	0.25	–IS	–IS	+IS
L to W	12	4	12	4.5	1.6	–2.5	+HS	+IS	–S
L to W; wind following	12	3	6	5.6	1.3	–2.9	+HS	+IS	–S
L to W; wind not following	0	1	6	–1.1	0.68	0.26	–IS	+IS	+IS
H to E; L to W	11	4	8	4.7	2.0	–2.7	+HS	+IS	–S
H to E; L to W; wind following	11	3	3	5.8	1.7	–3.2	+HS	+IS	–S
H to E; L to W; wind not following	0	1	5	–0.98	0.84	0.17	–IS	+IS	+IS
H to E and/or L to W	14	6	24	4.0	2.0	–2.4	+HS	+S	–S
H to E and/or L to W; wind following	13	5	13	4.7	2.1	–2.8	+HS	+S	–S
H to E and/or L to W; wind not following	1	1	11	–0.75	0.02	0.32	–IS	+IS	+IS
Neither H to E nor L to W	0	1	48	–4.0	–2.0	2.4	–HS	–S	+S
Neither H to E nor L to W; wind following	0	1	0	–0.39	3.4	–0.89	–IS	+IS	–IS
Neither H to E nor L to W; wind not following	0	0	48	–3.9	–2.7	2.6	–HS	–S	+S
Following winds	12	6	7	5.0	3.5	–3.3	+HS	+HS	–S
Side winds	2	0	23	–1.1	–1.6	0.96	–IS	–IS	+IS
Opposing winds	0	1	40	–3.3	–1.6	2.0	–HS	–IS	+S
Calm winds	0	0	2	–0.56	–0.39	0.37	–IS	–IS	+IS
Cold front to S or E	0	0	28	–2.5	–1.8	1.6	–S	–IS	+IS
Cold front to N or W	12	5	13	4.3	2.2	–2.6	+HS	+S	–S
No cold fronts near	2	2	31	–1.8	–0.50	0.95	–IS	–IS	+IS
Warm front to S or W	2	0	4	1.2	–0.70	–0.31	+IS	–IS	–IS
Warm front to N or E	10	4	6	4.5	2.3	–2.7	+HS	+S	–S
No warm fronts near	2	3	62	–4.8	–1.7	2.7	–HS	–IS	+S
Warm sector	9	3	3	4.9	1.9	–2.8	+HS	+IS	–S
Rain present	1	2	22	–1.7	0.10	0.69	–IS	+IS	+IS

Methods of analysis.—Factors such as different categories of wind direction and the presence of pressure systems and fronts in various positions were considered using the method outlined by Raynor (op. cit.). In this method, the number of days on which a specific type of migration (A, B, or C) and a specific weather condition occurred together is compared with the number of days on which both that type of migration and that weather condition would be expected to occur together if there were no correlation between the volume of migration and that weather factor. In each test, the quantity,

TABLE 2

MEANS OF NUMERICAL WEATHER PARAMETERS WITH VARIOUS TYPES OF DAYS

Weather parameter at 0100 EST	Arithmetic mean ± standard deviation				Significance of A–C difference
	Type-A days (major wave)	Type-B days (minor wave)	Type-C days (little mig.)	All days together	
Units: F.					
Temperature—Toronto	58.8±7.1	53.0±9.5	47.2±7.0	49.2±8.6	HS
Temperature—South of Lake Erie	64.3±4.1	54.1±8.4	50.8±8.2	53.0±8.9	HS
Temperature—Dew point interval—Toronto	7.6±5.6	12.3±6.0	8.6±5.0	8.8±5.3	IS
Temperature—Dew point interval—South of Lake Erie	9.6±4.0	10.1±3.5	8.2±4.4	8.5±4.3	IS
Temperature—Dew point interval increase over day before—Toronto	–5.2±7.9	-0.14±7.0	0.89±5.4	0.01±6.3	HS
Temperature—Dew point interval increase over day before—South of Lake Erie	–1.6±4.1	0.14±3.7	0.15±5.9	-0.08±5.5	IS
Units: Knots					
Wind velocity—Toronto	5.8±3.3	6.7±5.5	7.2±4.5	6.9±4.5	IS
Wind velocity—South of Lake Erie (Cleveland, Columbus, Pittsburgh)	5.9±2.6	4.3±1.8	6.7±2.6	6.4±2.6	IS
Units: Tenths of sky					
Cloud cover—Southern Ontario	3.8±4.0	4.1±4.4	4.6±4.3	4.5±4.3	IS
Cloud cover—South of Lake Erie	4.2±3.7	2.0±3.6	4.9±4.3	4.6±4.2	IS
Low and medium cloud cover—Southern Ontario	2.6±4.1	2.7±4.3	2.7±4.0	2.7±4.0	IS
Low and medium cloud cover—South of Lake Erie	0.77±1.8	0.00±0.0	2.8±4.0	2.3±3.7	IS

IS = insignificant (< 95% confidence level); HS = highly significant (⩾ 99.7% confidence level).

$\frac{\text{observed less expected number of days}}{\text{standard dev. of expected number of days}}$ was compared with a table of values of *t* to establish the degree of significance of the observed-expected difference. The smaller the number of days used, the larger the observed-expected difference to standard deviation ratio must be to be significant at any confidence level. In practice, when dealing with the over 30 days, the correlation is significant (at the 95 per cent confidence level) when the observed-expected difference is twice the standard deviation and highly significant (99.7 per cent level) when the difference is three times the standard deviation. These data appear in Table 1.

A second method of analysis was used for numerical parameters such as temperatures, fractions of the sky cloud covered, and wind velocities. The arithmetic means of each parameter for all types of days together and for each type of day singly were calculated. The differences between the means of

TABLE 3

MEANS OF NUMERICAL WEATHER PARAMETERS FOR THE BEGINNING AND END OF A MAJOR MIGRATORY WAVE

	Arithmetic mean ± standard deviation			
Weather parameter at 0100 EST	All days together	1st Type-A day of wave	Day before 1st Type-A day of wave	Day after last Type-A day of wave
Units: F				
Temperature—Toronto	49.2±8.6	56.6±5.8	52.2±10.2	52.8±8.1
Temperature—South of Lake Erie (Cleveland, Columbus, Pittsburgh)	53.0±8.9	63.4±4.8	56.4±3.7	60.7±5.9
Temperature increase over day before—Toronto	0.29±8.6	4.4±8.6	6.0±8.8	–4.8±4.4
Temperature increase over day before—South of Lake Erie	–0.01±8.4*	7.0±5.8	8.0±6.3	–3.5±4.4
Temperature—Dew point interval increase over day before—Toronto	0.01±6.3	–9.4±8.1	2.8±5.1	0.33±4.3
Temperature—Dew point interval increase over day before—South of Lake Erie	–0.08±5.5	–2.6±5.4	0.67±3.7	–2.7±4.9
Units: Knots				
Wind velocity—Toronto	7.0±4.5	7.0±4.0	6.7±3.1	5.8±1.9
Wind velocity—South of Lake Erie	6.4±2.6	8.2±2.0	6.7±2.6	6.3±2.3
Units: Tenths of Sky				
Cloud cover—Southern Ontario	4.5±4.3	4.2±4.7	2.2±3.6	5.2±4.3
Cloud cover—South of Lake Erie	4.6±4.2	5.0±3.3	5.0±3.9	4.3±4.4
Low and medium cloud cover—Southern Ontario	2.7±4.0	4.0±4.9	1.7±2.9	2.8±4.1
Low and medium cloud cover—South of Lake Erie	2.3±3.7	2.0±2.5	1.8±3.7	0.17±0.37

* The overall daily increase derived from the slope of a least squares line through a scatter plot of the daily 0100 temperatures was 0.18°F.

type-A and type-C days were tested for significance using the "*t*-test." These data appear in Table 2. The means of the numerical parameters for the first and last type-A days of a wave and for the day before the first type-A day of a wave were also calculated in order to determine the conditions when mass movements begin and end. This set of results appears in Table 3.

RESULTS AND DISCUSSION

The results of this study are presented in Tables 1–4. These results are interpreted and discussed below.

Migration correlated with wind and pressure systems.—Following winds were highly significantly associated with migration of both types A and B into

TABLE 4

MIGRATION WITH WIND FOLLOWING COMPARED TO MIGRATION WITH WIND NOT FOLLOWING IN VARIOUS TEMPERATURE RANGES

0100 temperature (F)	Wind following, no rain			Wind not following, no rain		
	No. A days	No. C days	No. A days / No. C days	No. A days	No. C days	No. A days / No. C days
31–35	0	0	—	0	1	0
36–40	0	0	—	0	6	0
41–45	0	0	—	0	10	0
46–50	0	2	0	0	8	0
51–55	0	2	0	0	11	0
56–60	2	0	∞	1	3	0.3
61–65	4	0	∞	0	2	0
66–70	4	0	∞	1	2	0.5
71–75	1	0	∞	0	0	—

Ontario. The differences between the observed and expected numbers of times type-A migration occurred with following, side, opposing, and calm winds were, respectively, positively highly significant (+HS), negative and insignificant (–IS), negatively highly significant (–HS), and negative and insignificant (–IS) (Table 1). For type-B days, the correlations were similar, but, except with side winds, less significant. Following winds are the only winds positively correlated with type-A or -B migration, and opposing winds are highly significantly disassociated with major waves.

Since wind directions are largely determined by the locations of pressure systems, air masses and wind must be considered together. The flow of air around high pressure areas (highs) is clockwise, while that around low pressure areas (lows) is counter-clockwise. Thus, southerly winds are found with a high to the east and/or a low to the west.

In the present study, type-A days were highly significantly correlated with highs to the east, lows to the west, and with both simultaneously. The percentage of the days with lows to the west that were type A was greater than the percentage of the days with highs to the east that were type A. However, the percentage of the days with both a high to the east and a low to the west that were type A was still greater. The number of type-A days on which there was neither a high to the east nor a low to the west was much lower than can be ascribed to chance (–HS). All of the correlations between air masses and type-B days were similar to the air mass and type-A day relationships, but less significant. Thus, most migration occurs with a pressure gradient falling from east to west.

In general, the migration into Ontario was found to correlate with the air mass situations described above at higher degrees of significance when the wind was following than when it was not. The observed-expected differences for type-A migration correlation with highs to the east, lows to the west, and with both simultaneously were all +HS when the wind was following compared to all –IS when it was not following. The set of negative correlations with other than following winds would probably have been more significant if more data had been available. Minor waves were associated with the pressure systems as above to higher degrees when the wind was following than when it was not, but only the high to the east, wind not following situation was negatively correlated with type-B migration. Following wind, some factor accompanying following wind, or a combination of such factors, but not pressure system locations, influences migration when the pressure gradient falls from east to west.

The present study does not support the generally held view that light winds are favorable and strong winds unfavorable for migration. While the mean 0100 wind speeds at Toronto and south of Lake Erie were both lower on type-A than on type–C days, neither type A–type C difference was significant (Table 2). Furthermore, the average wind speed on the first type-A day of a wave south of Lake Erie where the flights probably originated (8.2 knots) was above (but not significantly) both the average for all type-C days (6.7 knots) and the average for the day after the last type-A day of a wave (6.3 knots). This indicates that, on the average, migrants began to move while the wind speed was higher than when most birds were not moving and while it was higher than when migration was halting.

The 0100 wind speeds never exceeded 15 knots south of Lake Erie and did so only two times at Toronto. It appears likely that at the relatively moderate speeds prevalent at night during late spring in central North America, wind strength has little effect on the volume of migration.

Migration correlated with the presence of fronts.—Warm fronts were classified as being to the S or W or as being to the N or E. These categories are synonymous with those of being about to pass through or having recently passed through southern Ontario. For type-A migration, there was a + IS correlation with warm fronts to the S or W and a +HS correlation with warm fronts to the N or E. The arrival of two major waves with quasi-stationary fronts (classified as warm) just south of Lake Erie was responsible for the slight positive correlation with warm fronts to the S or W. While the surface winds are not normally following before the arrival of a warm front, the upper winds can be (see Raynor, op. cit.). After warm fronts have passed through, there is usually a low to the west and south-westerly winds, both of which have already been seen to be associated with mass migration.

Cold fronts were classified as being to the N or W or as being to the S or E of southern Ontario (i.e., being about to pass through or having recently passed through, respectively). For type-A migration, there was a +HS correlation with cold fronts to the N or W and a significant negative correlation (–S) with cold fronts to the S or E. The +HS correlation with cold fronts to the N or W was probably caused by the association of these cold fronts with warm fronts to the N or E centered in the same low pressure areas. The –S correlation with cold fronts to the S or E could be caused by the rain accompanying the fronts and the opposing winds behind them. The negative correlation might have been more significant if grounded waves could have been distinguished more readily from onrushing ones.

The relationships between migration and warm sectors were tested. For this study, a warm sector was defined as the area across which a warm front had passed and a cold front was about to (and later did) pass. The correlation with type-A migration was +HS; that with type-C migration was –S. The statement of Bagg, et al. (1950:13) that "pronounced movement will take place into or through a given region during the interval between the passage of a warm front through that region and the subsequent arrival of a cold front" is supported.

Both warm and cold fronts ordinarily involve warm southerly winds on the side upon which migration occurs, rain and strong variable winds at the frontal area and cold opposing or side winds on the other side. Thus, the type of front being encountered by vernal migrants in flight is not overly important: birds meeting either type of front are usually grounded by the opposing winds and rain.

Migration correlated with temperature.—The present study indicates that both high temperatures and increases in temperature are *associated* with heavy migration. The mean 0100 temperature in Ontario and south of Lake Erie were very highly significantly higher on type-A days than they were on type-C days. The type-A day–type-C day differences were 11.6 F and 13.5 F respectively in the two areas. One cannot explain the higher type-A day temperatures on the basis of normal seasonal increases in temperature, for a least squares line through a scatter plot of the 0100 temperatures south of the lower lakes shows a daily increase of only 0.18 F from 50.4 F at the beginning of the coverage period to 56.0 F at the end of the coverage period. In addition, over half of the type-A days (8 of 14) occurred in the first half of the coverage period. As expected, the mean temperatures in both areas on the first type-A day of a wave were slightly less above the type-C day means than were those for all type-A days. Nevertheless, the first type-A day–type-C day differences were significant at the 99 per cent level in both areas. The mean temperatures in both areas on the day before the first type-A day of a wave were less than those on the first type-A day. However, they were greater than the means for type-C days. The mean 0100 temperature increases from the day before to the day of the first type-A day of a wave were 4.4 F in Ontario and 7.0 F south of Lake Erie. Neither increase was significantly above the mean daily increase for the coverage period, but that for south of Lake Erie was almost so. The mean increases from two days before to the day before the first type-A day of a wave were 6.0 F and 8.0 F for the respective areas. The 8.0° increase for south of Lake Erie was significant. The mean increases from two days before to the day of the first type-A day of a wave (10.4 F and 15.0 F, respectively) were highly significant in both areas. These results suggest that any influence of temperature on the initiation of migration would be cumulative and gradual. However, we have not yet determined if temperature itself does *influence* migration.

Temperature has been considered by some to have a direct influence on the timing of migration. Lack (1963), working in England, presented data to show that both temperature and wind direction exerted direct influences on spring migration. However, Raynor (op. cit.) attributed no importance to temperature during spring in eastern North America. In Illinois, Graber and Cochran (op. cit.) considered the influence of temperature to be subordinate to that of wind direction in both spring and fall. Hassler, Graber and Bellrose (1963) believed that temperature was not of primary importance in Illinois in the fall.

On the day after the last type-A day of a wave, the mean 0100 temperatures in the two areas were lower than on the preceding day but still above the means for the coverage period. At Toronto, the mean temperature drop from the day of to the day after the last type-A day of a wave was 4.8 degrees to 52.8 F (the overall mean for the coverage period was 49.2 F). South of Lake Erie, the drop was only 3.5 degrees to 60.7 F (the coverage period mean was 53.0 F). It seems unlikely that these small and statistically insignificant decreases in temperature could in themselves stop a mass movement. Furthermore, the lower mean temperatures per se could not stop the birds for they were still above the seasonal averages. By considering the mean and standard deviation of the temperatures on the first type-A day of a wave in both areas, about one-fourth of the major waves would be expected to start with temperatures lower than the means for the day after the last type-A day of a wave. In fact, of the six major waves for which data are available, one began with a temperature at Toronto lower than the mean Toronto temperature on the day after the last type-A day of a wave and two began with a temperature south of Lake Erie lower than the mean there on the day after the last type-A day of a wave. It seems likely that factors other than temperature and changes in temperature are responsible for the termination of mass migrations. In particular, changes in other weather parameters and decreases in the supply of birds physiologically ready to migrate must be considered.

It should be recognized that the correlations between migration and *mean* temperatures investigated here may be oversimplifications. While there was a highly significant correlation between high temperature and type-A migration, one major wave began with a temperature at Toronto of less than the type-C day mean. Further discussion of the importance of temperature to the timing of migration appears later.

Migration correlated with humidity.—While it seems unlikely that humidity influences the timing of mass migration, there was some correlation between the two. There were no consistent or significant differences between the different types of days in the mean size of the interval between the 0100 temperature and the 0100 dew point. This indicates that the value of the relative humidity is not correlated with variations in the volume of migration. However, it was found that the mean actual temperature—dew-point-temperature differences had decreased in size from the previous day on major wave days in general and on the first major-wave day of a wave in particular. On little movement days, the mean difference increased slightly in size. The change in size of the interval from the previous day was highly significantly different on type-A days from what it was on type-C days at Toronto, but insignificantly different south of Lake Erie. Thus, there is some correlation between major waves and increasing relative humidity. However, it had also increased on the day after over the day of the last type-A day of a wave south of Lake Erie by about the same amount that it had increased over the previous day on the first type-A day of a wave. Increasing relative humidity could hardly help both to start and to stop a mass movement. While no analysis was done, it was apparent that the absolute humidity (the amount of water vapour present per unit of volume of air) as indicated by the dew point value itself was correlated with migration much as temperature was (i.e., Type-A migration occurred with high and rising absolute humidity).

Graber and Graber (1962:81) suggested that conditions with high humidity "may be optimum for migration, because of the effect of such conditions in reducing dehydration." However, the marked influence of warm southerly winds appears to be of much more importance to the timing of flights than is the influence of these inconsistent, less statistically significant humidity changes. Since high humidity is usually concurrent with the other significantly associated factors, perhaps the commonly used term, "warm southerly winds" should read, "warm, moist southerly winds."

Migration correlated with cloud and rain.—Correlations were made between migration and the amounts of sky covered at 0100 both by all kinds of cloud and by only low and medium cloud. The average amounts of sky covered by each of these cloud classifications both in Ontario and south of Lake Erie were all insignificantly less on type-A days than on type-C days. The differences in the averages between the two types of days were very slight except for the almost significant difference between the average amounts of low and medium cloud on type-A and type-C days south of Lake Erie. Although four of the 13 major wave days for which data are available had 0.7 or more of the sky cloud covered south of Lake Erie, the cloud was opaque on only one of those days. No type-A day had total overcast south of Lake Erie.

While these results suggest that cloud is unfavorable to migration, there were other contradictory data. The average total cloud cover south of Lake Erie on the first type-A day of a wave (0.50) was insignificantly greater than that on little movement days (0.49). In addition, the average cloud cover of both classifications in both areas had not decreased from the day before on the first type-A day of a wave. The large and increasing average amounts of cloud on the first days of waves were caused by the proximity of fronts. Warm fronts often moved through just before the arrival of the first birds of mass movements. Many of these birds probably started flying in clearer weather and then overtook the warm fronts which advanced at an average speed of only 11 knots (calculated from positions at 12 hour intervals on the weather charts). Thus, it would appear that cloudy weather is less favorable to migration than is clear weather, but that the amount of cloud cover as a determinant of the volume of migration is of secondary importance. Hassler et al. (op. cit.) suggested from autumn radar studies that "some migration does occur on nights of complete overcast," but that "not all birds in the migratory state will depart under overcast skies."

The present study supports the commonly accepted view that rain is unfavorable to migration, but not as strongly as might be expected. The difference between the number of major-wave days that had rain and the number expected if migration were not affected by rain was only –1.7 times the standard deviation (–IS). This would be significant at the 90 per cent confidence level, but not at the accepted 95 per cent level. Several type-A movements on days which were classified as having rain probably missed the precipitation by arriving at a different time or place. Thus the disassociation between rain and migration would have been more significant if we knew which birds actually did encounter rain.

Wind direction vs temperature as a determinant of the volume of migration.—While all authors agree that both wind direction and temperature are correlated with the varying volume of migration, they disagree on which factor actually influences the volume. The difficulty in analysis has been in separating the effects of high temperature and following wind which usually are concurrent. I believe that the methods used here can successfully separate the effects, but more data will be required for a final answer.

In order to determine if temperature had a direct influence in causing type-A migration, the mean temperatures south of Lake Erie for type-A and for other types of days were compared when simultaneously there was a following wind, a high to the E and/or a low to the W, and no rain. The mean on type-A days was 64.9 ± 3.9 F; that on other types of days was 52.4 ± 7.3 F. The difference is very highly significant. Thus on different types of days, the temperatures were highly significantly different ($P < .001$), while other important weather factors (including wind direction) remained essentially constant. Hence, the volume of migration can be influenced directly by temperature.

Table 4 was designed to show whether wind direction could have a direct influence on the volume of migration. It indicates the number of type-A days and the number of type-C days in several 0100 temperature ranges both when the wind was following and when it was side or opposing. Only those days on which there was essentially no rain either below Lake Erie or in southern Ontario were used. Within individual temperature ranges, we are able to compare the frequencies of major-wave days under conditions differing only in wind direction, for the temperature is nearly constant (ranges only 5 F wide) and there is no rain.

It is seen that the ratio of the number of type-A to the number of type-C days under the condition of following wind is greater than or equal to the corresponding ratio under the condition of side or opposing wind in all temperature ranges in which the ratios both exist. Furthermore, the ratios are equal only when they are both zero. This suggests that wind direction can have a direct influence on the timing of migration. A chi-square test in each temperature range, however, shows that in none of the ranges is there a significant difference between the proportion of A to C days with following and the proportion with side or opposing winds. This probably indicates that not enough days are present in each range. When all of the ranges above 55 F are grouped together, there are 11 type-A days and no type-C days with following winds compared to two type-A days and seven type-C days with side or opposing winds. For this combination of ranges, $\chi^2 = 10.0$, indicating a high degree of significance ($P < .005$) in the difference of the proportions of A to C days with different wind directions. It was considered at least partially justifiable to group the ranges above 55 F together because above that temperature, all days with following wind were type-A. Hence a further increase in temperature (above 55) when the wind was following could not possibly have stimulated more type-A days. We can conclude that wind direction probably does have a direct influence on the volume of migration, but further work with much larger quantities of data will be necessary for a more definite answer.

It has already been shown that the mean decrease in temperature on the day after over the day of the last type-A day of a wave is too small to stop mass migration. Since the mean temperature increased by several degrees from two days before to the day before the first major wave day of a wave in addition to increasing from the day before to the day of the first day with mass migration, rising temperatures appear to be unable to cause rapid changes in the volume of migration. This supports Lack's view (1960*a*). None of the days used in Table 4 with 0100 temperatures south of Lake Erie of less than 59 F were type A. All of the days in Table 4 with 0100 temperatures of 59 F or above were type A if the wind was following; 2 out of 9 were type A if the wind was side or opposing. This suggests that the temperature must be above a certain value for major waves to occur and that above this value, wind direction exerts the dominant influence on the volume of migration. This indication is in agreement with the results of Lack (1963) in England.

SUMMARY

This paper presents an analysis of correlations between the volume of bird migration into southern Ontario during the late spring in 1961, 1962, and 1963 and various weather parameters.

Following winds and high temperature are correlated with major waves of migrants, but changes in temperature by themselves do not appear to be able to cause immediate changes in the volume of migration. The data suggest that mass migration takes place only when the temperature is above a limiting value but that above that value, wind direction exerts the major influence on the volume of migration. Very little migration occurs without warm following winds. Since warm following winds are caused by high pressure areas to the east and/or lows to the west, these pressure situations are positively correlated with major waves. They themselves have a negligible influence on migration. There is a negative correlation between rain and major waves, but it is not as highly significant as might be expected.

Fronts, warm sectors and changes in humidity showed significant correlations with the volume of bird movement. These factors do not themselves influence migration significantly, but they are associated with other factors (wind direction, temperature, rain) which do.

Wind speeds, the amount of cloud present and the relative humidity showed no consistent or significant correlations with the volume of bird migration.

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A STUDY OF AUTUMNAL POSTMIGRANT WEIGHTS AND VERNAL FATTENING OF NORTH AMERICAN MIGRANTS IN THE TROPICS

David T. Rogers, Jr. and Eugene P. Odum

Although there have been several papers dealing with vernal arrival weights and autumnal fattening of trans-Gulf migrants in the United States, virtually nothing has been published concerning these two phases of bird study in the tropics. In fact, published data on arrival weights in the U.S.A. and Bermuda actually have not dealt with postmigrants but with birds which were interrupted during flight by television towers or storms (Odum et al., 1961; Nisbet et al., 1963). Wetmore (1939) stated that migrants arriving in Venezuela were exhausted to the point of having their breast muscles reduced to mere bands. According to Voous (1957) large numbers of birds arrived on the island of Curaçao off the coast of Venezuela ". . . in such a state of exhaustion that their bodies were hardly more than an assemblage of bones and dry muscles." The statements of Wetmore and Voous are interesting but they are not quantified and probably do not represent typical postmigrants.

Likewise there are few data from the tropics concerning weights of North American migrants during spring migration. Beebe (1947) gave some weights of premigrant birds in Venezuela but so few data were presented that no conclusions could be drawn from them.

In the fall of 1963 a trip was taken to northern Panama for the purpose of obtaining data on the postmigratory weights of trans-Gulf migrants. The birds were netted in an area close to the town of Almirante which is a port on the Caribbean Sea just south of the border of Costa Rica in the province of Bocas del Toro. This area was chosen because a netting operation consisting of 100 mist nets had already been set up by the Gorgas Memorial Research Laboratory in Panama City. The netting area was located in a second growth rain forest tract, little cultivated, although extensive banana plantations were located fifteen miles to the north.

In the spring of 1964 another trip was taken to Central America to obtain data on the buildup of weights prior to migration. This trip, taken in conjunction with a U. S. Public Health Service encephalitis team, was to the Stann Creek Valley of British Honduras. The netting operation in British Honduras differed from the one in Panama by being in an area under extensive agriculture. Most of the nets were set up at the edges of citrus groves, a habitat which was selected because it was preferred by the Orchard Oriole (*Icterus spurius*), an abundant transient and winter resident. After termination of the netting operation in British Honduras, postmigrants were netted in Louisiana at Grand Isle and the Delta National Wildlife Refuge.

MATERIALS AND METHODS

Weighing of birds was accomplished on a triple beam balance. Since weighings took place in houses which were rather open and subject to wind currents, weights were rounded off to tenths. The birds were caught in Japanese mist nets and held in cages for periods varying from two to seven hours, thus insuring that their digestive tracts would be relatively empty. In Panama the banding of the Catbird (*Dumetella carolinensis*), Wood Thrush (*Hylocichla mustelina*), Swainson's Thrush (*Hylocichla ustulata*), Gray-cheeked Thrush (*Hylocichla minima*), and Veery (*Hylocichla fuscescens*) was carried out by personnel of the Gorgas Memorial Research Laboratory. Therefore, the data presented herein on the above species do not represent all birds caught in the netting operation but that portion of the catch which could be weighed.

Data on birds taken in the U.S.A. are from television tower casualties at Tall Timbers Research Station, Tallahassee, Florida, and from the netting operation in Louisiana. All fat-free weights were derived from television tower casualties by an extraction process described in detail by Rogers and Odum (1964).

RESULTS AND DISCUSSION

Fat-free weights.—Since the main purposes of this study were to estimate the amount of fat remaining in postmigrants and to follow the buildup of fat reserves in premigrants in the tropics, it was necessary first to establish fat-free weight values for the species being studied. In an analysis of a mixed sample of spring and fall birds, Rogers and Odum (1964) showed that the fat-free weights of 4 species of warblers did not depend on the amount of fat remaining in the birds. Working on the assumption that the same situation applies to other species of tower casualties at Tallahassee, the fat-free weights in Table 1 were calculated using all available spring and fall specimens of species being studied.

It should be emphasized that the specimens which were used to derive the fat-free weight means in Table 1, as well as those used by Rogers and Odum (1964), contained not less than 0.25 g fat/g non-fat dry weight. Such birds are not believed to be "stressed" from the standpoint of lacking fat "fuel." Although the spring birds had already completed long flights, they still had some migratory fat reserves. The term "migratory fat reserves" is defined for purposes of this paper as that fat stored in adipose tissues which is readily available as flight fuel. As will be pointed out later, all specimens examined in

TABLE 1

MEAN WEIGHTS, RANGES, AND STANDARD DEVIATIONS OF FAT-FREE WEIGHTS FROM TELEVISION TOWER CASUALITIES AT TALLAHASSEE, FLORIDA

Species	Number of individuals	Mean wgt. and range, g	S.D.
Hylocichla mustelina Wood Thrush	77	41.64 34.31–48.11	3.07
Hylocichla minima Gray-cheeked Thrush	25	25.68 22.68–29.36	1.85
Hylocichla fuscescens Veery	121	26.71 21.31–32.42	2.42
Hylocichla ustulata Swainson's Thrush	73	25.46 20.61–29.57	1.96
Dumetella carolinensis Catbird	68	31.80 27.15–35.86	2.23
Vireo olivaceus Red-eyed vireo	55	14.30 12.39–17.13	1.11
Protonotaria citrea Prothonotary Warbler	72	10.99 9.68–12.75	0.68
Vermivora peregrina Tennessee Warbler	12	7.46 6.75– 7.92	0.42
Dendroica pensylvanica Chestnut-sided Warbler	73	8.31 6.97– 9.06	0.68
Seiurus aurocapillus Ovenbird	18	15.98 13.89–17.82	1.06
Seiurus noveboracensis Northern Waterthrush	88	13.95 9.93–17.00	1.13
Piranga rubra Summer Tanager	22	25.07 21.56–27.88	1.60

this study had some fat even when they had obviously been forced to burn some muscle proteins or other non-fat tissue for energy, thus reducing their fat-free weights. Throughout the remainder of this paper, the term "fat-free weight" will refer to the weight minus extracted fat of birds collected from the television tower at Tallahassee. This weight is presumed to represent the mean fat-free weight of migrants which have not exhausted their stored fat or "migratory fat reserves."

Postmigrants in Panama in autumn.—Table 2 includes data from birds captured during fall migration in Panama. It is not known what percentage of these birds had just arrived, or had been in Panama for several days. The fact that most of the birds were caught at times when large numbers of individuals were flying into the nets at one time suggested that the birds were still in flocks and probably new arrivals.

TABLE 2

MEAN WEIGHTS, RANGES, AND STANDARD DEVIATIONS OF LIVING BIRDS NETTED IN PANAMA DURING FALL MIGRATION WITH ESTIMATED FAT REMAINING BASED ON FAT-FREE WEIGHTS IN TABLE 1

Species	Number of individuals	Mean wgt. and range, g	S.D.	Est. fat g
Hylocichla mustelina	24	42.62 36.9–49.1	3.19	0.98
Hylocichla minima	138	27.47 22.3–33.7	2.59	1.79
Hylocichla fuscescens	43	27.02 20.1–38.0	3.41	0.31
Hylocichla ustulata	321	27.53 20.4–37.2	2.87	2.07
Dumetella carolinensis	101	31.32 26.5–37.4	2.41	0.00
Vireo olivaceus	203	16.75 11.4–21.6	2.00	2.45
Protonotaria citrea	7	11.91 10.8–13.1	0.88	0.92
Vermivora peregrina	37	8.65 7.0– 9.1	0.55	1.19
Dendroica pensylvanica	20	8.01 6.8– 9.1	0.58	0.00
Seiurus aurocapillus	87	15.74 12.9–19.0	1.30	0.00
Seiurus noveboracensis	165	14.69 10.5–19.2	1.54	0.74
Piranga rubra	22	27.33 22.6–34.5	3.00	2.25

It is evident from the mean weights of postmigrants in Panama (Table 2) that individuals of some species had not only exhausted their migratory fat reserves but had begun to lose some fat-free weight as well. In 3 species, *Dumetella carolinensis*, *Dendroica pensylvanica* and *Seiurus aurocapillus*, the mean weights in Panama were actually below the mean fat-free weights for birds of those species killed in Florida. After migratory fat reserves have been exhausted, it is likely that the bulk of weight loss comes from the breast muscles. It was noted during the handling of some of the very light birds that the breast muscles seemed reduced so that the keels of the sternums protruded noticeably.

It is probable that individuals of some species other than the three mentioned previously, also had begun to lose some of their fat-free weight. For instance, the lower end of the range of weights from Panama is beneath the lower end of the range of fat-free weights in *Vireo olivaceus*, *Hylocichla ustulata*, *Hylocichla fuscescens* and *Hylocichla minima* (Table 1).

Odum, Rogers, and Hicks (1964) suggested that all fat should not be considered available to a bird for energy purposes. Three birds caught in Panama and returned frozen to the United States had weights below the lowest fat-free weight recorded for tower casualties in Florida. It should be safe to assume that these three birds had begun to use some of their fat-free weight for energy and thus should have had minimum amounts of fat. Data on these three birds, one each of the species *Hylocichla fuscescens*, *H. ustulata* and *Vireo olivaceus*, are presented in Table 3, along with data from some other noticeably thin birds which were returned frozen from Panama. Table 3 shows that some fat remained in all these birds. Based on Table 3 roughly 0.3 g of fat in the smaller warblers, 0.5 g in vireo-sized birds and 1.0 g in thrush-sized birds is non-storage fat and unavailable as fuel to a migrating bird except, perhaps, at expense of living tissues. The fat indices of the birds in Table 3 are well below the lowest values presented by Odum et al. (1964) who suggested that ". . . at least 0.2 g of fat per gram of nonfat is not storage."

It is important to note that the water indices of the birds in Table 3 are within the range presented by Odum et al. (1964) although, as already indicated, the fat indices are not within the range. The specimen of *Hylocichla fuscescens* in Table 3 was a recaptured bird which had four days to drink. Yet this individual did not have a higher water index than the others in Table 3. These facts bolster the contention that water is not usually limiting to migrating birds. A full discussion of the evidence for and against water as a limiting factor during migration can be found in Nisbet et al. (1963) for data to that date. Since that time 2 additional papers (Rogers and Odum, 1964 and Odum et al., 1964) have presented data which indicate that water is not usually limiting. Further evidence to this effect can be found in the data on extremely thin birds in Table 3.

Postmigrants in Louisiana.—Six of the species which were captured in Panama were caught also in Louisiana on their way north in the spring. As with the birds in Panama, it is believed that most of the birds netted in Louisiana were new arrivals. In fact, migration "waves" could be observed at Delta National Wildlife Refuge, with flocks of mixed species moving through the trees. The twittering of these birds made it possible to hear them coming before they could be seen. During the periods when large groups were on the move, Catbirds could be flushed from the ground in groups of 15 or more birds. The fact that most of the mass movements of birds in Louisiana occurred early in the afternoon strengthens the contention that most of them were new arrivals because the time would coincide with the expected arrival

TABLE 3

DATA FROM SOME UNUSUALLY LIGHT POSTMIGRANTS CAUGHT IN PANAMA WHICH WERE BELIEVED TO HAVE LOST SOME OF THEIR FAT-FREE WEIGHT AND THE RANGE OF FAT-FREE WEIGHTS FROM TALLAHASSEE, FLORIDA

Species	Range fat-free wgt.[1]	Wgt. g	Fat g	Water index[2]	Fat index[3]
Hylocichla fuscescens[4]	21.3–32.4	16.3	0.62	1.97	0.14
Hylocichla ustulata	20.6–29.6	20.4	1.06	2.21	0.18
Vireo olivaceus	12.4–17.1	11.2	0.50	2.28	0.15
Oporornis philadelphia		9.2	0.38	2.34	0.14
Oporornis formosus		10.8	0.39	2.38	0.13
Oporornis formosus		11.8	0.46	2.44	0.14
Wilsonia canadensis		6.9	0.27	1.90	0.12
Seiurus noveboracensis	9.9–17.0	14.4	0.54	2.26	0.13
Seiurus noveboracensis		13.1	0.66	2.24	0.17
Dendroica petechia		8.0	0.29	2.22	0.12
Dendroica petechia		7.5	0.33	2.26	0.15

[1] see Table 1; [2] water content divided by nonfat dry weight; [3] nonfat dry weight divided by fat weight; [4] recaptured bird.

time of nocturnal trans-Gulf migrants which had left Central America or Mexico early the previous night.

The six species which were caught both in Panama and Louisiana are compared in Table 4. In every case, the means from Panama are the lower although a *t* test shows that two sets of means do not differ statistically. The differences indicate that either the birds become fatter in Central America before flying north than before flying south and/or the southward flights to Panama involve longer or more difficult flights. It is more likely that the latter explanation is better because tower casualties from the fall at Tallahassee are among the fattest organisms known (Odum et al., 1961). Also as will be shown later, spring premigrants in British Honduras were not unusually fat although birds were leaving. Perhaps the birds caught in Panama had flown all the way from North America nonstop while those caught in Louisiana had taken off from an area farther north in Central America or Mexico. However, it is likely also that during fall migration, some birds which are in Panama did not fly nonstop from North America. Rogers (1965) found that several birds killed during a nocturnal rainstorm in Panama had enough fat to fly ranges estimated from 411 to 1179 miles. It was postulated that these individuals may have stopped farther north in Central America or Mexico.

Odum et al. (1961) noted that spring tower casualties at Tallahassee still had enough fat reserves to have continued flying inland for several hours. These fat reserves led the authors to suggest that ". . . long distance migrants accumulate more fat than is normally needed to complete any given flight."

TABLE 4

NUMBER OF INDIVIDUALS, MEAN WEIGHTS, STANDARD ERRORS OF THE MEANS, AND SIGNIFICANCE TESTS FOR DIFFERENCES BETWEEN POSTMIGRANTS FROM PANAMA IN THE FALL AND LOUISIANA IN THE SPRING

Species	Panama			Louisiana			t[1]
	No. of individuals	Mean wgt., g	S.E.	No. of individuals	Mean wgt., g	S.E.	
Hylocichla mustelina	24	42.62	0.65	52	44.83	0.66	*
Dumetella carolinensis	101	31.32	0.24	46	35.67	0.27	***
Vireo olivaceus	203	16.75	0.14	148	17.31	0.15	**
Seiurus noveboracensis	165	14.69	0.12	8	15.26	0.63	NS
Seiurus aurocapillus	87	15.74	0.14	18	16.62	0.35	**
Piranga rubra	22	27.33	0.64	30	28.15	0.58	NS

[1] 1, 2, or 3 asterisks indicate statistical differences between means at the levels of 95 per cent, 99 per cent, and 99.9 per cent respectively. Nonsignificant differences are marked NS.

This hypothesis based on spring arrivals on the Florida Gulf coast must now be reconsidered in view of numerous birds which appear to have been pushed to the limits to complete the fall migration as far as Panama. Further studies at various points in Central America are needed.

The fact that postmigrants in Panama were, on the average, leaner than those in Louisiana and considerably leaner than tower casualties at Tallahassee (Odum et al., 1961) is important for several reasons: (1) it suggests that southward migration in the fall may be more arduous than the northward flight in spring and thus provide a strong selection factor; (2) the survival of birds which have evidently catabolized muscles for energy suggests that flight-range capabilities may be greater than would be predicted on the basis of energy in fat stored in adipose tissue; (3) comparison of live weights and fat-free weights provides a means of estimating routes and distances flown by migratory birds.

The estimation of flight-range capabilities of birds has, in the past, been based upon fat reserves only (Odum et al., 1961) with no consideration given to the possibility that birds may fly some distance on the energy derived from muscle catabolism. Since the fat-free weights of individuals within a species have a range, it is not possible to say just how much fat-free weight has been used by a bird based on mean values. However, if the Veery which was caught in Panama at 20.1 g (Table 1) left North America as an "average Veery" i.e. with a fat-free weight of 25.68 g, then roughly 6.6 g of fat-free weight was lost (considering 1.0 g of the net weight was unavailable fat).

If the ash-free dry weight of long range migrants is assumed to have a value of at least 5.4 kcal/g (Odum et al., 1965) and ash-free fat-free weight is roughly 71.1 per cent water (mean of 13 individuals of three species), then

FIG. 1. Frequency diagrams of weight classes for male Orchard Orioles netted in British Honduras. A line has been drawn through the weight class which contains individuals theoretically capable of an 800 mile flight.

FIG. 2. Frequency diagrams of weight classes for female Orchard Orioles netted in British Honduras. A line has been drawn through the weight class which contains individuals theoretically capable of an 800 mile flight.

6.6 g of fat-free weight would yield about 10.6 kcal. Using an estimate of 0.10 kcal/g fat-free weight–hr for the energy requirements of migratory flight and a flight speeed of 30 knots (Nisbet et al., 1963), 10.6 kcal would allow an extra 4.0 hours of flying time or 138 miles.

With some birds arriving in Panama without migratory fat reserves, it is not difficult to imagine that some individuals may have been unable to make the trans-Gulf flight. It is possible also that many individuals arrive so exhausted that they do not survive. It would be of interest to know just how much basic body weight a bird can lose and still recover. There were five recaptures that showed a weight gain even though initially they weighed less than the mean fat-free weight for the respective species. These individuals are marked by asterisks in Table 5. Of these, a Catbird caught on 24 October weighed less than the lowest fat-free weight which has been recorded for that species. By 29 October it had gained 1.8 g. Therefore it is safe to assume that birds can recover weight after losing some of their fat-free weight.

Premigratory weight buildup in British Honduras.—Whereas the birds captured in Panama were necessarily recent postmigrants, those in British Honduras were a mixture of winter residents and spring transients in unknown proportions. However, a changing species composition of the catch and sudden changes in the number caught for a particular species were circumstantial evidences for an influx of spring transients during the period when nets were operated in British Honduras.

The four species which were caught in sufficient numbers to allow an analysis of weight changes with time were the Orchard Oriole, Catbird, Indigo Bunting (*Passerina cyanea*), and Yellowthroat (*Geothlypis trichas*). Figures 1 through 5 are weight distribution frequencies for these four species with males and females separated in the case of Orchard Oriole. In the other species sex was either not determinable by plumage, as in Catbirds, or females were scarce.

Using 9.0 kcal/g fat (Odum et al., 1965), the flight metabolism and speed estimates presented earlier, and assuming every individual to have a fat-free weight which is average for the species, estimates can be made concerning the number of birds capable of flying from British Honduras to any other point of known distance. The two complicating factors which must be disposed of are: (1) some fat is unavailable for energy and (2) fat-free weight can be used for energy. Since neither of these quantities has been precisely measured, they have been considered as essentially cancelling each other in the following discussion although it probably introduces a slight error toward underestimating flight-range capabilities.

If the mean fat-free weight for Orchard Orioles is assumed to be 18.14 ± 0.40 g (from 11 extracted individuals), the weight necessary to make a non-

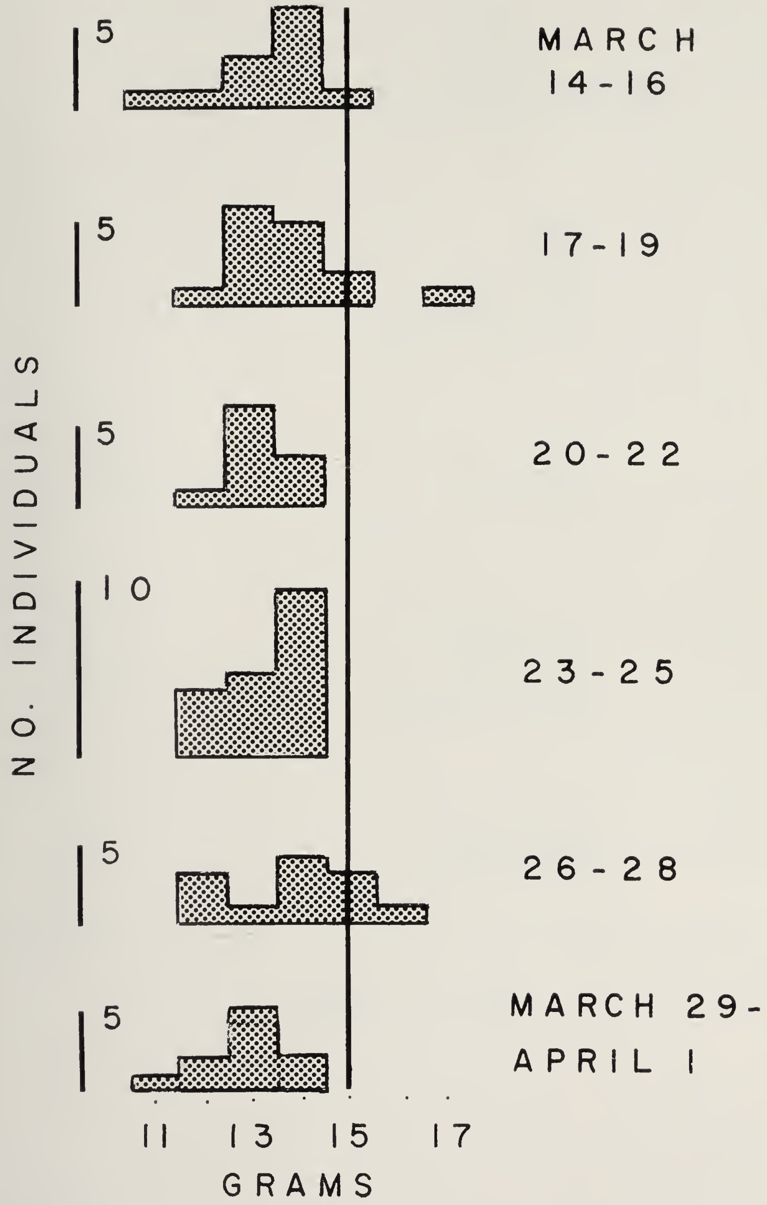

FIG. 3. Frequency diagrams of weight classes for male Indigo Buntings netted in British Honduras. A line has been drawn through the weight class which contains individuals theoretically capable of an 800 mile flight.

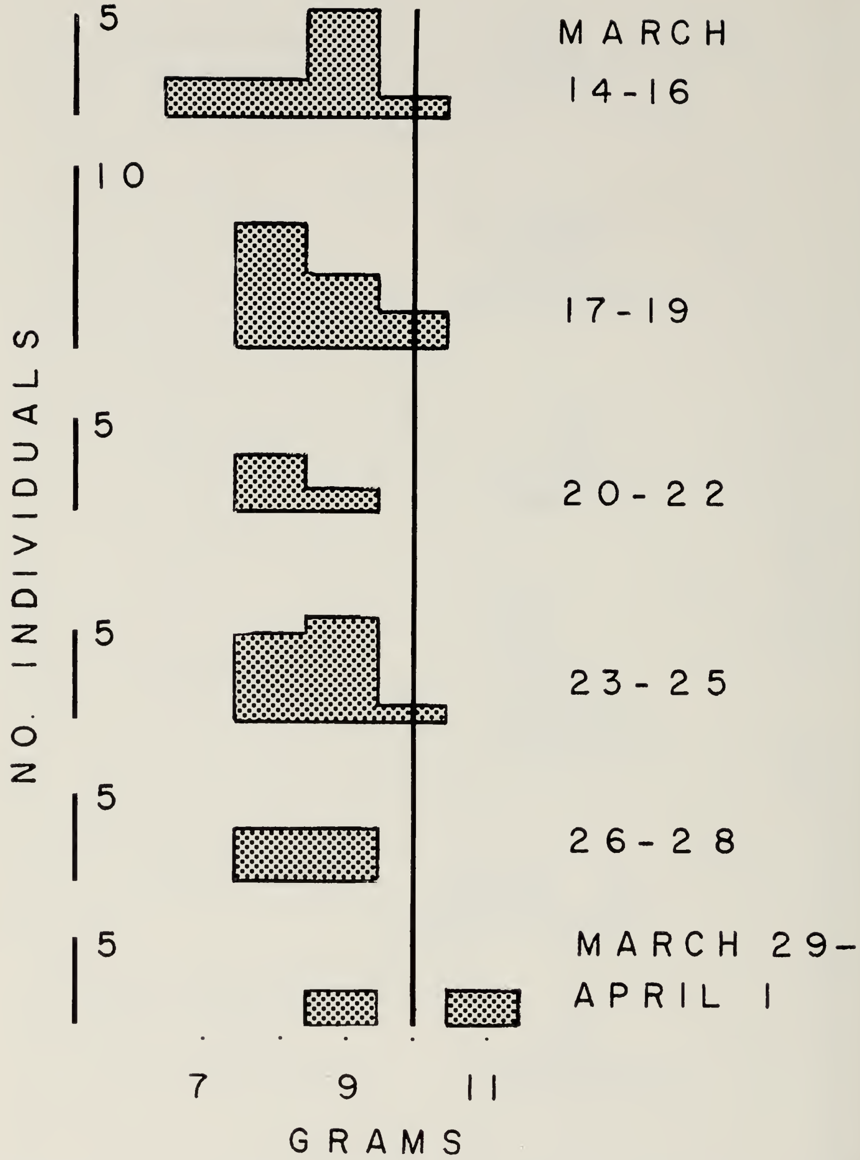

Fig. 4. Frequency diagrams of weight classes for male Yellowthroats netted in British Honduras. A line has been drawn through the weight class which contains individuals theoretically capable of an 800 mile flight.

stop flight of 800 miles from British Honduras to North America would be 22.9 g (flight energy = 0.1 kcal/g fat-free weight–hour; fat = 9.0 kcal/g; flight speed = 30 knots; fat is the only energy source; all fat is available). It can be seen from Figures 1 and 2 that Orchard Orioles in the 22 g block. and above, became more frequent as the season progressed. For instance, during the period 23–25 March, 43.8 per cent of the male Orchard Orioles appeared to be capable of 800 mile flights. The females did not show a weight buildup equal to the males with few becoming capable of 800 mile flights. It seems that many male Orchard Orioles are capable of nonstop flights from British Honduras to North America while most females are not and therefore perhaps move northward by land before attempting trans-Gulf migration; or perhaps they remain longer at Stann Creek. Figure 6 shows that a greater percentage of males than females were leaving. This is to be expected if males will arrive on the breeding grounds earlier than the females.

Using a fat-free weight of 12.12 ± 0.08 g for Indigo Buntings (mean of 88 individuals), individuals weighing 15.1 g would have a potential flight range of 800 miles. It can be seen from Figure 3 that the percentage of birds in the 15 g group and above attained a maximum of 25 per cent during the netting period 26–28 March. This indicates that at least some individuals of this species may be able to cross the Gulf from British Honduras to Louisiana.

The mean fat-free weight of 12 extracted Yellowthroats was 8.36 ± 0.12 g. Individuals of this species weighing roughly 10.5 g could be considered as having the necessary reserves to fly nonstop to North America. The weight frequencies for Yellowthroats (Fig. 4) show that birds with 800 mile flight capabilities were few even though the number of birds caught was showing a sharp decline indicating departure from Stann Creek station. These facts would indicate that this species moves north overland perhaps achieving maximum fatness farther north in Central America.

The Catbirds (Fig. 5) demonstrated neither a sharp decline in numbers caught nor a high proportion of birds capable of an 800 mile flight (39.7 g). Therefore no conclusions can be drawn about where this species has its final fattening phase. Perhaps they attained trans-Gulf capabilities from British Honduras after discontinuation of the netting operation.

It seems then, that flight-range capabilities of migrants at Stann Creek indicate that some species have a high proportion of individuals which attain the ability for long flights while other species are migrating through the area with only moderate fat reserves.

The phenomenon of weight loss in recaptured birds.—Nisbet et al. (1963) noticed that a high percentage of Blackpoll Warblers recaptured during migration showed a weight loss unless two or more days had lapsed since the previous capture. The authors cited references in which others had noticed a simi-

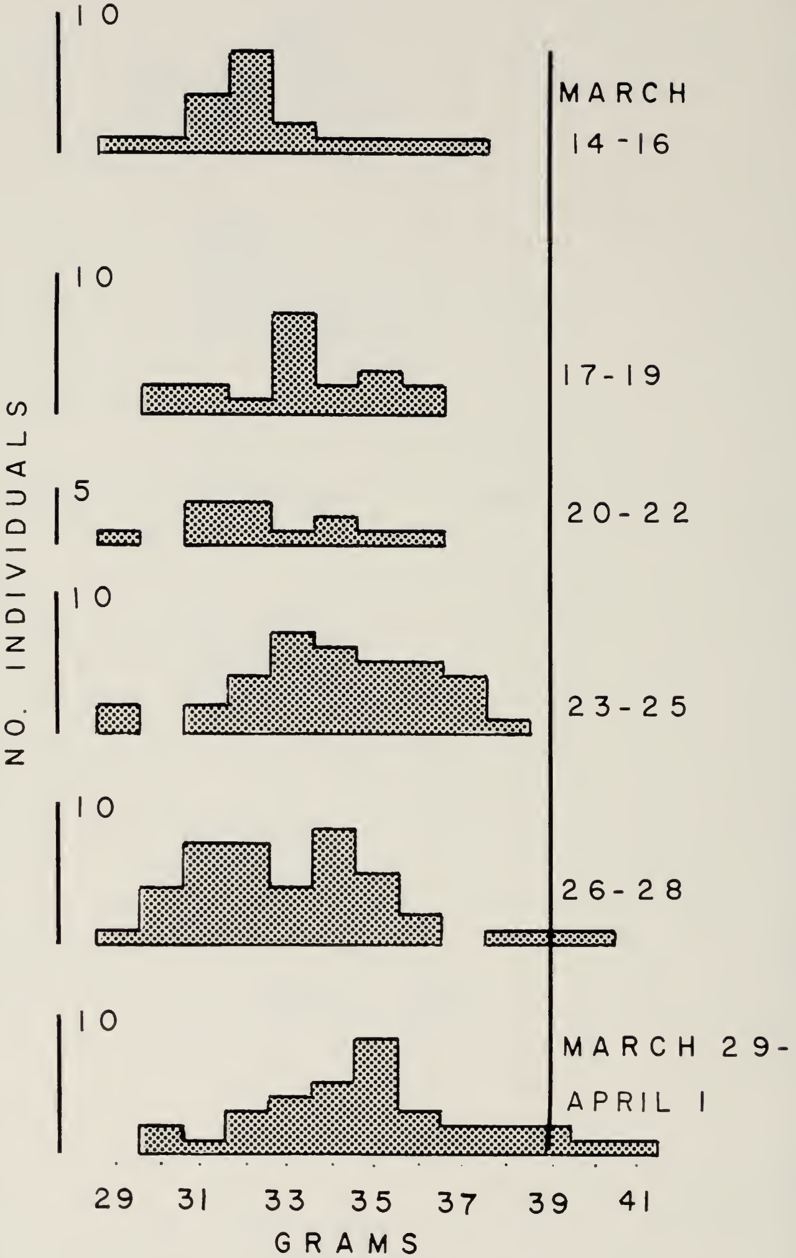

Fig. 5. Frequency diagrams of weight classes for Catbirds netted in British Honduras. A line has been drawn through the weight class which contains individuals theoretically capable of an 800 mile flight.

TABLE 5
WEIGHTS OF RECAPTURES IN PANAMA

Species	Date	Weight g	Date	Weight g	Date	Weight g	Date	Weight g	Date	Weight g
Dumetella carolinensis	10/24	26.5	10/25	25.7						
" "	10/27	32.1	10/28	29.7						
" "	10/23	28.7	10/28	26.7						
* " "	10/22	27.7	10/28	33.3						
* " "	10/24	25.5	10/29	28.3						
* " "	10/28	31.3	10/31	32.3						
" "	10/28	33.7	10/31	34.5						
" "	10/29	35.0	11/ 1	34.4						
" "	10/24	29.6	10/26	29.0						
Hylocichla ustulata	10/26	24.7	10/29	23.5						
" "	10/27	25.6	10/30	26.2						
Icteria virens	10/11	24.3	10/19	25.4						
" "	10/21	23.1	10/22	22.3						
" "	10/11	22.3	10/14	22.5						
" "	10/17	24.0	10/18	22.1						
Seiurus noveboracensis	10/13	14.4	10/21	14.6						
" "	10/16	14.6	10/21	14.6						
" "	10/10	15.2	10/12	13.9	10/25	14.8				
" "	10/13	17.3	10/14	16.3						
" "	10/13	14.3	10/14	13.6						
" "	10/13	18.0	10/14	17.1						
" "	10/13	15.5	10/17	13.7						
Dendroica petechia	10/16	8.3	10/21	8.6						
Oporornis formosus	10/12	14.6	10/22	14.3						
" "	10/14	11.3	10/15	11.6	10/16	11.3	10/18	12.1	10/31	13.2
**Piranga rubra*	10/ 7	23.8	10/23	29.9						
Seiurus aurocapillus	10/15	17.1	10/24	19.1						
Hylocichla minima	10/25	29.0	10/26	25.0						
Oporornis philadelphia	9/23	12.6	9/30	11.7						
" "	10/ 5	11.4	10/14	9.9						
" "	10/14	10.5	10/16	9.5	10/19	10.2	10/22	9.1		
" "	10/14	10.0	10/17	9.1						
**Hylocichla fuscescens*	10/ 1	25.5	10/ 4	23.6	10/10	28.1				
" "	9/30	28.7	10/ 4	16.3						
Vireo olivaceus	10/11	19.5	10/13	17.9						
" "	10/ 9	15.9	10/14	17.9	10/17	16.7				
" "	10/10	18.7	10/11	16.9						
" "	10/14	16.3	10/15	15.2						

* Individuals which were below the mean fat-free weight of television tower casualties from Tallahassee, Florida, and later showed a gain in weight.

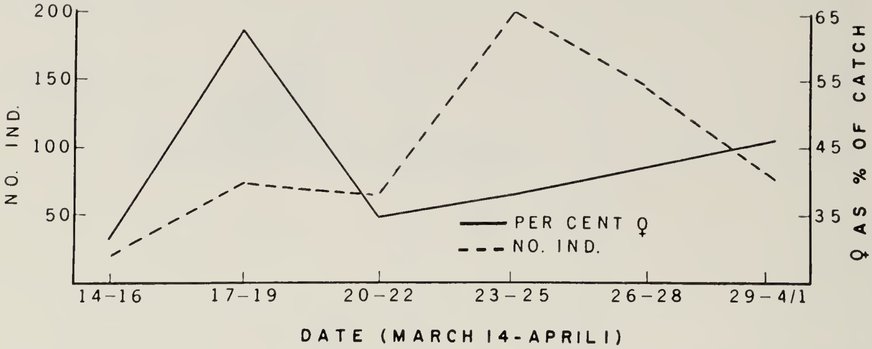

Fig. 6. Total catch of Orchard Orioles and percentage of the catch which was females. British Honduras.

lar loss in postmigrants and it was hypothesized that such weight losses might be a general phenomenon among postmigrants. Mueller (1964) has recorded similar losses in migrating Swainson's Thrushes but he believes that the losses are caused by a general trauma which is brought on by handling birds. The recapture data from Panama (Table 5) show that 14 of 15 birds which were recaptured within two days had lost weight. Table 6, which summarizes the recapture data from Panama, shows that the recaptured birds demonstrated a weight loss similar to that shown for the Blackpoll Warbler in that after two days, there was a sharp decrease in the percentage of birds which were below their initial weights when first handled. The weight losses cannot be blamed on the bleeding operation of the encephalitis team alone because only thrushes and Catbirds were bled but all species showed the weight losses.

The recapture data from British Honduras are more instructive as to the question of a cause for weight loss because many of the individuals were not postmigrants but were winter residents. It can be seen from Table 7 that 25 of 28 recaptured Orchard Orioles had lost weight even though the population as a whole was gaining weight. The two orioles which did not lose weight

Table 6

A Summary of Recapture Data from Several Species of Postmigrants in Panama

Days after first capture	Number of individuals	% that lost weight
1	11	90.9
2	4	100.0
3	8	50.0
4–6	9	33.3
7–	8	37.5

TABLE 7
RECAPTURES FROM BRITISH HONDURAS

Species	Date	Weight g	Date	Weight g
Icterus spurius	3/24	19.1	4/ 1	18.1
	3/25	22.5	3/31	19.4
	3/28	25.9	3/31	23.1
	3/21	19.5	3/30	17.4
	3/24	19.6	3/30	17.6
	3/23	15.9	3/30	16.9
	3/26	22.9	3/29	19.8
	3/19	18.4	3/29	16.7
	3/28	20.6	3/29	18.6
	3/25	22.8	3/28	21.8
	3/24	27.4	3/28	22.8
	3/24	29.3	3/28	26.3
	3/24	20.3	3/28	16.6
	3/18	18.4	3/28	17.7
	3/20	19.4	3/27	18.1
	3/21	22.3	3/27	20.9
	3/18	21.5	3/26	21.7
	3/18	21.5	3/25	22.1
	3/21	19.2	3/25	16.9
	3/15	20.9	3/25	16.5
	3/19	21.7	3/24	20.1
	3/20	22.0	3/24	19.7
	3/21	19.5	3/24	17.7
	3/18	19.3	3/23	17.9
	3/20	16.4	3/23	15.9
	3/21	22.0	3/22	20.3
	3/17	17.7	3/19	16.5
Seiurus aurocapillus	3/13	19.3	3/17	17.4
	3/18	15.8	3/24	15.2
Seiurus noveboracensis	3/23	14.8	3/24	14.3
	3/24	16.1	3/30	15.0
Wilsonia citrina	3/25	9.5	3/26	9.1
	3/15	8.7	3/27	8.4
Dendroica petechia	3/22	8.1	3/26	8.2
Icteria virens	3/25	24.4	3/28	21.7
Passerina cyanea	3/20	12.7	3/28	12.4
Guiraca caerulea	3/20	24.5	3/31	23.4

just retained the weight they had in the beginning and were not caught until at least seven days after the first capture. In addition to Orchard Orioles only one recaptured Yellow Warbler (*Dendroica petechia*) of 10 recaptures of various species did not have a loss in weight. It should be emphasized that the weight losses of recaptures in British Honduras occurred in premigrant populations except for spring transients which are postmigrants. Of course, it cannot be stated with absolute certainty that all the birds in Table 7 were not spring transients and thus postmigrants of a sort but such would be highly unlikely. The recapture data from British Honduras, then, strongly indicate that weight losses are caused by handling.

SUMMARY

The autumnal arrival weights in Panama and vernal fattening in British Honduras were studied for several species of trans-Gulf migrants. Birds arriving in Panama were extremely thin and many were below the estimated fat-free weights for the species. Fat indices on some specimens which were extracted, were below any which have been reported previously in the literature. Evidence is presented that fat-free weight may have been used as an energy source in some postmigrants.

The premigratory buildup of fat reserves in Catbirds, Orchard Orioles, Indigo Buntings, and Yellowthroats in British Honduras indicated that some individuals of these species attained trans-Gulf flight capabilities at different dates while the fattening of sexes differed by date in the Orchard Oriole. The possibility that Stann Creek Valley may be a final stop in Central America for some species during spring is discussed.

Data on weight changes in recaptured birds indicated that weight losses between capture dates may have been caused by handling of the birds.

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21 JULY 1965.

THE INFLUENCE OF LIGHT INTENSITY ON OVIPOSITION OF THE COTURNIX QUAIL

Howard L. Hosick

Interest in the Japanese Quail (*Coturnix coturnix japonica*) as an avian laboratory species has been spreading rapidly. Because of the increasing need for birds and eggs for study, there is much work being done on factors affecting egg laying by the quail. One of the major influences is light (see Abplanalp, 1961; Reese and Reese, 1962; Wilson et al., 1962). As with other birds, notably chickens and ducks, most of these studies have involved the role of photoperiodism with respect to egg laying. We have been more interested in the effects of light intensity as such on the egg laying patterns of the quail. Where other studies have shown a definite correlation between photoperiodism and egg laying (Abplanalp et al., 1962; Abplanalp, 1961), this study shows that time and place of oviposition are influenced by the available light intensity.

MATERIALS AND METHODS

Cages 142 cm (56 inches) by 55 cm (22 inches) by 30 cm (12 inches) deep of one-inch wire mesh were set up as shown in Figure 1. A variety of light sources was employed, one at a time, including a fifty watt light bulb, a fifty watt bulb heavily filtered with colored cellophane, and a ten watt bulb. The ten watt source placed in one end of the cage gave a light gradient along the cage length ranging from forty foot-candles near the source to less than one-half foot-candle at the opposite cage end. Intensities were measured as incident light.

The cages were blocked from extraneous light by heavy, dull, black plasticized cloth. The cage bottoms of one-inch wire mesh effectively prevented rolling and kicking about of the eggs after they were laid. Food and water positions were changed frequently in relation to one another and the light source to eliminate their placement as a factor in position of egg laying, and to avoid a training effect, as discussed below.

There were approximately twenty birds to a cage, of which 25 per cent were males. Ten to twelve eggs were collected daily. Food was commercial Purina game bird chow. Lights were kept on in the cages continuously. Room temperature was fairly constant at 22 degrees centigrade.

RESULTS

We first used incandescent white light sources, in an attempt to ascertain the precise intensities in which laying tended to occur. The results are summarized in Figure 2. A large proportion of the eggs (60.8%) were laid be-

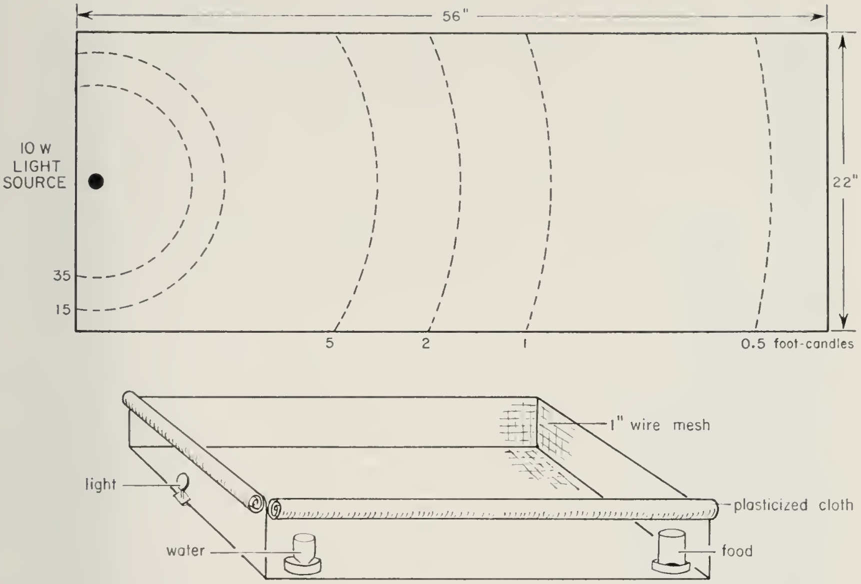


FIG. 1. Floor-plan and a three-dimensional sketch of the cage setup used. Dotted lines in top figure indicate light intensities at various cage positions. Note light, food, and water, shown in a typical arrangement.

tween two and 0.5 foot-candles intensity. Seventy per cent of the eggs in this range (or, 55.3% of the total eggs) were placed in light intensities between one and 0.5 foot-candles. This latter range of 0.5 foot-candles could be resolved no further due to limitations on the photometer employed in these determinations, and practical limitations involving the precise positioning of the eggs when dropped on the one-inch mesh floor.

It should perhaps be noted that precisely one egg was gathered per day in the higher light intensity ranges. This fact tends to indicate that the same bird was doing the abberant laying in all cases; perhaps this bird had some malfunction (blindness) which caused her to lay her eggs in response to some other stimulus (for example, heat). This assumption has not been verified.

One light source used was a fifty-watt incandescent bulb, which put out enough light so that the intensity even at the opposite end of the cage was greater than the two-foot-candle maximum of the preferred laying range. The food container was placed precisely in the middle of the cage; hence, it cast a shadow, and this shadow was the only cage area in which the light intensity was less than two foot-candles. Consequently, ninety per cent of the eggs laid under these conditions were laid in the shadow of the food can. When the

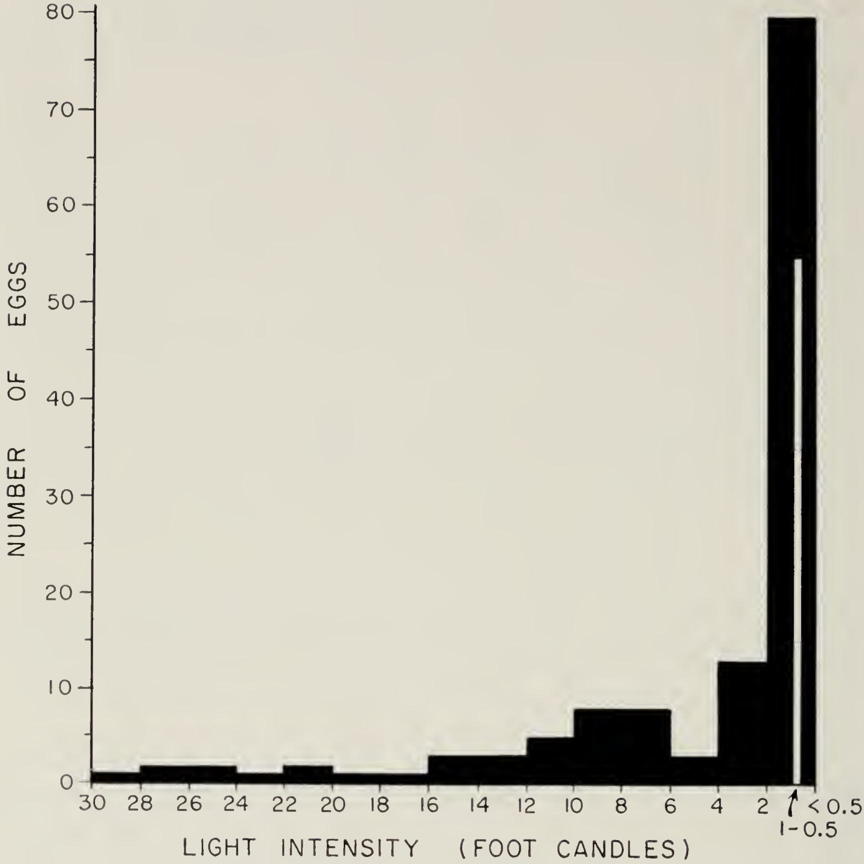


FIG. 2. Number of eggs collected versus collection intensities for white light. Note majority of eggs laid at less than two foot-candles, and most of these between one and 0.5 foot-candles.

food can was moved against the rear of the cage, so that it cast no shadow, the eggs were still deposited precisely where they had been before—that is, where the food-can shadow had been, but where there was now an increased light intensity (ranging from four to twenty foot-candles). This training effect continued for about one week, during which time progressively fewer eggs were laid daily in the higher intensity area, and more were laid at the very rear of the cage. These results are summarized in Figure 3, which is a plot of number of eggs collected versus light intensity for the first week after the food container was moved. A greater number of eggs was laid in the higher light intensities than under normal conditions (Fig. 2).

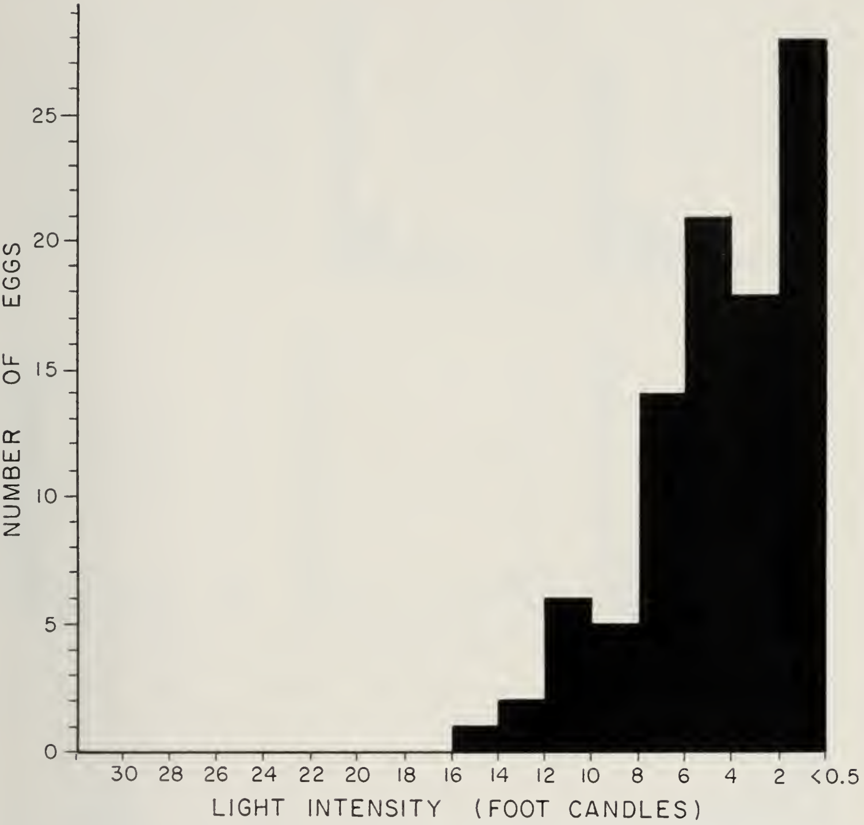
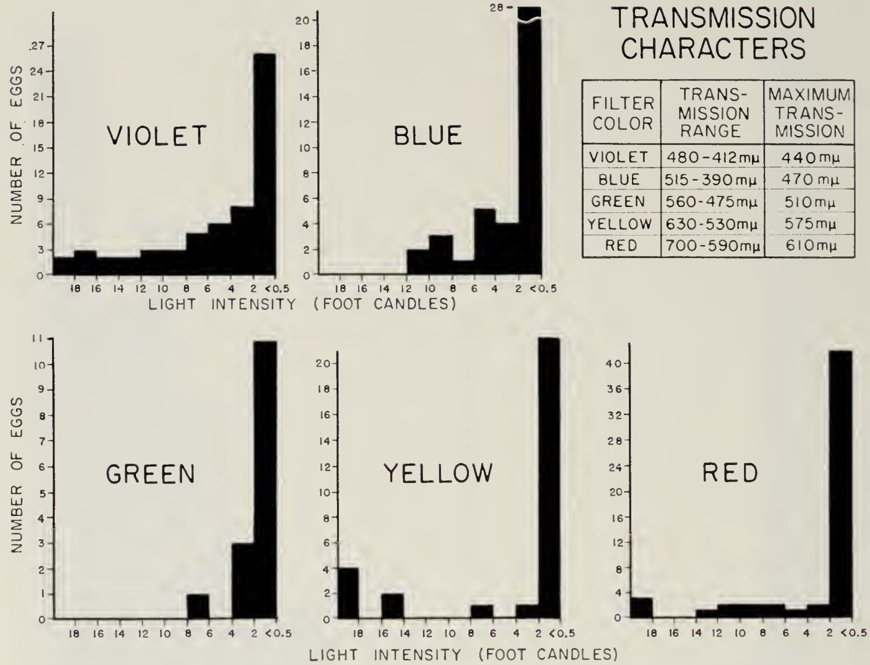


FIG. 3. Demonstration of "training effect," as explained in text. Plot of number of eggs versus light intensities, for first week after low intensity shadow eliminated from cage. Higher intensities shown here found where shadow had been.

Having attained these results with a white light, similar studies were made using colored lights to ascertain whether the egg laying response was initiated by light of a particular wavelength, rather than by the sum of wavelengths given by a white light. Using the same experimental setup as before, but with colored cellophane filters over the light source, essentially the same results were obtained as for the white light. These results are summarized in Figure 4.

The colored filters cut down the light intensities to a considerable extent: the cages were, in fact, quite dark throughout. Consequently, egg production dropped off markedly, and after several weeks essentially no eggs were being laid. These results agree with those of Abplanap (1961). The eggs which were gathered during this period were small, sterile, and had extremely thin



TRANSMISSION CHARACTERS

FILTER COLOR	TRANS-MISSION RANGE	MAXIMUM TRANS-MISSION
VIOLET	480-412mμ	440mμ
BLUE	515-390mμ	470mμ
GREEN	560-475mμ	510mμ
YELLOW	630-530mμ	575mμ
RED	700-590mμ	610mμ

Fig. 4. Number of eggs collected versus light intensities for various colored light sources. Note similarity, in all cases, to Fig. 2.

shells. The effects of darkness on *Coturnix* are well known and have been described (Abplanalp, 1961; Abplanalp et al., 1962; Wilson et al., 1962). After being subjected to the original light intensity for one week, egg production was back to normal. Reinitiation of egg laying was thus easily accomplished in *Coturnix* although this is not so easily done with some other birds (Farner, 1964).

The darkness effects were least pronounced with red light; egg production in red light continued normally for almost one month. This may be because red light penetrates organic tissue best, and thus a lower intensity of red light will elicit the same response as a higher intensity light of another color (Farner, 1964), or perhaps the visual "oil filters" responsible for color vision in birds (Wald, 1950) differ slightly. If the red droplets were either in less abundance than yellow or red-green droplets, allowing more red light to reach the actual photoreceptors of the cones, or were more readily penetrable than the other two, a greater visual response for a given light intensity would be elicited. It should be noted, however, that two conflicting responses were observed, in that egg laying continued for a longer time in the red light, indi-

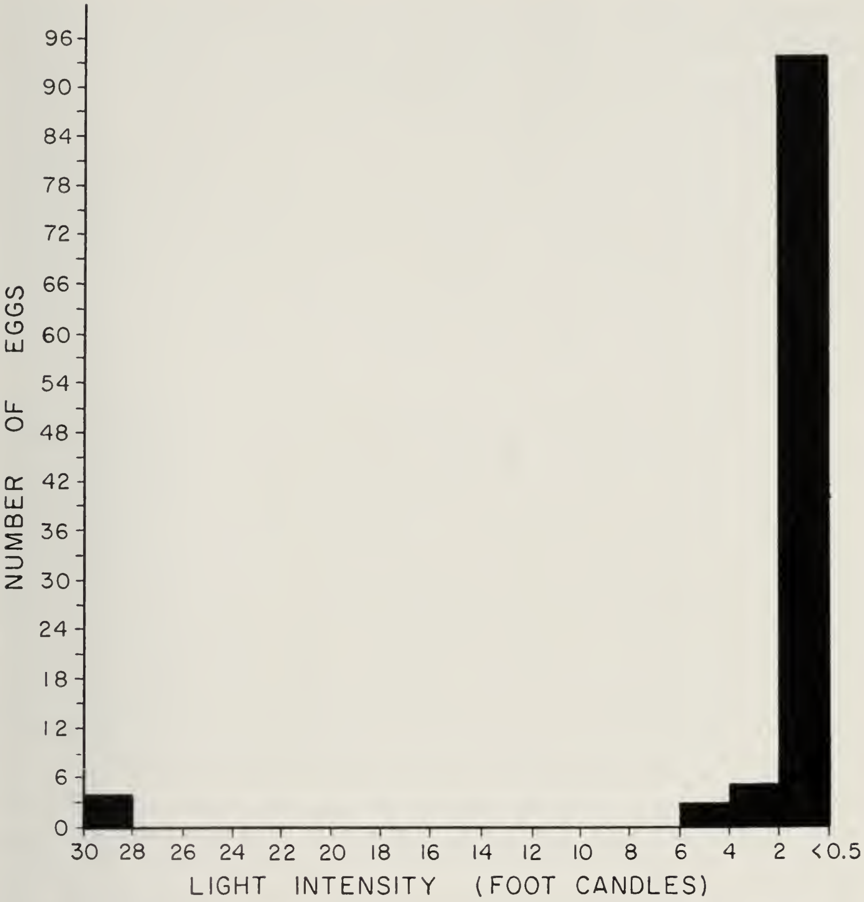


FIG. 5. Number of eggs collected versus light intensities from cage having heat filter placed to eliminate differential temperature effects on oviposition.

cating greater sensitivity to long wavelengths, yet eggs were placed in the same light intensities in which they were placed with all other light sources.

According to Wald (1950), there are droplets in the visual cones of birds corresponding to each of the three primary colors, and a fourth type, which is essentially clear. Thus a part of white light is able to penetrate all droplets, and the response elicited by a given white light would naturally be greater than that from a colored light of comparable intensity. Thus laying is most readily maintained in white light.

At this point in the experiments, it was impossible to ascertain with certainty whether the observed response was the result of a light or of a temperature gradient. Whereas a light gradient was indeed observable, the incandescent light source also produced a partial temperature gradient through the cage length, which may have been the cause of the observed egg distribution, rather than the variations of light intensity within the cage.

Temperature and light as factors were effectively separated by the use of a heat filter consisting of two sheets of one-fourth inch thick plate glass, mounted two inches apart in a wooden frame. Using this device in front of the light source, a temperature difference of no greater than 0.5 degrees centigrade was ever observed in simultaneous readings over the cage length. Under conditions with a light gradient but constant temperature, oviposition occurred in the 2—0.5 foot-candle range in 88.7 per cent of all cases. These results are shown in Figure 5.

In these determinations, the small, ten-watt bulb was used. Because of reflection and absorption by the glass filters, the maximum light intensity within the cage was decreased from 40 to 34 foot-candles with this light source. The effect on the minimum intensity within the cage could not be determined due to equipment limitations. The result of the lowered intensity, however, was that the 2-0.5 foot-candle range occupied 70 per cent of the cage length, or 20 per cent more than previously. Egg distribution within the 1—0.5 foot-candle range was more easily observable in the increased area covered thereby; assortment was found to be random within that range.

During this period, several of the female quails were becoming blind. The eyes of these birds were observed to be swelling shut. As this blindness progressed, more and more eggs were laid in the higher light intensities.

During a period of one week, the individuals used in these experiments were subjected to sixteen hours of high intensity light, which was, however, constant over the entire cage length. During the other eight hours of the day, the birds were subjected to the usual light gradient. All eggs were laid during the eight hours of relative darkness, apparently, as they were gathered in the same pattern as before. These results substantiate the premise that long-period high intensity light may inhibit the actual laying response (Farner, 1964).

DISCUSSION

Egg laying in low light intensities may confer several adaptive advantages on the quail. These intensities correspond to the very early dawn hours, at which time the air and ground temperatures are still relatively low. Thus the eggs will be rapidly cooled upon laying. This cooling has been found to be necessary before development of the embryo can proceed (Padgett and Ivey, 1964).

The light at dawn (and dusk) tends to be shifted toward the red end of the spectrum in comparison with the light during the rest of the day, due to refraction of the sunlight by a greater depth of atmosphere. As explained previously, the egg laying response is easily elicited by red light. Thus the propensity to lay eggs in low light intensities is reinforced by the fact that said light intensities tend to be "red" when found in the birds' natural environment.

When the results here described are considered along with the work of others on the effects of light on the reproductive behavior of *Coturnix* quail, it becomes apparent that both light intensity and photoperiodism are important in the integrated response observed. Wilson et al. (1962) have made studies indicating that rate of sexual maturation is independent of light intensity. The same paper indicates the importance of day length on reproductive maturation, with photoperiods of fourteen or more hours being required for quantity egg production. This mechanism results in the production of eggs primarily in the long days of spring, when other factors such as food supply and temperature are optimal. An even longer photoperiod, such as that found in later months (June, July) may result in a dropping off of egg production (Farner, 1964). This lowering of egg production was not observed in the white light experiments here presented, even though lights were on in the cages continuously. This may have been due to the exceedingly low light intensities in which the birds spent part of their time. As a bird moved from the rear of the cage (farthest from the light—low intensity) to the front of the cage (near the light—high intensity) and back again, it may be considered to have undergone a brief high intensity light exposure. Because light intensities greater than 0.5 foot-candles were found over a much larger cage area than were low intensities (less than 0.5 foot-candles), and because movement of the birds was random throughout the cages, it can be considered that each bird was regularly subjected to a high-intensity exposure of greater than twelve hours per twenty-four hour day.

Farner (1964) has described a "pre-reproductive preparatory period" which he has observed in birds. This consists of a high-intensity, relatively long photoperiod, such as a spring day, which is actually responsible for maturation of the reproductive system in preparation for copulation and egg laying. Egg laying can then occur at a later time when conditions for it, in turn, are optimal. The high intensities of light available in our experimental setup fulfill this preparatory function. The odd effects observed in the red light may be due in part to this light color precipitating reproductive maturation more readily.

Abplanalp (1961) has also done studies involving pre-conditioning, which indicate that a period of darkness prevents egg production during its application but enhances the later response of the hens to light. On the other hand, he indicates that intermittent lighting has an adverse effect on egg production. Both of these conditions were present in the white light setups employed by us (as explained above) yet egg production remained high. The effect of darkness apparently outweighs the intermittent lighting effects on subsequent egg laying.

The hens' inherent physiological tendency to ovulate once every twenty-four hours was not interrupted by the setup employed, as laying remained high and steady (during the first series of white light experiments). Such interruptions are, however, common under conditions of simple unnatural day lengths (Abplanap, 1962).

Wilson and Huang (1962) indicate that, in the studies they have made, about eighty per cent of *Coturnix*' eggs were laid in the afternoon. However, it should be noted that the attendants were in the area during the early morning hours when egg laying would normally take place, quite possibly frightening the birds enough to delay oviposition. Arrington (1962) concurs with this afternoon-laying observation. More work is needed on this subject, as conflicting observations are apparent (Arrington et al., 1962; Wilson and Huang, 1962; Abplanalp, 1961).

SUMMARY

Coturnix quail has been found to lay its eggs in low light intensities when a range of intensities is available. The intensities at which laying took place were found to be independent of light color, although other responses were modified in monochromatic lights. The experimental setup used allowed for both development of the reproductive systems of males and females and the finalization of this maturation, namely, the laying of fertile eggs. The response to the influences of light intensity is apparently evolutionarily significant, in that several advantages are therewith conferred upon the species. Results employing heat filters to eliminate temperature differences over the cage length indicate that temperature gradients play essentially no role in these results.

ACKNOWLEDGMENTS

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THE CONTEXT OF SONGS IN THE YELLOW WARBLER

Douglass H. Morse

Recent studies (Gill and Lanyon. 1964: Ficken and Ficken. 1965*b*) have shown that in some wood warblers (Parulidae) there are two distinct male songs. Accented Ending Song and Unaccented Ending Song. In some species Unaccented Ending Song appears to be primarily given to males of the same species. whereas Accented Ending Song is usually given to female mates and to males of other species. Although song in most passerines functions in the maintenance of territory and in the satisfactory completion of the breeding cycle. the possible interspecific function of song has not been widely recognized.

The purpose of this study was to investigate the two songs of the Yellow Warbler (*Dendroica petechia*) and to analyze their respective motivation and significance. The responses of this species and the closely related Chestnut-sided Warbler (*D. pensylvanica*) to each other were carefully noted.

Yellow Warblers were studied intensively during May–July. 1963–64. and June–July. 1965. thus encompassing the entire breeding cycle. Most investigations were conducted in two areas: Webster. Androscoggin Co.. and Bremen and Damariscotta. Lincoln Co.. Maine. Supplementary observations were made during May and June. 1964. in Tewksbury and Newburyport. Essex Co.. Massachusetts.

Extensive field notes were made at the time of observations. Some of the birds were marked with regulation government bands plus small patches of Magic Marker applied to their feathers to facilitate identification of individuals.

The study areas in Maine (one in Webster. one in Damariscotta. and two in Bremen) are in each instance marshy areas invaded by an encroaching band of woody vegetation led by speckled alders (*Alnus rugosa*). willows (*Salix* sp.). and meadow sweet (*Spiraea latifolia*). Other prominent transitional species found outside this inner fringe of woody vegetation include red maple (*Acer rubrum*). and gray birch (*Betula populifera*). The study area at Webster is situated in an abandoned beaver pond: the other areas in Maine are old lakes that are gradually filling in with vegetation. The Tewksbury site is a marshy area partially covered with speckled alders and a few red maples. Studies made at Newburyport were in a sandy area fairly densely covered with bayberry (*Myrica pensylvanica*) and beach-plum (*Prunocerasus maritima*).

RELATION OF THE BIRDS TO THE AREA

In the northeastern United States the range of Yellow Warblers is particularly spotty and is the result of their fairly close adherence to wet areas not

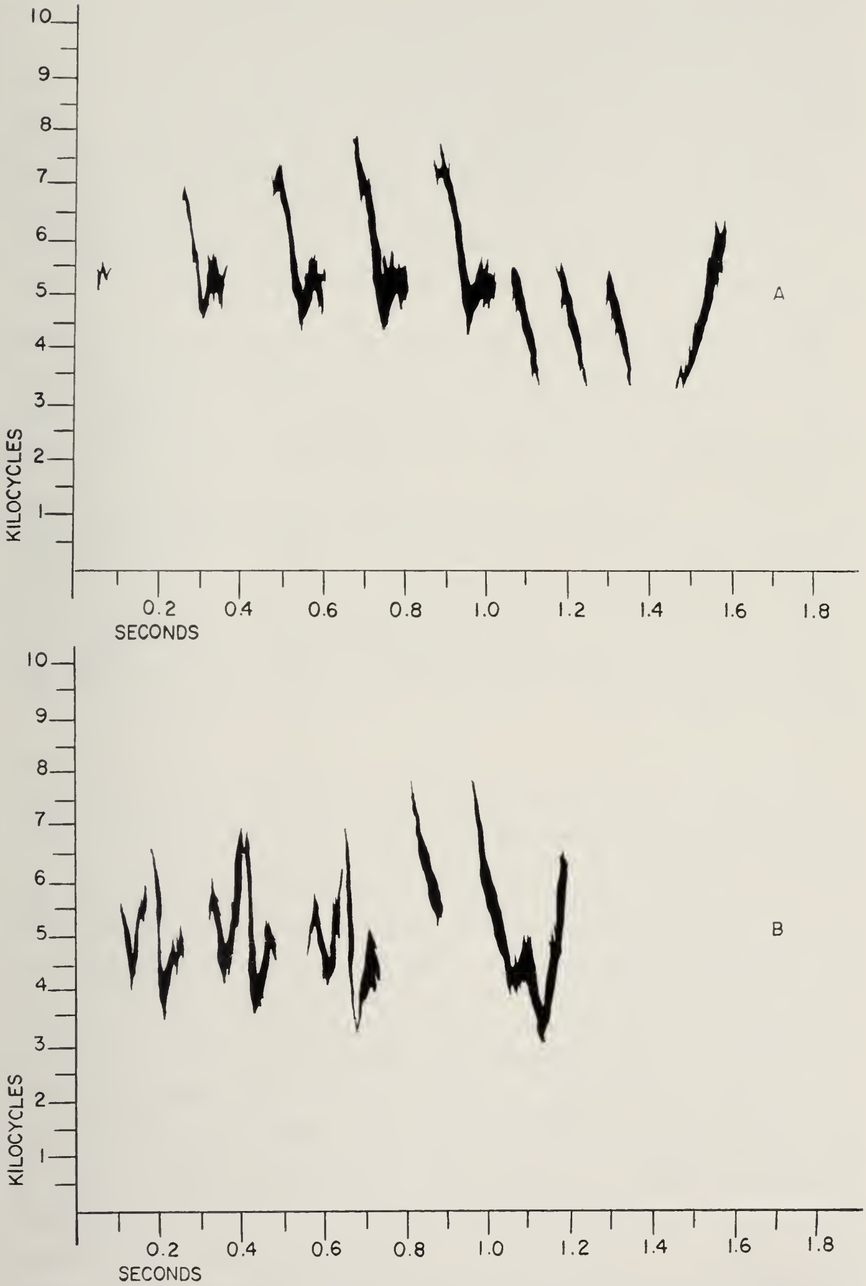

Fig. 1. Sound spectrograms of the vocalizations of Yellow Warbler: A, Accented Ending Song; B, Unaccented Ending Song.

completely covered by a tree canopy, to certain brushy areas, or to residential situations. The different species of warblers in and about relatively undistrubed wet areas are not separated ecologically in the same manner as the spruce-woods *Dendroica* warblers described by MacArthur (1958). Rather, their separation under natural conditions is a transitional one, as might be expected because of the steady habitat change often found in some of these areas. This change is particularly rapid about beaver ponds, the heightened water level being the result of dams built by beavers (*Castor canadensis*), which break soon after abandonment, and result in a secondary lowering of the water level.

Where available Yellow Warblers often used tall trees for singing perches, but also nested successfully in a few territories that did not contain elevated perches, apparently an important requirement of Yellow Warblers studied elsewhere by Kendeigh (1941) and Ficken and Ficken (1965*a*). The favored foraging and nesting habitat for Yellow Warblers in wet areas is on land partially covered by alders and willows from one and one-half to four meters tall, where they are usually the only *Dendroica* species found. The only other parulid regularly present is the Yellowthroat (*Geothlypis trichas*), which is a bird of the underbrush and apparently is not a close competitor. In the largest alders that are on the edge of the maple-birch zone and into that zone itself, Chestnut-sided Warblers predominate, in addition to American Redstarts (*Setophaga ruticilla*). Yellow Warblers are uncommon here.

RESULTS

The Yellow Warbler has two different songs, which are given in distinct situations (Fig. 1). Similar song types were recorded in this species by Ficken and Ficken (1965*b*).

Accented Ending Songs.—Accented Ending Songs were involved either with behavior performed about the female or about other species, notably Chestnut-sided Warblers (Table 1). This song predominated directly preceding and following copulation as well as about the nest while the female was incubating. If males had been singing an Unaccented Ending Song before coming in close contact with the female, they changed to Accented Ending Songs at that time. Accented Ending Songs were predominant prior to and during pair formation (Table 5). Many other times this song would also be given when from the context it was difficult to postulate why one pattern (or the other) would be chosen at that time. However, as the season progressed a strong tendency developed for Yellow Warblers to sing one particular song pattern in areas of previous experience of one sort or another. For instance, Accented Ending Songs would be delivered in the close vicinity of the nest even when the female was foraging a considerable distance away.

TABLE 1

APPARENT CONTEXT FOR SOME SONGS OF MALE YELLOW WARBLERS

Activity		Number of responses
Loud Accented Ending Song		
During and/or following presence of female Yellow Warbler		40
Copulation and/or female soliciting	9	
Close proximity	11	
Female fed on nest	11	
Near nest occupied by female	8	
Foreign female chased	1	
During and/or following presence of male Chestnut-sided Warbler —singing on territory edge		23
Along Chestnut-sided Warbler territory edge in absence of Chestnut-sided Warbler		44
Prior to arrival of females in spring		heavily predominant (see Table 5)
Loud Unaccented Ending Song		
During and/or following presence of male Yellow Warbler on territory edge		68
Along Yellow Warbler territory edge in absence of other male Yellow Warbler		59
Intrusion of other Yellow Warbler into territory		22
Probable antiphonal singing between two males at greater distance than above		frequent
		N = 256

Where Yellow Warbler territories were bounded by Chestnut-sided Warbler territories, a strong tendency existed to give Accented Ending Songs along the edge bordering the Chestnut-sided Warbler territory in the male bird's presence and, especially after territories had been firmly established, even in its absence (see Table 2). Upon several occasions (including two interspecific fights) Yellow Warblers changed from Unaccented Ending Songs to Accented Ending Songs when they came into close contact with male Chestnut-sided Warblers, as might be expected if Accented Ending Song was being given in response to the male Chestnut-sided Warbler.

Unaccented Ending Songs.—Unaccented Ending Songs were heard at times that contact with other male Yellow Warblers was established (Table 1), almost every song preceding or following an actual overt hostile action being of this pattern (Table 3). In the few instances that normal volume Loud Accented Ending Songs were given immediately prior to overt hostilities, the singing birds probably were unaware of the individuals until the attack was launched. Unaccented Ending Songs also predominated when a male

TABLE 2

SONG PATTERN GIVEN ALONG EDGE OF OTHER WARBLER TERRITORIES BY YELLOW WARBLER

Pattern		Number of responses
Chestnut-sided Warbler territory		
Male Chestnut-sided Warbler absent		
Accented Ending Song		44
Unaccented Ending Song		9
Another male Yellow Warbler present	2	
Another male Yellow Warbler singing on a boundary common to individual concerned	2	
After fight with another male Yellow Warbler elsewhere	1	
No explanation	2	
Unaccented and Accented Ending Songs—no explanation	2	
Male Chestnut-sided Warbler present		
Accented Ending Song (includes four fights)		23
Unaccented Ending Song—another male Yellow Warbler present and singing		5
Yellow Warbler territory		
Male Yellow Warbler absent		
Accented Ending Song—female Yellow Warbler nearby in evidence		2
Unaccented Ending Song		59
Male Yellow Warbler present		
Accented Ending Song		0
Unaccented Ending Song		68
		N = 210

sang along the border of a territory adjoining another Yellow Warbler territory in the male's presence and in its absence after territories had been firmly established (see Table 2). It was again difficult to determine at times why this particular song was sung, but a definite stereotypy with respect to past encounters was apparently an important factor in the production of this song in particular parts of the territory also. The strong tendency to sing Unaccented Ending Songs along the edges of other Yellow Warbler territories even in the absence of another male is an example of this phenomenon, and much of the data in Table 2 is the result of it. Responses were more predictable along borders shared with other Yellow Warblers than they were along borders shared with Chestnut-sided Warblers. Both along Yellow and Chestnut-sided warbler territory edges, the responses were slightly more predictable when both males were present than when one bird sang along a temporarily undefended edge. Other observations suggested that in addition to the development of stereotypy, unanalyzable song patterns in these birds were in large part the result of immediately preceding activities, the presence of other birds not seen by the observer, or both factors.

TABLE 3

SONG PATTERN IMMEDIATELY PRECEDING AND FOLLOWING OVERT HOSTILITIES BETWEEN MALE YELLOW WARBLERS

Pattern preceding	Pattern following	Number of responses
Silent	Silent	1
Silent	Loud Unaccented	3
Muted Accented	Muted Accented	1 (one song, then Loud Unaccented)
Muted Unaccented	Silent	1
Muted Unaccented	Loud Unaccented	2
Loud Accented*	Silent	1
Loud Accented	Muted Unaccented	1
Loud Accented	Loud Unaccented	1
Loud Unaccented	Muted Accented	1
Loud Unaccented	Muted Unaccented	1
Loud Unaccented	Loud Unaccented	10
		—
		N = 23

* On the occasions that Loud Accented Ending Songs preceded overt hostilities, the birds involved appeared initially unaware of the other's presence, then attacked immediately.

Intermediate Songs.—Intermediate Songs were sometimes sung when the birds changed from one song pattern to another, and they appeared intermediate in motivation. This song type usually has a weak upslurred accented ending, but it is of an overall lackluster quality when compared to the Accented Ending Song. Intermediate Songs vary between typical Accented Ending Songs and typical Unaccented Ending Songs. Variations of Intermediate Song may be given by a single individual. The motivation resulting in production of Intermediate Songs may be comparable to that in Blackburnian Warblers (*Dendroica fusca*) (Morse, MS) and American Redstarts (Ficken, 1962) when they rapidly alternate their two basic song patterns. Neither of the two latter species appears to have a definite intermediate song. Yellow Warblers rarely if ever freely alternate Accented and Unaccented Ending Songs.

Silence and Muted Songs.—In moments of extreme aggression the birds were often silent, though occasionally Muted Unaccented Ending Songs were given (Table 4). Such phenomena were observed prior to or following a territorial encounter with another male, at a time that the two birds were situated very close to each other, or after a fight or chase. Ficken and Ficken (1965*b*) found similar responses in Yellow Warblers, Chestnut-sided Warblers, and American Redstarts. Occasional Muted Songs were also given during interactions between Yellow Warbler mates and between male Yellow Warblers and male Chestnut-sided Warblers. The occasional Muted Songs given in the

TABLE 4
ANALYSIS OF YELLOW WARBLER SONGS FOLLOWING SILENCE AND MUTED SONGS RESULTING FROM INTRUSION OF OTHER INDIVIDUALS

Stimulus	Song at time of stimulus	Song following stimulus	Number of responses
Yellow Warbler, male	Silence	Silence	3
	Silence	Muted Accented	1
	Silence	Muted Unaccented	3
	Silence	Loud Unaccented	7
	Muted Accented	Silence	1
	Muted Accented	Muted Accented	1*
	Muted Unaccented	Loud Unaccented	4
Yellow Warbler, female	Silence	Muted Accented	1
	Silence	Loud Accented	2
	Muted Accented	Loud Accented	1
Chestnut-sided Warbler, male	Muted Accented	Loud Accented	3
			N = 27

* One song, then Loud Unaccented.

presence of female Yellow Warblers and male Chestnut-sided Warblers were always Accented Ending Songs.

Chestnut-sided Warbler songs.—Briefer work conducted on Chestnut-sided Warblers in the study areas indicated that the contexts of their songs, which can also be separated into Accented and Unaccented Ending Songs, are similar to those of the Yellow Warbler. Chestnut-sided Warblers usually sang Accented Ending Songs when in the immediate presence of female Chestnut-sided Warblers and along Yellow Warbler territory edges both in the presence of and absence of male Yellow Warblers. Accented Ending Songs preceded and followed four interspecific fights that I observed. At this time Muted Accented Ending Songs were given by some individuals of both species, but no Muted Unaccented Ending Songs were heard. Unaccented Ending Songs were also heard when males were in close contact with other male Chestnut-sided Warblers and when working along territory edges of other Chestnut-sided Warblers. The Accented Ending Songs of Chestnut-sided Warblers are extremely species specific, but their Unaccented Ending Songs closely resemble the Unaccented Ending Songs of Yellow Warblers.

Conditions of high density.—The Damariscotta marsh contained the largest number of Yellow Warblers of any study area, approximately eight in an area of two hectares. It was the only plot studied in which Yellow Warbler territories were considerably smaller than one-third hectare. Significantly, this area contained birds that produced many less Accented Ending Songs (Table 5), and the overt hostile behavior here was more frequent than in any other

TABLE 5

TIME SPENT SINGING ACCENTED AND UNACCENTED ENDING SONGS IN LARGE TERRITORIES AND COMPRESSED TERRITORIES*

Date	Less than one-third hectare			One-third hectare or greater			Principal activity
	Acc.	Unacc.	Minutes	Acc.	Unacc.	Minutes	
Before 20 May	44.4	55.6	54	95.7	4.3	254	Before arrival of females and early arrival of females
20–31 May	13.6	86.4	44	47.2	52.8	671	Pair formation, nest building, egg laying
1–15 June	15.8	84.2	38	48.4	51.6	533	Incubation and early hatching
16–30 June	27.6	72.4	116	43.5	56.5	69	Young in nest and about nest
1–15 July	0.0	100.0	9	10.0	90.0	20	Young well fledged
			239			1547	

* Accented and Unaccented Ending Songs are recorded in percentages.

study area. Singing bouts and overt hostilities appeared to occupy the majority of the time and energy of the male birds through much of the breeding season. Fights and chases occurred more than five times as frequently here as they did in the Webster study area (1.7 fights and chases per hour to 0.3 fights and chases per hour), the difference in frequency being highly significant ($P < .001$). In Iowa, Kendeigh (1941) also noted a higher incidence of interactions where territories were very small than where they were larger. The individuals located in the areas of greatest density seldom if ever uttered Accented Ending Songs. Marginal individuals displayed a stronger tendency to produce Accented Ending Songs than did the central ones, especially on the part of their territory distal to the region of maximum concentration. In isolated pairs of Yellow Warblers there appeared to be the greatest tendency of all for the males to utter Accented Ending Songs, where moderate densities of the species occurred this tendency was lower, and where high densities occurred the tendency was lowest. Nevertheless, Unaccented Ending Songs were a conspicuous part of the repertoire of both the former groups of these birds. Unfortunately, my numerical data for lone birds are not sufficient for analysis.

Priority of activities.—Intraspecific territorial defense apparently claims priority over the activities usually associated with the Accented Ending Song, as suggested by observations of the birds of the Damariscotta marsh. When singing along Chestnut-sided Warbler boundaries, Yellow Warblers typically gave Accented Ending Songs, and Table 2 indicates that in 10 (and probably more) of the 14 exceptions when Unaccented Ending Songs were sung, another male Yellow Warbler was nearby. Similarly when a second male Yellow Warbler approached a pair during female solicitation or copulation, the territorial male almost immediately gave chase, and changed to Muted Unaccented Ending Songs and then Loud Unaccented Ending Songs following the chase.

Seasonal change in song pattern.—Similar to Ficken and Ficken (1965*b*), I noted a seasonal change in song patterns (Table 5), which appeared correlated with various stages of the reproductive cycle. Although this change also occurred in the Damariscotta marsh, during the period that young were fledged there was a very significantly higher percentage of Unaccented Ending Songs under these conditions of high density ($P < .001$ through 15 June, $P < .05$ from 16 to 30 June, and probably not significant in a small number of observations after 30 June) than in other situations. Though Accented Ending Songs were curtailed in the birds located in the center of the Damariscotta study area, this pattern was most frequent about the edge of the marsh at the time of and prior to pair formation. Both central and peripheral birds all appeared to have obtained females, and there was no indication that the central birds experienced more than the usual difficulties in doing so. However, I have no data on the nesting success of these center birds compared to those on the periphery and individuals studied in other plots.

DISCUSSION

The contexts in which the two main Yellow Warbler songs are sung suggest the following motivations: Unaccented Ending Songs are given when there is a strong attack tendency or a conflict of the attack and escape tendencies. Accented Ending Songs on the other hand occur in situations in which these tendencies are not strongly activated.

The presence of species-distinct Accented Ending Songs in pairing and subsequent reproductive activities probably decreases the possibility of actual or attempted mixed pair formation in Yellow and Chestnut-sided warblers that might follow if Unaccented Ending Songs were used for this purpose. Though the plumages of these two species are distinctly different, their favored habitats are often so dense that song may be a particularly important initial factor in species discrimination, and a distinctive song may eliminate considerable confusion among them. Songs of a species-distinct type delivered in the presence of males of the opposite species allow territorial birds to distinguish between species. Yellow and Chestnut-sided warblers in the study areas only overlapped each other in habitat preference rather than using the same habitat. The information that a bird is of the opposite species may indicate that it does not constitute as important a challenge as a bird of the territory owner's species. On one of the few occasions that a Yellow Warbler was observed singing Unaccented Ending Songs on the edge of a Chestnut-sided Warbler territory when not in the presence of other male Yellow Warblers, a Chestnut-sided Warbler was singing Unaccented Ending Songs nearby. Unaccented Ending Songs probably serve as a stronger threat of possible hostilities, both intraspecifically and interspecifically, than do Accented Ending Songs. The very indistinctness of the Unaccented Ending Songs of both species suggests an interspecific advantage (see Marler, 1957). This advantage may be that when a male bird strays into the other species' territory, any Unaccented Ending Songs given by the owner of the territory in the course of its activities serve to repress this intruder just as they would discourage a male of the same species as the territory holder.

Ficken and Ficken (1965*b*) noted that a Chestnut-sided Warbler singing only Unaccented Ending Songs was unsuccessful in obtaining a mate and that an American Redstart that sang only Unaccented Ending Songs was the last to obtain a mate. These observations suggest that at least in these two species, individuals using an Accented Ending Song at this time are more successful in obtaining a mate than are birds giving only Unaccented Ending Songs, but that at least in the American Redstart it is possible for a male to obtain a mate even if it lacks an Accented Ending Song.

Yellow Warblers in the Damariscotta marsh that sang very few if any Accented Ending Songs were successful in obtaining females and in maintaining the relationship through the breeding season. Males usually remained on the territories, which appeared well defined in contrast to the dense population of this species studied in a prairie community by Kendeigh (1941).

Yellow Warbler habitats, particularly those in the Damariscotta marsh, were often more open than those of the Chestnut-sided Warbler and American Redstart, and visual displays may form a more important part of pair formation than in the other two species. Also, the birds in the Damariscotta marsh probably were dominant individuals occupying optimal habitat rather than peripheral non-dominant birds. These individuals did not permit intrusions into their territories by other males to go unchallenged, as did the Chestnut-sided Warbler and American Redstart described by the Fickens. Perhaps the quality of the territory is of considerable importance in this species (see Ficken and Ficken, MS). Chestnut-sided Warblers and other closely related species were not observed in the middle of this marsh, so the use of the Accented Ending Songs in advertising to the female might not be as important here as in other areas where interspecific encounters occurred more often.

Though the Accented Ending Song is the pattern associated with the epigamic aspects of the breeding cycle it appears that it is of geologically younger origin than the Unaccented Ending Song, a conclusion also reached by Ficken and Ficken (1962) for several species of warblers possessing one essentially common song pattern. In 1961 and 1964 I studied three tropical members of this highly polytypic species, two of the "Mangrove" type (*D. p. bryanti* in northwestern Yucatan and in British Honduras and *D. p. xanthotera* in southwestern Costa Rica) and one of the "Golden" type (*D. p. rufivertex* on Cozumel Is.) and found that all of these birds sang one pattern, comparable to the Unaccented Ending Song and subject to considerable variability. Bond (in Griscom and Sprunt, 1957) implies a similar situation in other West Indian "Golden" Warblers, stating that their songs resemble the nondescript ones of North American forms, though occasionally being more melodious. None of the forms that I studied frequent areas occupied by closely related species. West Indian forms are only found outside the isolated mangrove habitat on small islands, which have a depauperate fauna (see Bond, 1930).

Thus populations of this group lacking closely related sympatric species possess a single (though variable) song, while others with closely related sympatric species possess two distinct, though less variable, patterns. It appears probable in this case that the species-specific Accented Ending Song developed in response to interspecific pressure as a way of rapidly distinguishing Yellow Warblers from other closely related species.

The taxonomic treatment of the *Dendroica petechia* group has long been a matter of controversy (e.g., Peters, 1927; Aldrich, 1942; Griscom and Sprunt, 1957). The apparent ability of some North American Yellow Warblers to obtain mates without singing Accented Ending Songs suggests that song itself would not be a completely effective isolating mechanism between these individuals and the tropical ones, should the breeding ranges of the populations ever come together. Thus the absence of the species-distinct song in this case could not be considered an adequate reason in itself for splitting these forms.

SUMMARY

From 1962 to 1965 the songs and accompanying behavior of Yellow Warblers (*Dendroica petechia*) were studied in Maine and Massachusetts. Breeding Yellow Warblers frequent low alders and willows, where they often are the only nesting species of *Dendroica*. In more mature growth this species is largely replaced by the Chestnut-sided Warbler (*D. pensylvanica*). Yellow Warblers possess both Accented and Unaccented Ending Songs. Accented Ending Songs were almost always given in the presence of female Yellow Warblers or male Chestnut-sided Warblers. Unaccented Ending Songs were given in the presence of other male Yellow Warblers. As the season progressed these songs became associated with certain parts of a territory, even in absence of an obvious stimulus. Intermediate Songs were sometimes sung when birds changed song patterns and appeared intermediate in motivation to the two major patterns. Silence or Muted Songs often occurred when two male Yellow Warblers were in close contact, and also when in close contact with female Yellow Warblers or male Chestnut-sided Warblers. A very low incidence of Accented Ending Songs occurred in one study area where territories were small and competition intense, but these birds obtained mates. Unaccented Ending Songs are probably sung when a strong attack tendency or a conflict of attack and escape tendencies exist. Accented Ending Songs probably occur when these tendencies are not strongly activated. The existence of two different songs probably serves effectively in

species recognition where closely related sympatric species are present. Tropical populations of Yellow Warblers studied sang only Unaccented Ending Songs and were the only warblers in the habitat.

ACKNOWLEDGMENTS

I wish to thank Drs. M. S. and R. W. Ficken for timely discussion and criticism of the manuscript. The Museum of Zoology and Department of Zoology at Louisiana State University sponsored my travel in tropical America while I was engaged principally in other investigations. The sound spectrograms (Fig. 1) were made from a phonograph record of the Federation of Ontario Naturalists (Borror and Gunn, 1958). This study was partially supported by the National Science Foundation (GB-3226).

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AN ANALYSIS OF WINTER BIRD-POPULATION STUDIES

J. DAN WEBSTER

BEGINNING in 1948, *Audubon Field Notes* has published a series of winter bird-population studies, at first under the editorship of Robert E. Stewart, and more recently Haven Kolb. Altogether, 506 studies have appeared in the 17 years. Apparently no one, heretofore, has had the temerity to make an analysis, but in thoughtful editorial comments, Kolb pointed out that Pacific Coast populations are more dense; and Stewart that more mesic habitats have higher densities.

The method of winter population studies should be explained briefly. The area studied is from 15 to 100 acres, although forest plots studied are nearly all between 20 and 60 acres. (Personally, I find that 20–30 acres is the best size for a forest area census by a lone observer.) At least 6 times during the winter a count is made in which all birds seen or heard on the area in a day are recorded and an average is taken. The counts are converted to a density of birds per 100 acres. Of course, a few census workers have very properly counted elongated habitats or edges in a linear fashion, as birds per mile.

My analysis here includes only forests (248 studies) and grasslands (25 studies), and edges have been omitted as far as possible. Many forest areas included, however, contain several species which are "edge species" in the sense of Kendeigh (1944) because of the edge effect of windfalls, small creeks and the like. I compared the very few counts from desert, marsh, and other

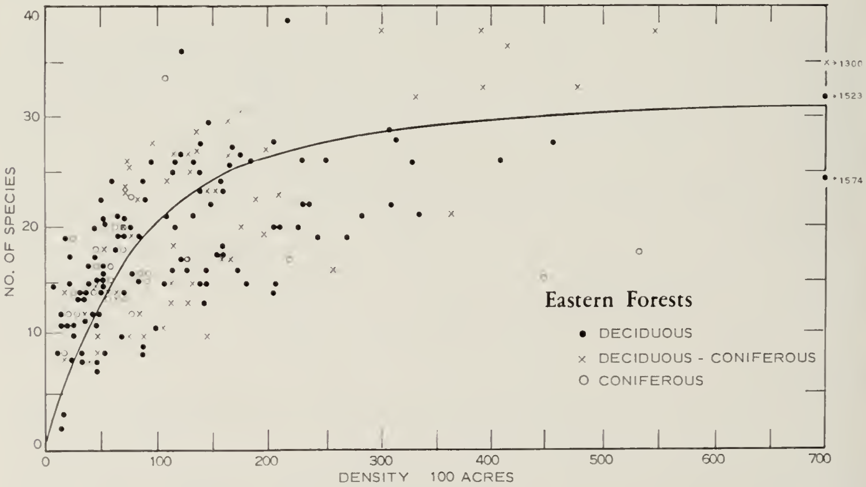

FIG. 1. Eastern Forests.

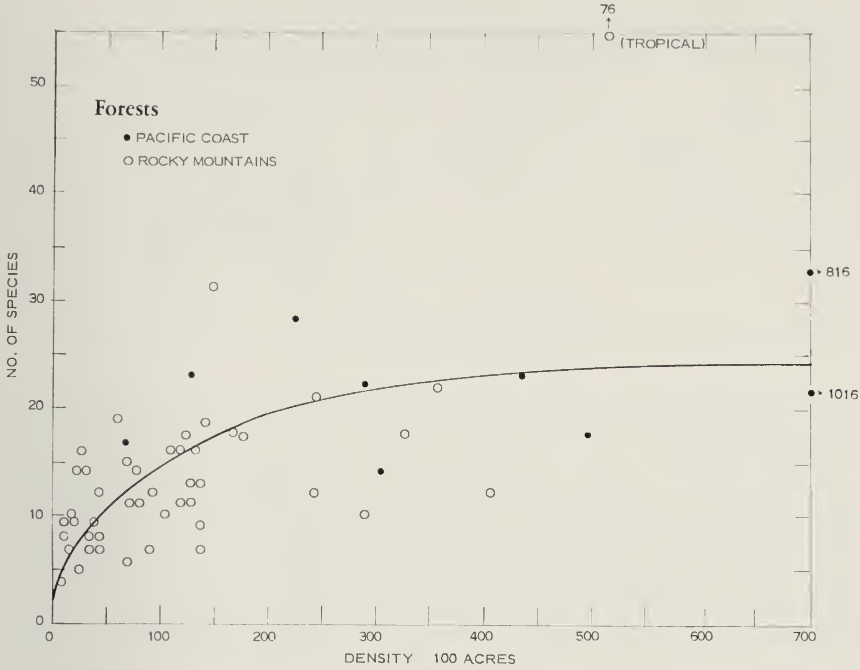

FIG. 2. Forests.

major natural habitats without reaching any conclusions worth mentioning. I lumped several areas of fairly dense woodland in with forest in crude fashion.

First I plotted species number against density, or species/density ratio (Fig. 1). Clearly, the data from eastern coniferous forests, eastern deciduous forests, and eastern mixed coniferous-deciduous forests approximate a parabola, with the higher values of the mixed forests (mostly southern pine mixed with oaks or gums) tending to higher species number than the other two habitats. In western forests a similar relationship appears, although the data from the Pacific Coast are scanty, with low values lacking (Fig. 2). A single count from tropical woodland is very high in species number.

In his analysis of breeding bird census data. Udvardy (1957) plotted similar curves. His tropical data described a steep straight line. I conclude. with Udvardy, that bird density in temperate forests and woodlands is dependent upon the number of niches and the number of species at hand to settle there. In tropical woodland, density is proportional to the number of species present, presumably reflecting a greater number of niches present and filled. The only thing surprising about this is that the winter data so closely support breeding figures.

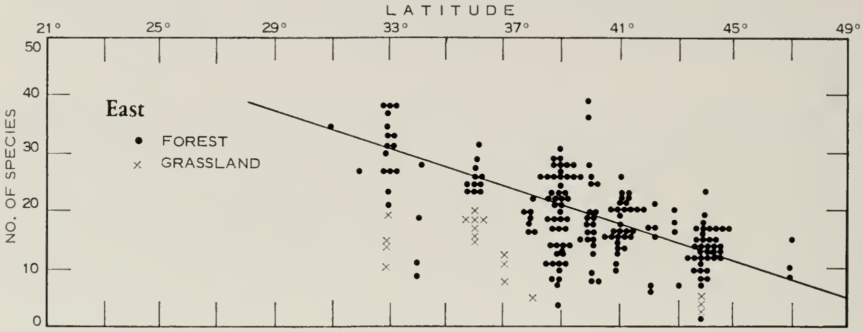

FIG. 3. East.

Grassland data are consistent with the above generalizations, but are too few to bear scrutiny.

Second, I plotted species number against the terrestrial latitude of the point where the census was made. In Figure 3, censuses from eastern deciduous forests appear as solid dots and censuses from various types of artificial grasslands in eastern United States (airfields, pastures, etc.) as crosses. The former approximate a straight line, with a regression of 1.6 species per degree of latitude northward. The grassland data would appear most consistent with an almost parallel, but lower, line to that of the forest data.

In the western Cordillera, or Rocky Mountain—Sierra Madre Occidental axis, Figure 4 shows forests as dots and grasslands (mostly prairie) as crosses again. The relationship is about the same—grassland parallel to, but lower

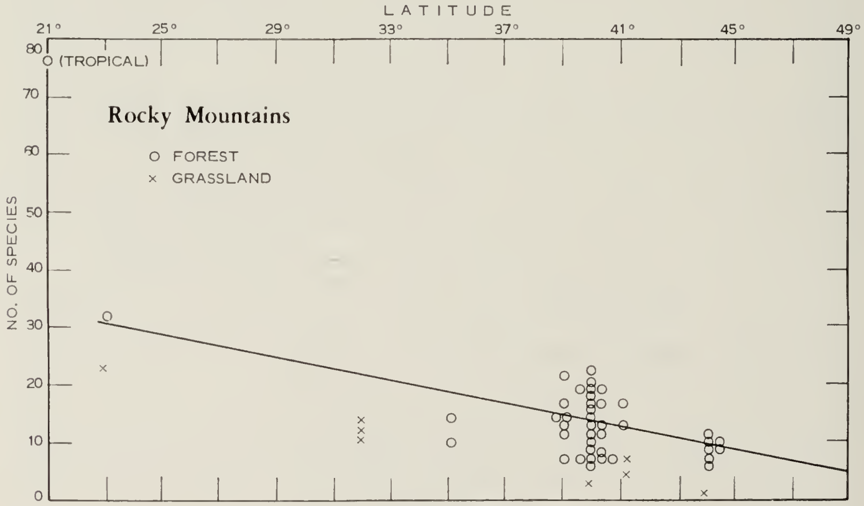

FIG. 4. Rocky Mountains.

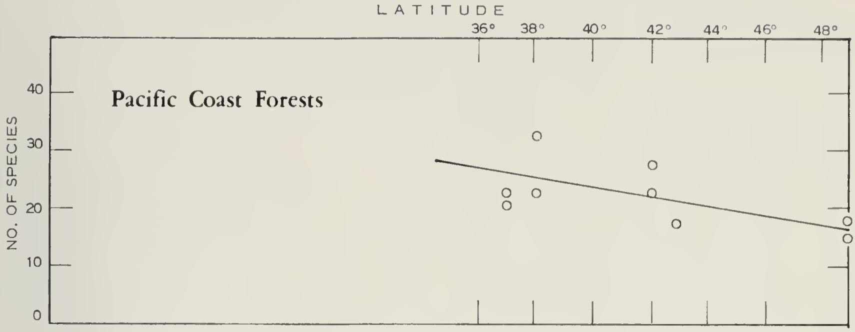

FIG. 5. Pacific Coast Forests.

than, a straight line for forest, the regression being 1 species per degree of latitude northward. A single tropical census is much too high, apparently representing an entirely different relationship.

Pacific Coast censuses (Fig. 5), representing forested localities from Santa Cruz, California, to southern British Columbia, suggest a straight line with a regression of 0.9 of a species per degree of latitude northward.

It would seem, then, reasonable to generalize that within each major temperate biome species number decreases by about 1 per degree of latitude northward.

Third, I plotted density against latitude. On Figure 6 are forest census data only—hollow dots from the Pacific Coast, solid dots from the East, and crosses from the Rocky Mountain—Sierra Madre Occidental axis. A curve has been drawn which approximates the Eastern data; a similar but lower curve would best represent the Rockies, and a similar but higher the Pacific Coast. Scanty grassland data (not shown) suggest the same type of relationship. In other words, density decreases northward, but at a decreasing rate as latitude increases. For the forest data, the vertices of the curves are at about 35° in the Rockies, 37° in the East, and 41° on the Pacific Coast. This suggests that long-lasting snow cover in the woods may be the limiting factor affecting density in the north and that some other factor may be limiting further south.

I am unable to derive any generalization from this relationship other than this: Different limiting factors operate on total bird densities within each major habitat north and south of about latitude 38°N. Notice that the tropical census is consistent with the others. Sorting that data into finer ecological classifications (coniferous forest, mixed deciduous-coniferous, spruce-fir, etc.) did not change the nature of the relationship, so far as I could see, and so they have not been plotted here.

Some theories for the origin of the migratory habit—the "Northern Ancestral Home Theory" and the "Southern Ancestral Home Theory"—need a

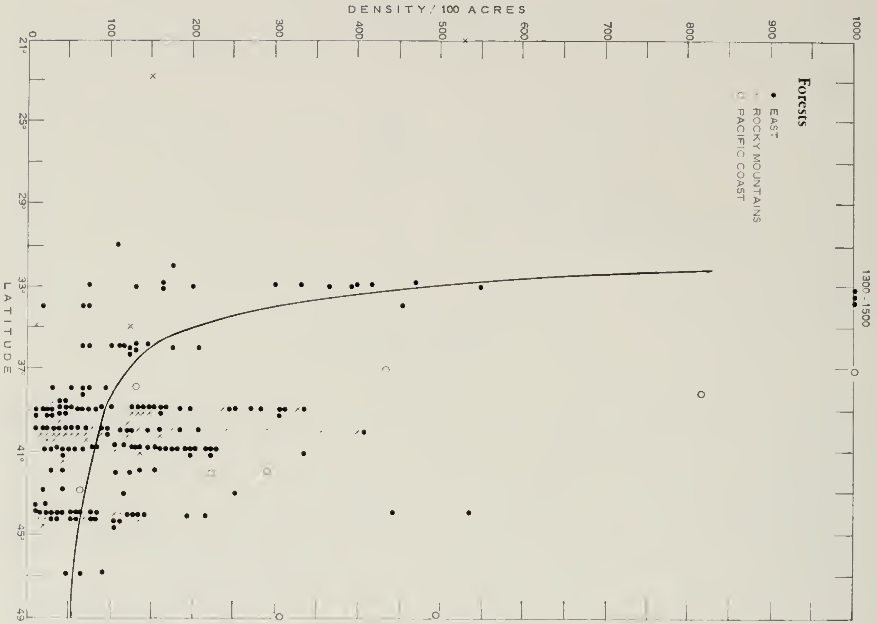

FIG. 6. Forests.

measure of the degree of crowding toward the equator in winter. For that matter, it is obvious that there is *some* equatorial crowding in Northern Hemisphere winter, because at that season many boreal birds have flown south to the tropics and few birds have flown south from the tropics into the Southern Hemisphere. Figure 6 provides a tentative measurement of the degree of southward crowding in winter.

Comparison of winter data with breeding bird censuses as reported in *Audubon Field Notes*, 1937 to 1964, is of interest (Table 1). For simplicity, the breeding bird densities, calculated on the basis of territorial males, have been doubled for comparison with these winter data which are calculated on individual birds. Breeding census data were taken from Udvardy's (1957) analysis; inspection of more recent censuses (1957–64) indicates no radical changes. In the forest censuses, species number in the mean of each major category rises by from four to seven species, winter to summer. Density rises from winter to summer in the mean of each category, also, multiplying by factors of from 1.5 to 4.4. In the grassland censuses, on the other hand, mean species number declines from winter to summer by five and density declines by almost one half.

Udvardy did not compare breeding data with latitude, but he did point

TABLE 1
SEASONAL CENSUS COMPARISON

	Winter			Breeding		
Area	Number of counts	Mean species number	Mean density	Number of counts	Mean species number	Mean density
Deciduous forest, Eastern	187	19	148	130	23	600
Deciduous-coniferous mixed forest, Eastern	55	21	175	46	28	490
Coniferous forest, Eastern	25	16	101	28	20	440
Coniferous forest, Rockies and Pacific Coast	48	13	165	26	19	254
All grasslands	26	12	278	21	7	150

All densities are per 100 acres; breeding densities are doubled from the originals, which were expressed as territorial males only.

out that densities in tropical forests and savannas tended to be higher than in temperate forests and savannas, although not above temperate extremes. Apparently the same is true of winter densities.

Perhaps future winter population studies from tropical and from far northern localities will make these preliminary hypotheses valid and meaningful.

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EXTERNAL PARASITES OF THE BLACK-BELLIED TREE DUCK AND OTHER DENDROCYGNIDS*

BURRUSS McDANIEL, DONALD TUFF, AND ERIC BOLEN

The waterfowl tribe Dendrocygnini represents a unique and largely unstudied segment of the world's avifauna. Some ecological aspects of the Black-bellied Tree Duck (*Dendrocygna autumnalis*) have recently been summarized for South Texas (McDaniel et al., 1962; Bolen, 1962, 1964; Bolen et al., 1964). Information regarding the external parasites of the Black-bellied Tree Duck has become available during the course of these studies. An additional survey of external parasites has been consolidated from the literature for all tree duck species.

HOST NOMENCLATURE

Because of what appears to be a host-specific relationship between the external parasites of the Black-bellied Tree Duck, some clarification regarding the bird's scientific nomenclature and geographic distribution is needed. Prior to 1947 the Black-bellied Tree Duck was regarded as consisting of two races, the distinctively gray-breasted *Dendrocygna autumnalis discolor* of South America and *D. a. autumnalis* of Central and North America. The host-specificity of external parasites was largely based on this terminology. However, Friedmann (1947) proposed that *D. a. autumnalis* was divisible into two races based on the coloration of belly and abdominal plumage. His designations, *D. a. fulgens* for Texas and northeastern Mexico and *D. a. lucida* for birds in the remainder of Mexico and Central America, have been recognized by the current AOU Check-list (1957) and are used in this paper for our descriptions of host birds. The reader should be aware, however, that many authorities dispute these races and continue to use the older nomenclature (cf. Delacour, 1954:47 and Conover, 1948:314 for further discussion). *D. a. discolor* remains recognized by all workers as the South American race.

Accordingly, parasite terminology may or may not agree with that of the host species. To avoid further confusion, Figure 1 is inserted with both the former and present nomenclature of the Black-bellied Tree Duck; Figure 2 shows *D. a. fulgens* taken at the collecting area, Lake Corpus Christi, Live Oak County, Texas. In the text, nomenclature follows that of the papers cited but, where need be, current terminology has been enclosed in brackets.

Following are species of the anatid tribe Dendrocygnini listed in phylo-

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* Contribution No. 94, Rob and Bessie Welder Wildlife Foundation, Sinton, Texas.

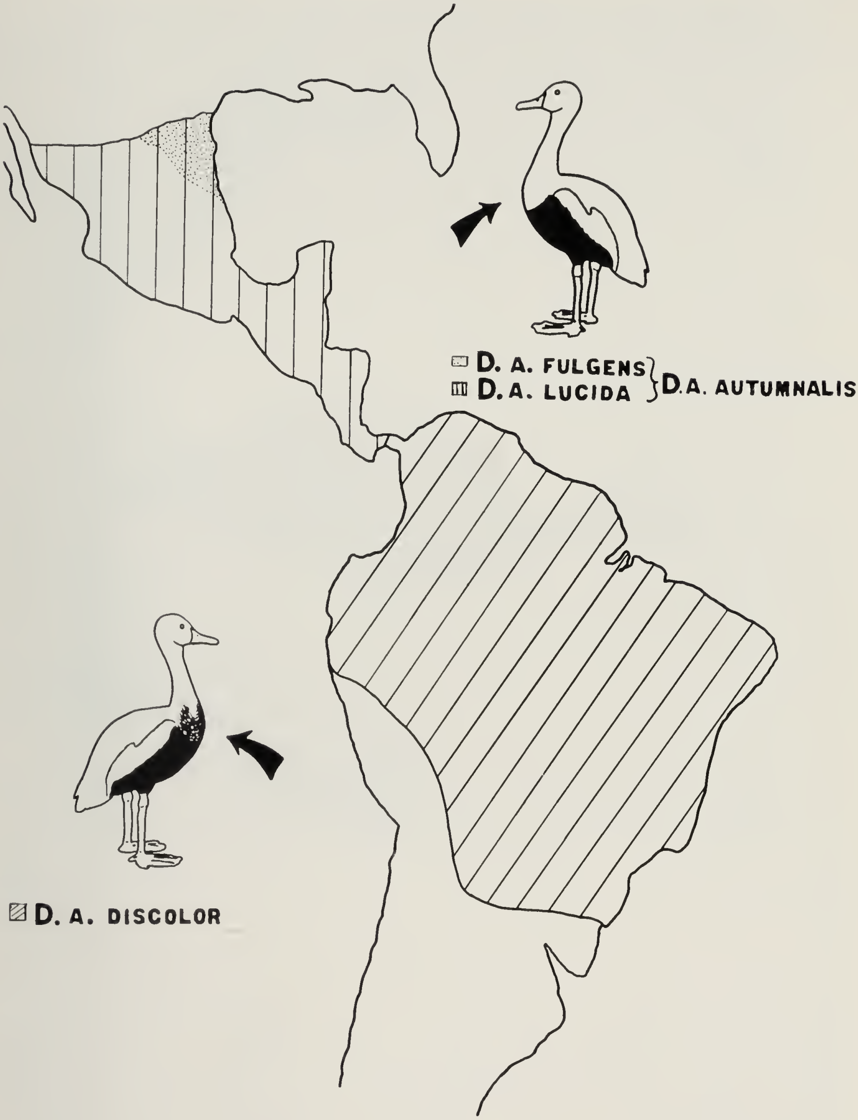

Fig. 1. Range map of Black-bellied Tree Duck and subspecies. Nomenclatural equivalents of Delacour (1954) and Friedmann (1947) as indicated.

genetic order, the most primitive at the top, the more advanced below, according to Delacour and Mayr (1945:11). Common names are taken primarily from Scott (1961:34).

FIG. 2. Northern race of Black-bellied Tree Duck at Lake Corpus Christi, Texas study area.

Black-billed, or Cuban Tree Duck[1]	*Dendrocygna arborea*
Spotted Tree Duck	*Dendrocygna guttata*
Black-bellied, or Red-billed Tree Duck	*Dendrocygna autumnalis*
Indian, Javan, or Lesser Tree Duck	*Dendrocygna javanica*
Fulvous Tree Duck	*Dendrocygna bicolor*
Wandering Tree Duck	*Dendrocygna arcuata*
Plumed, or Eyton's Tree Duck	*Dendrocygna eytoni*
White-faced Tree Duck	*Dendrocygna viduata*

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[1] Several authorities, mainly European, consider the tribe as "whistling ducks" whereas American authors utilize "tree ducks" for the group. The latter terminology is used here although it should be acknowledged that the implication of being tree-dwellers is not applicable to all species. Where several common names are given, the first listed will be used in this paper.

PARASITES OF THE ORDER MALLOPHAGA (CLASS INSECTA)

Acidoproctus hopkinsi Carriker, from *Dendrocygna autumnalis discolor* collected by M. A. Carriker at Simiti, Bolivar, Colombia, 31 March 1947.

A. h. mexicanus Carriker, from *D. a. autumnalis* (*D. a. lucida*) collected by C. Shaw at Tamuin, San Luis Potosi, Mexico, 19 September 1946; from *D. a. fulgens*, collected by J. Wiseman at Cameron County, Texas, December 1958.

Anatoecus dentatus autumnalis Carriker, from *D. a. autumnalis* collected by C. Shaw at Tamuin, San Luis Potosi, Mexico, 19 September 1946.

Trinoton aculeatum Piaget, from *D. a. fulgens* collected by Bolen and McDaniel at Lake Corpus Christi, Live Oak County, Texas, 16 September 1963.

Acidoproctus hopkinsi has been separated by Carriker (1949, 1954) on the basis of host specificity into two subspecies: *A. h. mexicanus* collected in Cameron County, Texas from the host *D. a. fulgens* (*D. a. autumnalis*); and *A. h. hopkinsi* collected in Simiti, Bolivar, Colombia from the host *D. a. discolor.* During the study of external parasites from Black-bellied Tree Ducks no specimens of *A. hopkinsi* were found even though this was a form especially searched for on all hosts examined. Therefore, the possibility of the subspecies *A. h. mexicanus* being elevated to specific rank cannot be definitely established. However, in a study of Carriker's figures of the genitalia (Carriker, 1949, 1954, 1960) there is considerable variation in these structures. Malcomson (1960) listed the following members of the genus *Acidoproctus* from *Dendrocygna*: *A. hopkinsi* from *D. autumnalis*; *A. maximus* from *D. arborea*; *A. rostratus* from *D. viduata. Anaticola chaetodens* was recorded from *D. bicolor.*

Anatoecus dentatus is commonly reported from members of the order Anseriformes. Emerson (1964*a*) states in his checklist that he follows the classification of *Anatoecus* given in the recent work by Keler (1960) and adds that a comprehensive study of the genus is still needed. Subspecies are established by the apparent host specificity. The subspecies from the Black-bellied Tree Duck (*D. a. autumnalis*) proposed by Carriker (1956) has only been taken from *D. a. fulgens.* This subspecies was found mainly infesting the head region of hosts collected in South Texas.

The genus *Trinoton* has been recorded from members of the family Anatidae. Emerson (1964*b*) found *Trinoton aculeatum* on two North American hosts, *Dendrocygna autumnalis* and *D. bicolor.* Clay (1963) examined numerous specimens of *Trinoton* from several species of *Dendrocygna.* She concluded that the populations of *Trinoton* on *D. bicolor, D. arborea,* and *D. autumnalis discolor* appear to be conspecific with *Trinoton aculeatum* from the type host *D. viduata. T. aculeatum* collected from *D. a. fulgens* establishes a new host record for this subspecies. During the present study only two Black-bellied Tree Ducks were found infested with these lice, with each bird having from one to three specimens on the body.

PARASITES OF THE ORDER ACARINA (CLASS ARACHNIDA)

Freyana dendrocygni Dubinin, from *Dendrocygna autumnalis fulgens* collected by E. Bolen and B. McDaniel at Lake Corpus Christi, Live Oak County, Texas, 5 August 1963 (male and female adult birds); 16 September 1963 (two adult males and a single juvenile male); 9 May 1964 (single female adult).

Brephosceles sp.,[2] from *D. a. fulgens* collected by E. Bolen and B. McDaniel at Lake Corpus Christi, Live Oak County, Texas, 5 August 1963 (male and female adult birds).

Leptosphyra sp.,[2] from *D. a. fulgens* collected by E. Bolen and B. McDaniel at Lake Corpus Christi, Live Oak County, Texas, 5 August 1963 (male and female adult birds); 16 September 1963 (two adult males and a single male juvenile); 9 May 1964 (single female bird).

Avenzoaria sp.,[3] from *D. a. fulgens* collected by E. Bolen and B. McDaniel at Lake Corpus Christi, Live Oak County, Texas, 5 August 1963 (male and female adult birds); 16 September 1963 (two adult males and a single male juvenile); 9 May 1964 (single female bird).

Eutrombicula alfreddugesi Oudemans from *D. a. fulgens* collected by E. Bolen and B. McDaniel at Lake Corpus Christi, Live Oak County, Texas, 5 August 1963 (male and female adults).

Freyana dendrocygni has been recorded from a wide range of *Dendrocygna* hosts (Radford, 1953, 1958; Dubinin, 1951, 1953): *D. javanica*, *D. arcuata*, *D. eytoni*, *D. bicolor*, and *D. viduata*. Two other species of *Freyana*, *F. largifolia*, and *F. furculasetae* are also recorded from *Dendrocygna*; *F. largifolia* from *D. bicolor*, and *F. furculasetae* from *D. guttata*. *F. dendrocygni* is predominantly a wing mite, but in heavily infested birds they may be found on the body. All metamorphic stages of the mite were found on the Black-bellied Tree Ducks collected in South Texas.

The discovery of members of the mite genera *Brephosceles*, *Leptosphyra*, and *Avenzoaria* on Black-bellied Tree Ducks establishes a new host record. The genus *Brephosceles* has been taken from other Anseriformes (Radford, 1958): *Anas platyrhynchos* (*Brephosceles anatina*), *Netta rufina*[4] (*B. agthinae*), and *Mergus merganser* (*B. forficiger*). *Leptosphyra velata* (Megnin) is described as taken from a member of the family Anatidae. The genus *Leptosphyra* is more frequently associated with the charadriiform hosts but is also recorded from other avian orders. The genus *Avenzoaria* Radford is somewhat restricted to Charadriidae and Scolopacidae hosts (Radford, 1958). Members of *Avenzoaria* on Black-bellied Tree Ducks now extend the host record to include the order Anseriformes. It is not uncommon to find Black-bellied Tree Ducks associating with Charadriidae and Scolopacidae species in South Texas. However, females and immature stages of this

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[2] These two mites were found to represent new species. Their descriptions are to be published in a forthcoming paper by the senior author in which other related members are treated.

[3] Only females and nymphs were found on this host. Without the male specific identification is not possible.

[4] The genus *Netta* contains the only species involving a cross with a tree duck, *Dendrocygna viduata* × *Netta peposaca* (Delacour, 1927).

mite were observed in large numbers on the Black-bellied Tree Ducks examined during this study. It is unfortunate that no males were secured making specific identification of this species possible.

The finding of *Eutrombicula alfreddugesi* is not surprising; it is the most common chigger found in the nesting region of Black-bellied Tree Ducks in South Texas. *E. alfreddugesi* has been recorded as a parasite of many vetebrate hosts, including birds (Radford, 1958).

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GENERAL NOTES

Head-scratching behavior of some hand-raised birds.—I report here on the head-scratching behavior of several species of birds that I have hand-raised during the past 10 years. By "hand-raising," I mean that I took nestlings or recently-fledged young and fed them until they became independent. I raised the Jungle Babblers, Red-vented Bulbuls, Common Ioras, Tailorbirds, and Common Bayas while at the Maharaja Sayajirao University of Baroda, Gujarat State, India, during the 1964–1965 academic year. The other birds I raised in my aviary at Ann Arbor, Michigan.

The following species that I raised scratched their head *indirectly* (that is, by bringing the foot forward and upward over the wing): Red-vented Bulbul (*Pycnonotus cafer*; Pycnonotidae), Common Iora (*Aegithina tiphia*; Irenidae), Tailorbird (*Orthotomus sutorius*; Sylviidae), Mockingbird (*Mimus polyglottos leucopterus*), Kirtland's Warbler (*Dendroica kirtlandii*), Common Baya (*Ploceus philippinus*), Cardinal (*Richmondena cardinalis*), Rose-breasted Grosbeak (*Pheucticus ludovicianus*).

This appears to be the first report of head-scratching behavior in the Red-vented Bulbul, Common Iora, Tailorbird, and Common Baya. Such behavior by other species belonging to the same families as these species has, however, previously been described by Simmons (1957. *Ibis*, 99:178–181; 1961. *Ibis*, 103a:37–49).

The following species that I raised scratched their heads *directly* (that is, by bringing the foot forward under the wing): Jungle Babbler (*Turdoides striatus*; Timaliidae), Cedar Waxwing (*Bombycilla cedrorum*), Yellow-breasted Chat (*Icteria virens*).

This is the first report for head-scratching behavior in the Jungle Babbler and for the Bombycillidae. Nice and Schantz (1959. *Ibis*, 101:250–251) reported direct head scratching by the Yellow-breasted Chat.

It has been established previously that there is some individual, generic, and familial difference or variation in head-scratching behavior (e.g., Nice and Schantz, 1959. *Auk*, 76:339–342; 1959. *Ibis*, 101:250–251; Ficken and Ficken, 1958. *Ibis*, 100:277–278; Dunham, 1963. *Auk*, 80:375). I have watched many adult Kirtland's Warblers on their breeding grounds and have never seen them scratch any way other than over the wing. Despite many hours of close observation of my hand-raised Kirtland's Warblers over a period of eight years, rarely did I observe head-scratching behavior. Only once did I observe direct head scratching, and this was by a bird approximately 14 months old. On the other hand, I have never seen a Jungle Babbler (either wild or captive) scratch its head any way except under the wing, nor did I ever observe my Yellow-breasted Chats use any other method than direct scratching.

In addition to individual difference, there is an ontogenetic pattern, at least in some species. The first attempts at head scratching by the Common Iora and the Tailorbird, for example, were made under the wing, but only because the birds had not yet developed adequate muscular coordination to maintain their balance on one leg while scratching their head with the other leg. Within a period of approximately 24 hours after their first attempts, however, neuromuscular coordination was established and thereafter the birds invariably scratched their heads over the wing. In fact, young birds have the "drive" or "urge" to scratch their heads before they are physically capable of doing so. This can be observed easily as a bird draws one leg forward with the "intention" of scratching but abruptly retracts the leg to regain balance simply because the bird is unable to support itself on one leg.—ANDREW J. BERGER, *Department of Zoology, University of Hawaii, Honolulu, Hawaii, 6 December 1965.*

Rough-legged Hawk catches fish.—On 29 May 1964 one of us (HCM) saw a Rough-legged Hawk (*Buteo lagopus*) sitting on the beach of Lake Michigan about 2.4 km east of Cedar Grove, Wisconsin. The hawk was sitting less than 2 m from the edge of the water and about 5 m from several sitting Herring Gulls (*Larus argentatus*). Upon closer approach the bird flushed, flew several hundred meters and again landed on the beach. The beach was littered with hundreds of dead alewives (*Pomolobus pseudoharengus*). Tracks in the sand indicated that the hawk had been walking about a great deal, picking at and eating portions of the dead fish. The bird was seen again on 30 May, perched approximately 3 m up in a willow (*Salix* sp.) about 50 m from the water. A bal-chatri trap (Berger, D., and F. Hamerstrom, 1962. *J. Wildl. Mgmt.*, 26:203–206), baited with a Starling (*Sturnus vulgaris*), was placed on the beach. The bird was observed (by RWM) to glide over the bal-chatri, apparently ignoring the Starling, continue out over the water and plunge into the water in the manner of an Osprey (*Pandion haliaetus*). After a few seconds the bird rose easily from the water and returned to its perch. Considerable numbers of dying and dead alewives were floating on the surface of the lake. After a few minutes the bird again glided out over the lake, plunged, and rose with a fish. The lake was quite calm, with practically no surf. The depth of the water at the points where the hawk plunged was about 30 to 60 cm. Later in the day NSM observed the hawk wading into the water, 10 to 15 cm deep, and picking at dead or dying alewives.

Although the Rough-legged Hawk is known to eat fish, and appears to have less of an aversion to water than most hawks of the genus *Buteo* (Bent, 1937. *U.S. Natl. Mus. Bull.*, 167:275, 277), we know of no previous record of this species actually plunging into the water to obtain fish. This incidental observation was made while the senior author was engaged in a study of bird migration supported by National Science Foundation grant GB 175.—Helmut C. Mueller, Nancy S. Mueller, *Department of Zoology, University of Wisconsin, Madison, Wisconsin (Present address: Department of Zoology, University of North Carolina, Chapel Hill, N.C.)*, and Robert W. Mueller, *Swarthmore College, Swarthmore, Pennsylvania, 7 October 1965.*

Osprey Nesting Survey.—In the summer of 1964, I worked as a "student assistant" at the Audubon Camp of Maine near Damariscotta, Maine. I did in my spare time a nesting survey of the local population of Ospreys (*Pandion haliaetus*) whose population as a whole has been sharply decreasing in the past several years, supposedly as a result of the use of biocides. My project was to collect empirical data on the nesting success. The area covered by the survey is that area of land and water plotted on the Louds Island, Maine, quadrangle map of the U.S.G.S. 7.5 minute series. The survey was concluded 10 August 1964.

The data were as follows: 13 located nests; 8 occupied nests; 5 unoccupied nests, 3 of them within the territory of other occupied nests; 1 nest started at the end of the summer but not included in these figures; 3 young hatched and fledged. Ideally an Osprey pair will hatch 3 young a year. If it had been a fully successful season, 24 young might have been hatched. Only 12½% of that number were.

There are no regular great population decreases among Ospreys as there are among some other bird and mammal species. The weather in the area was not extreme in any way. Double-crested Cormorants which *may* feed on different species of fish were quite plentiful and were successful breeders. Why were the Ospreys apparently affected as the cormorants were not?—Channing R. Kury, *246 Arch Street, Sunbury, Pennsylvania, 13 October 1965.*

Apparent lead poisoning in a wild Bobwhite.—This note reports a Bobwhite (*Colinus virginianus*) which apparently died in the wild from lead poisoning following ingestion of lead shot. The bird was found dead along a brushy fencerow bordering a harvested cornfield about one-half mile west of Stephen A. Forbes State Park, a public hunting area, near Omega, Marion County, Illinois, on 17 December 1964. Autopsy of the fresh and intact carcass revealed no gunshot wounds nor any other obvious cause of death. The

Fig. 1. Normal (left) and apparently lead-poisoned (right) Bobwhites and their respective gizzards. Photo by Wilmer D. Zehr, Illinois Natural History Survey.

quail probably died on 16 December, during an influx of cold weather. The bird, a juvenile female, was presumably a member of a nearby covey from which a second juvenile female, considered to be normal, was collected on 17 December 1964. Both quail had completed their postjuvenal molting.

Although both had well-filled crops and gizzards containing weed seeds and cultivated grains, plus grit in the gizzards, there were four lead shot in the gizzard of the quail found dead. The emaciated condition, enlarged gizzard, and discolored (dark red-lavender) flesh of the bird with the lead shot, which weighed only 130 grams, was in sharp contrast to the normal bird, which weighed 171 grams (Fig. 1). The shot were eroded to a diameter of about 1.5 mm or about the size of No. 11 shot.

Lead poisoning among waterfowl is well known but is rarely observed among gallinaceous birds. In New Mexico, Campbell (1950. *J. Wildl. Mgmt.*, 14:243–244) found a dead Scaled Quail (*Callipepla squamata pallida*) with 13 lead shot in its gizzard. Among wild pheasants, reports of lead poisoning are also rare (Hunter and Rosen, 1965. *California Fish and Game*, 51:207).

Stoddard (1931. "The Bobwhite Quail: its habits, preservation and increase") reported that a single shot pellet retained in the gizzard is sufficient to cause death from lead poisoning among penned quail up to 41 days of age and that one adult Bobwhite from Texas, which was liberated in Florida, died with two lead shot in its gizzard. Mortality of quail from ingested shot could conceivably reach significant proportions on intensively hunted areas without being noticed. As shown by Rosene and Lay (1963. *J. Wildl. Mgmt.*, 27:139–142) dead quail are rarely found in the wild, due to rapid decomposition, scavenging animals, and the density of their habitat.—RONALD L. WESTEMEIER, *Section of Wildlife Research, Illinois Natural History Survey, Urbana, Illinois, 7 December 1965.*

Ring-necked Pheasant moves newly hatched young.—On 5 June 1954, at Metropolitan Beach, Macomb County, Michigan, I discovered a nest of the Ring-necked Pheasant (*Phasianus colchicus*) in which six of the ten eggs had hatched—apparently within the last few hours. The female ran some distance away through the tall grass and disappeared from sight. When I returned to the nest about two hours later all of the young were gone, leaving four unhatched eggs. I looked carefully through the grass to see how far the young had scattered, as some of these were still not dry at the first observation. About 25 feet away I found all of the young in a hastily scratched and wallowed depression around which tangled grass stems had been gathered. Under normal circumstances the female would probably not have tried to lead the young away from the nest until sometime the next day. Whether the female would have continued incubation on the remaining four eggs after removing the young is doubtful. I moved the unhatched eggs and placed them in the cavity under the young. In the late afternoon, before leaving the area, I returned to find the young still at their last location. None of the unhatched eggs had yet been hatched. I was unable to return to the place later, and hence did not learn what the final outcome was. I have found no reference to this behavior in the literature on this species.—WALTER P. NICKELL, *Cranbrook Institute of Science, Bloomfield Hills, Michigan, 22 November 1965.*

Ring-necked Pheasants hatch in nest of Blue-winged Teal.—On 26 June 1954 near Metropolitan Beach, Macomb County, Michigan, I found the nest of a Blue-winged Teal (*Anas discors*) containing 11 eggs. In the same nest were two of the smaller olive-brown eggs of the Ring-necked Pheasant (*Phasianus colchicus*). One week later I again visited the area and was fortunate enough to find two pheasants, one with dry down feathers, the other newly hatched in the nest. None of the teal's eggs had hatched and none gave sounds of pipping activity. Under ordinary circumstances the incubation periods of the two species have been listed as 23 days maximum for the teal (Bergtold, W. H., 1917. "Incubation Periods of Birds," p. 81) and 25 days for the pheasant (Bent, A. C., 1932. "Life Histories of North American Gallinaceous Birds," p. 314) although 81.7% of 656 eggs listed by Bent hatched on the 23rd day. It has been generally assumed that Michigan ducks do not start incubation until the last egg is laid. This same is apparently true of the gallinaceous birds, including the pheasant. I cannot explain this apparent discrepancy in the hatching times of the two species in this nest.

Two years before, on 31 May 1952, I had found one egg of the Ring-necked Pheasant in the nest of the Blue-winged Teal in the same locality. The nest contained 8 eggs of the host (Fig. 1). Two other observers in this same locality reported Blue-winged Teal's nests containing the eggs of Ring-necked Pheasants. The first of these was reported (Detroit Audubon Survey Nesting Card) by Mrs. Irene Jasper. This nest contained 6 eggs of the host and one of the pheasant on 7 May 1952. The second nest on 28 May 1955 contained 12 duck eggs and two pheasant eggs (also Detroit Audubon Survey Nesting Card report, by Mrs. B. J. Johnston). The second observation on the following 2 June by Mrs. Johnston revealed two one-day-old pheasants on the back of a teal. These were photographed by William Hopkins. The two young pheasants were placed in the nearby nest of a teal which already contained eggs. Again, as in the first instance, the teal's eggs had not hatched.

Fig. 1. Egg of Ring-necked Pheasant in nest of Blue-winged Teal, Metropolitan Beach, Macomb County, Michigan, 21 May 1952.

It is well-known that under certain circumstances Ring-necked Pheasants not uncommonly lay one or more eggs in the nests of other birds of their species and occasionally in the nests of chickens, Bobwhites, Ruffed Grouse, and Sooty Grouse (Bent, A. C., op. cit.) but apparently nothing is known of the fate of the pheasant's eggs under these conditions. On 16 May 1953 Dr. D. S. McGeen, in Waterford Township, Oakland County, Michigan, found three eggs of the pheasant in the nest of a Bobwhite (*Colinus virginianus*) in which there were 8 of the host's eggs.

I believe that the pheasants' laying in the nests of Blue-winged Teals mentioned above was due to the destruction of the pheasants' nests by grass cutters and lawnmowers in the park area. This destruction probably caused the pheasants to seek other nests in which already-formed eggs could be laid.—WALTER P. NICKELL, *Cranbrook Institute of Science, Bloomfield Hills, Michigan, 22 November 1965.*

Tufted Titmouse destroys bagworms.—Several times during August 1965, I found a bagworm (*Thyridopteryx*) lying on the grass under a large pine tree in our yard in La Grange, Lewis County, Missouri. Yet no bags were visible on the tree. Each bag had been opened and the "worm" was missing.

On the morning of 20 August, a Tufted Titmouse (*Parus bicolor*) carrying a bagworm, flew from a neighbor's ornamental evergreen into our pine. After working perhaps 30 seconds, the bird raised its head and gulped down some fairly large object. At the same time, the bag dropped lightly to the ground. Examination showed that the "worm" was absent and the upper end of the bag had been snipped off as neatly as if done with scissors—unlike the ragged tear in a cocoon robbed by a woodpecker.

Then I recalled that a family group of titmouses habitually visited the area, each morning, and centered activities around my neighbor's evergreen which was very heavily infested with bagworms. Before the next morning, my alarmed neighbor had disposed of his infested shrub. The titmouses ceased their regular visits and no more empty bags were found.—HENRY HARFORD, *Route 1, Box 1192, Mount Dora, Fla. 32757, 26 November 1965.*

Melanism in the Ovenbird.—A melanistic Ovenbird (*Seiurus aurocapillus*), was mist-netted at the American Museum of Natural History's Kalbfleisch Field Research Station, Huntington, New York (Long Island), on 4 September 1965. This bird, an immature female, had completed its first prebasic (postjuvenal) molt and was not fat. Mensurally, the specimen (A.M.N.H. 785767) falls within the range of variation of 32 fall females of *S. aurocapillus* examined. It appears to be aberrant only with respect to the greater intensity of melanin pigment in areas of the plumage that are normally dark (streakings on the breast and flanks, lateral crown stripes, and moustachial streaks) and the presence of melanin in regions where dark feathers normally are not found (pileum, throat, malar region, superciliary region, undertail coverts, and central back region). In addition, the bill is decidedly darker and the tarsi and feet are slightly darker than normal.

I know of no previously published report of such extreme melanism in *Seiurus*, and Dr. Stephen Eaton has written me that his studies of the genus uncovered nothing of this nature. Two additional melanistic specimens of *S. aurocapillus* were called to my attention, however, in response to inquiries sent to a number of museums. (1) Dr. Lester Short, Jr., of the U. S. National Museum, sent me a specimen (female, U.S.N.M. 375991) collected by John B. Calhoun near Emory University, Dekalb Co., Georgia, on 5 October 1943. It differs from the New York bird in having melanin still more profusely distributed in regions that are normally not so pigmented, including the throat, malar,

FIG. 1. Melanistic Ovenbird, located at the right in these dorsal and ventral views, is compared with a specimen of normal plumage.

and auricular areas. By virtue of this more extensive distribution of melanin, the Georgia specimen superficially appears darker than the New York bird, but, in actuality, the dark areas are grayer (less black). In 1953, Dr. Alexander Wetmore marked on the specimen label: "melanistic probably *furvior*." The Newfoundland race (*S. aurocapillus furvior*), described by Charles Batchelder in 1918, averages darker and more intense in coloration than the nominate form. (2) William Jolly, of the Museum of Comparative Zoology at Harvard, sent me a specimen (female, M.C.Z. 275952) collected by W. E. D. Scott near Kingston, Jamaica, on 29 November 1890. Though this specimen is less conspicuously melanistic than the New York and Georgia birds, it is unique in having melanin deposits in the lores and more or less at random throughout most of the remiges and rectrices as well.—WESLEY E. LANYON, *American Museum of Natural History, New York*, 27 October 1965.

Bachman's Sparrow in Oklahoma.—On 20 January 1965, I collected a female Bachman's Sparrow (*Aimophila aestivalis*) in an ecotone area of Post Oak-Blackjack Oak woodlands and open grassland about 12 km northeast of Ada, Pontotoc County, in south-central Oklahoma. This habitat is characteristic of a large segment of the state (Duck & Fletcher, 1945. "A Survey of the Game and Furbearing Animals of Oklahoma"). The bird appeared to be in good condition and had extensive subcutaneous fat deposits.

The wing measures 61.5 mm; the tail measures 50 mm, but the rectrices are not fully grown. It appears that the whole tail was being replaced at the same time as the rectrices are all sheathed at the base. The specimen was identified as *Aimophila aestivalis illinoiensis* by George M. Sutton.

This is the sixth specimen for the state, and the first since 1937. Nice (1931, "The Birds of Oklahoma," Univ. of Okla. Biol. Survey) records a specimen taken by G. W. Stevens in Woods County in northwestern Oklahoma. Four specimens, three males and a female that was laying eggs, are reported by Sutton (1938. *Auk*, 55:507–508). These were taken on 23 April 1937 about 2 km east of Bethel in northern McCurtain County in the southeastern corner of the state. Several competent field observers have worked this area in recent years; but, to my knowledge, the only other record for the area is given by Baumgartner (1954. *Audubon Field Notes*, 8:261) in which he reported sight records by Tom Jessee on the McCurtain Game Preserve from December 1953 to 12 February 1954—no specimens were taken. I worked the Preserve extensively during the summers of 1961 and 1962 and have continued to make trips there at different seasons without finding this form. The Preserve is about 16 km east of the point where Sutton took the four specimens in 1937.

I wish to express my appreciation to George M. Sutton for subspecific identification. —William A. Carter, *Department of Biology, East Central State College, Ada, Oklahoma.* 28 October 1965.

THE NEXT A.O.U. CHECK-LIST OF NORTH AMERICAN BIRDS

The A.O.U. Committee on Classification and Nomenclature, with the acquiescence of the Council, has decided to extend the area of the next A.O.U. Check-list to cover all of geographic North America through Panama and including the West Indies. Hawaii will also be treated, possibly by way of appendix.

As a contribution to the project, ornithologists are requested to send to the Chairman of the Committee, at the address given below. copies of their papers affecting the distribution, classification, nomenclature, or ecology of birds in the area of the forthcoming Check-list, where they involve changes from the treatment in the last A.O.U. Check-list or in currently used distributional works dealing with Middle America, the West Indies, or Hawaii. To facilitate filing and reference it would be appreciated if at least two copies of each paper were sent where more than one species is treated.

Unpublished corrections of the last Check-list would also be useful, provided the information relating to each species is submitted on a separate sheet or card, with clear indication of the situs of any specimen involved or of the literature or other data relied upon. Unpublished sight observations are not solicited, because the A.O.U. Committee is in no position to screen them and the A.O.U. Check-list cannot include the details on which they might be judged by others.—Eugene Eisenmann, Chairman *A.O.U. Committee on Classification and Nomenclature, The American Museum of Natural History, New York, New York 10024.*

ANNUAL REPORT OF THE CONSERVATION COMMITTEE

The good news at the time of the University Park meeting was the reprieve given the California Condor by the voters of Ventura County when they turned down a referendum authorizing a local Water Conservation District to enter into a contract with the federal government for a project that would have required building a road across the Sespe National Condor Sanctuary. The decision was close, however, only 7531 nays to 7499 yeas, and the District is currently trying to get another vote authorized.

In June, an 85,000-acre fire ravaged the San Rafael Wilderness Area in the Los Padres National Forest, but the two condor sanctuaries (Sisquoc and Sespe) were still several miles to the east of the fire when it was stopped. The wildlife kill and vegetative regeneration which attends such fires may provide extra condor food in much less disturbed countryside than the birds normally visit.

LAND USE

The above emphasis on habitat conditions stresses the controlling role that our remaking of the landscape plays in the perpetuation of wildlife. Grandiose plans to build Rampart Dam on the Yukon River in central Alaska fortunately may have been dealt a death blow by the perceptive analysis provided by Dean Stephen H. Spurr of the School of Natural Resources at the University of Michigan, and five other colleagues. This study was financed by the nation's several conservation organizations through the Natural Resources Council of America, and represents a sound example of rallying science in opposition to vested interests in development for limited aims. The regional director of the U.S. Fish and Wildlife Service said of the proposed dam, "Nowhere in the history of water development in North America have the fish and wildlife losses anticipated to result from a single project been so overwhelming." (see Brooks, 1965; Leopold et al., 1966; Spurr et al., 1966).

That America is at last waking up to the conflicts in land use that are inherent in our current devotion to continued growth in population and production is evident in hearings on Senate Bill 2282, introduced by Senator Gaylord Nelson, Wisconsin. Called the Ecological Research and Surveys Bill (there are now companion measures in the House), it received enthusiastic backing from the nation's research ecologists on 27 April before the Senate Interior Committee.

Some questioned whether this program should be housed in the Department of the Interior, as now proposed, or somehow given higher standing within the Executive Department so that it could impose ecological coordination on the conflicting programs of several of the federal departments. Even Interior has difficult and disruptive conflicts of interest within its own organization, as exemplified by some of the approaches of the Bureau of Commercial Fisheries and the Bureau of Land Management.

THREATENED SPECIES

On 13–15 April in Washington, the Smithsonian Institution, with the help of The Conservation Foundation, held an important Conference on the Conservation of the Avifauna of Northern Latin America. As Dr. William Vogt, one of the originators, pointed out, several hundred species of migratory birds which occupy seven million square miles of the United States and Canada funnel southward through somewhat less than one million square miles of Mexico and Central America, and land use changes in these migratory lanes and in the terminal wintering grounds have been drastic in recent decades. These changes may become serious factors in the survival of many North American populations. We know rather little of the statistics of land use in Latin America, though the trend is toward deforestation, loss of diversity, and dessication of habitats. If hazards to North American migrant birds are to be avoided, we must find ways of helping our Latin friends to educate their own people to the values of wildlife, and press all the land-use agencies, including the U.S. Agency for International Development which administers much of our Alliance for Progress contributions, to adopt an ecosystematic approach. Unfortunately, this involves asking the people of Latin America to do what we have not truly succeeded in doing in our own country!

One outgrowth of this Conference was a new awareness for many participants that there has, of recent years, been a great increase of traffic in birds of all kinds—indeed in almost all animals—for the pet trade, and that this is now of truly alarming proportions and calls for national legislation if it is to be controlled.

Equally surprising to many in attendance was the fact that the U.S. Fish and Wildlife Service has no control over the importation of exotic species, for release and propagation by the several state fish and game departments, many of whom have been enthusiastic proponents of introducing new game species. Gordon W. Gullion's fine article (1965) on this problem deserves wide reading.

Through the Agricultural Experiment Station of Oregon State University at Corvallis, the Department of Fisheries and Wildlife of that State—thanks apparently to the prompting of its chief, Dr. Thomas G. Scott—has begun the publication of a series of Special Reports on "Endangered Plants and Animals of Oregon." Two, on fishes and reptiles and amphibians, have been issued to date. These lists give short status reports, and include distribution maps. They are a welcome and important adjunct to the U.S. Fish and Wildlife Service's "redbook" of threatened species, and are deserving of emulation by all State administrations.

Thanks to a 1965 appropriation of $350.000. the Bureau of Sport Fisheries and Wildlife has embarked on the first phase of a research and propagation program designed to help threatened species of American wildlife. A new unit is being developed for this purpose at the Patuxent Wildlife Research Center near Laurel, Maryland, under the direction of Dr. Ray C. Erickson.

The initial emphasis is properly placed on studies of the ecology of remnant populations. Winston E. Banko has been assigned to Hawaii to study a number of endangered birds there; Fred C. Sibley is extending the basic studies (see Koford, 1953; Miller, McMillan, & McMillan, 1965) of the California Condor; Donald K. Fortenbery is studying the black-footed ferret in South Dakota: and Norman E. Holgersen is studying the Everglade Kite and other rare southeastern species. C. Eugene Knoder is head of a new propagation unit, working with captive Whooping Cranes and Argentine Snail Kites, the latter being studied only for possible methods that might later help bolster the Florida Everglade Kite.

The success of this well-designed program of course depends on continuing Congressional support. Senator Karl E. Mundt has taken a special interest in this work and H.R. 9424, the Endangered Species Bill, passed in the House, awaited clearance by a Senate Committee as this report went to press in late June. One minor hitch was the opposition of the National Audubon Society to one provision of H.R. 9424 which would open all national wildlife refuges to hunting, at the discretion of the Secretary of the Interior. Hunting on federal refuges is now limited to no more than 40 per cent of each such area. The Society has endorsed the bill's other provisions. (Callison, 1966).

PESTICIDES

The chemical pesticides issue continues to be of broad concern, since there have been few official implementations of the 1963 President's Science Advisory Committee recommendation that we bring about an orderly reduction of the use of persistent insecticides. Only Secretary Udall's Interior Department and a few states have directed that the use of DDT and other persistent chlorinated hydrocarbons be stringently restricted. In the case of the states, it was usually only the Conservation Department that acted. Several states now have Pesticide Control Boards, but none of them has yet shown any important leadership in changing the pattern of chemical *use.* The emphasis is on "safe use," reflecting the naive notion that environmental contamination can be kept "below significant levels" when one is dealing with a long-lived toxin that is cycled through food chains and thus concentrated. A public symposium on the Scientific Aspects of Pest Control was conducted by the National Academy of Sciences in Washington 1–4 February, the fly in the ointment being that Mississippi Congressman Jamie L. Whitten was allowed to bombast the audience with his version of the indispensibility of chemical pest control in human welfare.

Of special interest was the publication of another President's Science Advisory Committee report (Tuckey, 1965) on environmental contamination and its forthright recognition of the fact that a whole generation of agricultural extension workers would have to be reoriented along ecological lines.

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WOS Conservation Committee
John W. Aldrich
Roland C. Clement, Chairman
Alexander Sprunt, IV

THE PRESIDENT'S PAGE

Our Society's Executive Council consists of the Officers, the 3 Elective Members, and the Past Presidents. Presently, there are 22 members of the Council; their names can be found on Page 341 in *The Wilson Bulletin* for September 1966. On pages 332–333 of that same number of the *Bulletin*, our Secretary, Pershing B. Hofslund, has summarized the principal actions of the Executive Council at its 1966 meeting. As can be seen under items 1–3 of these principal actions, an important duty of the Council involves determining where future Annual Meetings are to be held.

Turning again to the September 1966 *Bulletin*, we find (p. 376) a breakdown of the geographical distribution of the Society's membership. This shows the extent to which a large proportion of our membership is concentrated in the states and the province bordering on the Great Lakes. This fact carries some weight in the Council's determinations about the sites of Annual Meetings, for the feeling has been that our Meetings should be within reasonably convenient range of the geographical center of our membership.

The geographical breakdown also shows, however, that California, with 75 members, follows New York, Michigan, Ohio, Pennsylvania, and Illinois, in that order. Moreover, 178 members live within the 11 states and 3 provinces comprising the area which includes, and extends westward to the Pacific from, Saskatchewan, Montana, Wyoming, Colorado, and New Mexico.

At its next scheduled meeting, in June 1967, the Council will act upon a proposal that the Wilson Ornithological Society should consider the feasibility of a joint meeting with the Cooper Ornithological Society, at some future date, "somewhere in mid-continent." If a line connecting Winnipeg, Manitoba, and Brownsville, Texas, represents a fair approximation of mid-continent, the question arises: how far west of that line would it be practicable for the Wilson Society to meet? In 1965 we enjoyed an excellent meeting in the Back Hills of South Dakota, slightly west of the Winnipeg-Brownsville line. Should the Wilson Society consider meeting at some location which is as far west as the Black Hills, or even more so?

The foregoing is by way of background for saying that the Council, which will have this matter for consideration, would appreciate any comments from Wilson Society members regarding their feelings about a possible future Meeting at a site somewhere along, or to the west of, the Winnipeg-Brownsville line. The Council can best make a determination if it is aware of the wishes of the members of our Society.

Aaron M. Bagg

ORNITHOLOGICAL NEWS

Once again it becomes the Editor's pleasant job to publicly thank all those persons whose assistance made possible the preparation of the volume just completed. As usual the services of the Editorial Board, whose names appear on the back cover, were invaluable. In addition to these many other ornithologists kindly reviewed papers. C. Chandler Ross bore the large burden of preparing the Membership List which appeared in the September issue. The other Officers and Committee Chairmen were unfailingly responsive to requests made of them. Very special acknowledgment should be made to Don Eckelberry who painted the portrait of the *Ciccaba* owl expressly for the March issue. Miss Mildred Stewart prepared the index to Volume 78.

President Aaron Bagg has announced that Nominating Committee for 1967 will consist of: Phillips B. Street, Chairman; Maurice G. Brooks; and Roger T. Peterson. Any WOS member who would like to make suggestions to the Nominating Committee should feel free to contact any of these gentlemen before the Annual Meeting in June.

Any member of the WOS who has a resolution he would like to have considered by the Resolutions Committee at the next Annual Meeting should communicate the fact to the Secretary, who will turn it over in due course to the Resolutions Committee when the latter is appointed.

President Bagg has appointed the following Committee on Complimentary Student Memberships: Maurice G. Brooks, Chairman; H. Lewis Batts, Jr.; and Stephen W. Eaton. Undergraduate students at all colleges and universities in the United States and Canada will be eligible for these awards.

The Cornell Laboratory of Ornithology would like to remind contributors to the North American Nest Record Card Program to return their nest record cards for the 1966 breeding season as soon as possible. Last year over 25,000 completed cards were returned. Research workers are also reminded that these data are available for their use upon request.

The Eastern Birdbanding Association announces an annual award of $100 to be made to a student, either graduate or undergraduate, who is using bird banding as a part of a research project. Applications for this award should be submitted prior to 28 February 1967. Direct all inquiries and applications to Mr. Albert Schnitzer, Chairman Memorial Award Committee, 155 Wild Hedge Lane, Mountainside, New Jersey 07092.

FROM THE AOU

At its annual meeting in Duluth, Minnesota on 5 September 1966 the AOU elected the following officers:

Harold F. Mayfield, President	L. Richard Mewaldt, Secretary
Thomas R. Howell, First Vice-President	Burt L. Monroe, Sr., Treasurer
John W. Aldrich, Second Vice-President	Robert M. Mengel, Editor

and elected members of the Council: Phillip S. Humphrey, Wesley E. Lanyon, and Harvey I. Fisher.

George A. Bartholomew of the University of California, Los Angeles was awarded the Brewster Medal.

ORNITHOLOGICAL LITERATURE

The Birds of Kentucky. By Robert M. Mengel. American Ornithologists' Union, Ornithological Monographs No. 3, 1965; xvi + 581 pp., 4 col. pls., 43 figs., 9 drawings (vignettes), map of Kentucky. $10.00 ($8.00 to members of the A.O.U.). May be ordered from Burt L. Monroe, Sr., Ridge Road, Anchorage, Kentucky 40001.

This is a state bird book, new style. It is an ecological study of the birdlife of Kentucky, the author having made use of modern concepts and methods. Hence, it has the good features of a faunal catalogue, plus a balanced account of the varied habitats which support the state's avifauna. The reader will know what is there, but he will also have an idea as to why it is there.

As one of the home areas for John James Audubon, Kentucky is ornithological hallowed ground. Audubon stood, for a time at least, as resident ornithologist on the Kentucky frontier. Add to this the fact that every early explorer, traveler or adventurer—and a surprising number of these had scientific interests—who reached the West via the Ohio River had, perforce, to touch Kentucky. The list of visitors reads like a western "Who's Who." Dr. Mengel has not neglected the work of any of them; he has mined in a rich vein.

Only two of our states, Kentucky and Tennessee, extend from the Appalachians to the Mississippi Embayment. These, and only these, form a land bridge from eastern mountains to interior lowlands, with all the riches of fauna and flora that such expanses afford. Mengel divides Kentucky, for his studies, into seven physiographic sections, these ranging from the summit of Black Mountain at 4,150 to an elevation of 275 feet on the Mississippi River.

A major section of the volume is devoted to ecological studies of each of these seven physiographic regions. Characteristic birds are listed and related to the vegetative types which support them. Special attention is given to species which occur at the limits of their ranges. An analysis of each population suggests the probable place of origin of limital species. There is an attempt to assess the effects of deforestation, soil disturbances, and other man-made phenomena.

In his accounts of species and forms known to occur in Kentucky, Mengel gives no space to such matters as synonymy, general range, or species description. These things are abundantly cared for in today's general ornithological literature; they are not needed in a modern state bird book. Each species account begins with a brief statement as to status in Kentucky, then, whenever needed, there are more detailed statements as to occurrences in spring, summer, fall, and winter. There is a list of specimens examined, and the author has taken endless pains in tracing down supporting specimens of rare and little known species and forms.

Breeding species are given special attention, and in his accounts of these the author's penetrating ecological observations are most in evidence. He is never content merely to report that a bird is present; rather, he seeks reasons for its presence, and gives rich detail as to its habitat preferences. Zoology alone could not have produced such accounts; they are supported by botanical, geological, and edaphic studies as well.

There are the expected lists of hypothetical and dubious species, these fascinating sources for further field studies. There is a full bibliography and a fine index. Printing and paper are good, and there seems to be a minimum of typographical errors, sure sign of good proofreading and editing.

It is unavoidable, but true, that such state catalogues as this will seem obsolescent to present-day students in the field, particularly those keen-eyed and enthusiastic youngsters who are eager to discover what appear to be mistakes or discrepancies in a printed account. This may be the more apparent here since most of Mengel's studies are based on observations made some years ago. Fortunately, we are all becoming more aware, thanks to careful students of populations, that even common and widely distributed birds fluctuate widely in their numbers from year to year. This is why there will always be a place for good resident bird students who are in the field throughout the year. Let no beginner feel that all the work has been done, and that he has no contribution to make!

I suppose that reviewers are expected to be critical, if they have any function at all. If forced into this position, I would observe that Mengel's color plates are unfortunate in their reproduction. I cannot believe that Kentucky Eastern Phoebes have such yellow bellies, nor that Black Mountain Veeries are so washed out in their brown back coloration.

Now that this has been said, let's add that this volume is a fine and comprehensive study, one that will be followed in style by state bird catalogues of the future.—MAURICE BROOKS.

HANDBOOK OF WATERFOWL BEHAVIOR. By Paul A. Johnsgard. Cornell University Press, Ithaca, New York, 1965: 6¼ × 9½ in., xvi + 378 pp., 11 pls. (photos), 96 figs. (drawings). $10.00.

The name Paul Johnsgard and the subject of waterfowl behavior have become almost synonymous. His list of publications on the subject is impressive. His study of the evolutionary relationships among North American Mallards was particularly outstanding. I have been impressed by Dr. Johnsgard's ability to accomplish work and publish results at a rate few biologists have equalled. "Handbook of Waterfowl Behavior" is his most ambitious endeavor, but perhaps in this case he was too ambitious.

The Handbook of Waterfowl Behavior contains descriptions and discussions of the social aspects of the behavior of 133 species of waterfowl with special emphasis on displays associated with pair formation and copulation. Some of the material was drawn from the literature, but most is from motion pictures taken by the author at the Wildfowl Trust, Slimbridge, England. By the author's admission, the descriptive material is very incomplete.

Those who have been interested in the behavior of waterfowl might hope that such a broad knowledge of ducks and geese of the world would lead the author to new knowledge of the evolutionary relationships within this varied and interesting group of birds. Very few individuals are qualified to evaluate Dr. Johnsgard's conclusions regarding the classification of ducks and geese. The reviewer is not one of these individuals. However, the use of the comparative approach to behavior study requires detailed and quantitative data on the various species and genera in question. Perhaps Dr. Johnsgard's rather hurried walk through the forest of waterfowl behavior has given him insight into the taxonomic relationships among the forms found there; however, I do not see that he has developed a very solid foundation for such conclusions.

The author rarely delves into questions concerning the evolution and function of the social signals he describes. He seldom views behavior as the product of an adaptational process. I believe that it is difficult to speak authoritatively on the subject of behavior without some interest in this aspect of the problem. This weakness in Dr. Johnsgard's approach is understandable, for most of his observations did not take place in the natural environments of the animals.

The reviewer feels qualified to comment briefly on the discussion of the Pintail (*Anas* *acuta*). The behavior of this species is presented on pages 182–185. Under "General Behavior," preflight movements of the Pintail are considered. They are described as the usual type, neck-jerking and lateral head-shaking. My observations indicate that the most frequent preflight movement among Pintails is a rapid vertical movement of the bill while holding the neck outstretched and motionless. On page 185, copulation of the Pintail is described. The author states that head-pumping by the male and female is typical of the Pintail in the precopulatory situation. I have observed this behavior and have never seen the female perform head-pumping.

Throughout the discussion of the Pintail, the author omits most of the behavior which distinguishes the Pintail from other ducks. The seriousness of his omission is compounded by the emphasis it places on statements made. For example, diving behavior of Pintails is the first topic under General Behavior. During a three-year study of Pintails, I did not see diving occur. When the shallow-water habit of this species is compared to that of other species, I would venture to guess that the Pintail will be among the duck species which are least likely to dive for food.

As a person views the behavior of a particular species for the first time, he often fails to comprehend much of what he observes. Waterfowl seem to be especially troublesome in this regard for the language of the group is complex. If the Handbook of Waterfowl Behavior is used as a reference book or a field guide, it will help both the casual observer and the serious student to really *see* what he observes. The book will make that first step in the observation of ducks and geese much easier. Dr. Johnsgard states in the acknowledgments, ". . . the objective of the present report is merely to provide the barest minimum of information on each species that will allow other persons to compare their observations and to develop more detail and quantitative studies." In this light, the book represents a most worthwhile effort on the part of the author.—Robert I. Smith.

The Birds of Arizona. By Allan Phillips, Joe Marshall, and Gale Monson. University of Arizona Press, Tucson, 1964: 9½ × 12 in., xviii + 220 pp. $15.00.

At last, those who are concerned with birds in the Southwest have an accurate and authoritative volume covering a major part of the region. Although possessing one of the largest avifaunas of any state, Arizona has had no book treating its entire bird life. For many years—until early in 1964—there was not even an up-to-date checklist available. The annotated list which appeared that year as Part 4 of Lowe's "The Vertebrates of Arizona" was written by Monson and Phillips and was based on the same data that appear in the present volume. Some of the wording is exactly the same in both works. Users of both will note, however, that whereas the checklist employed nomenclature of the fifth edition of the A.O.U. Check-list, there are numerous departures from this in "The Birds of Arizona."

The book opens attractively with a colored frontispiece (by W. J. Schaldach) depicting a pair of Masked Bobwhites with golden-leaved cottonwoods and Baboquivari Peak in the background. Following a two-page preface by Guy Emerson is a table of contents, a list of museums referred to in the text, and an introduction by Marshall stating clearly the aims of the book and role of each author. Five well-illustrated pages of habitat information (with a sad commentary on man's destructive activities) by Monson and Phillips, and a map, precede the 212-page text. The latter treats each of the 423 species admitted to the Arizona list by the authors' strict criteria. (However, if A.O.U. Check-list nomenclature were here followed the species list would be longer.)

Forms of hypothetical occurrence are not numbered as are the others, but are included in brackets in their customary taxonomic position. Subspecies receive considerable attention but are treated within each species account. Space devoted to one species varies from five or six lines (e.g., Blue-footed Booby) to more than two pages (Screech Owl). The pages carry double columns of print and, very often, an outline map showing the Arizona distribution of one or more Arizona species or subspecies.

Each family is introduced by an interesting general summary of the group as represented in Arizona, with occasional comments on remarkable habits or structure of extralimital forms; these introductory discussions are largely by Monson. Two groups, the hummingbirds and *Empidonax* flycatchers have keys for specimen identification that will assist the bird-bander or anyone with a dead bird to name. Phillips' *Empidonax* key is more satisfying to use than any other heretofore available. Nevertheless, as the author states, it will not work 100 per cent of the time. (I might add that if a specimen won't "key out" here it is sufficiently interesting to warrant preservation; too many inexperienced banders continue to ring *Empidonax* flycatchers recorded positively as one species or another. It is not that easy.) The hummingbird key is useful only in a very general way, not permitting final distinction between, say, females of the two *Archilochus* species, or those of *Selasphorus*. But it does permit narrowing down the number of species to which an unknown individual may belong.

Marshall's introduction reveals that the book's aim is to "tell exactly where and when each kind of Arizona bird can be found and to remark what is interesting about it in Arizona." It tries "to present ornithology as an engaging pursuit full of absorbing problems, not as a static discipline with everything settled by pompous dicta of the experts. Original information that cannot be found in other books is emphasized. On almost every page we seek to entice the attention of the amateur ornithologist toward the biological problems that birds so superbly illuminate, in hopes that he will be encouraged to contribute to their solution." Certainly no one could quarrel with these aims nor with the sincerity evidenced by the authors in doing exactly as Marshall has written. Virtually every page does indeed reflect our present lack of detailed information on distribution, breeding, or movements of Arizona's birds. More than most other state bird books, this one emphasizes what we *don't* know.

On its positive side it has no equal as a source of information on southwestern birds. Nothing has been taken for granted. Wherever possible, specimens have been re-examined, regardless of their location. Unlike some modern books treating of bird distribution, the species accounts in this volume are based largely on critically examined specimens, not sight records. Many published reports, and even specimens in some cases, are viewed by the authors with a healthy skepticism which some may consider extreme. Throughout the book, dates of occurrence are italicized when supported by specimen evidence; furthermore, a parenthetical insertion reveals location of the specimen(s). References to specimens in the older literature are not taken at face value; everything appears to have been re-examined. Thus the accounts are exceptionally well documented and can be safely relied upon by the most critical reader.

The authors' extensive knowledge of living birds is reflected in the numerous worthwhile aids and cautions in field identification. Every reporter of sight records in the Southwest should read (and heed) these comments; there is much information here that is not in the field guides. To cite but a few examples: male Allen's and Rufous hummingbirds "cannot safely be distinguished in the field" owing to variable back color (p. 64); Clay-colored and Brewer's sparrows may be very difficult to distinguish, but "When in doubt, your bird is a Brewer's!" (p. 197); "the White-necked Raven is impossible to identify in life unless seen right beside the Common Raven, when its smaller size can be discerned" (p. 106). These may seem rather dogmatic statements in this era of enlightened field recognition. Nevertheless, I have been uncertain of several male *Selasphorus* that I have seen clearly; and without exception every questionable "Clay-colored" Sparrow I've taken has proved to be a Brewer's; you *know* if you see a genuine Clay-colored. Eight years' close association with southwestern *Corvus* has convinced me that only the uninitiated or careless observer identifies most ravens to species. The White-necked Raven (*C. cryptoleucus*) is, we all know, a desert or desert-grassland bird, whereas *C. corax* is more of a mountain species. Phillips states (p. 106), "A raven nest in a yucca or low mesquite would almost certainly be [that of] a White-necked." But the "almost" is important, as disclosed by our recent discovery of breeding Common Ravens in the mesquite-yucca-grassland near Silver City where it has been assumed that the only breeding ravens had to be *cryptoleucus.* I can likewise endorse the statement (p. 78) that "Many observers do not realize how much a Say's Phoebe resembles a kingbird . . . nor do they appreciate how similar to each other the various species of kingbirds appear." I cite these instances to emphasize my complete agreement with the authors, lest some readers be inclined to dismiss their words of caution. One must witness repeated misidentifications of some of these birds before becoming fully impressed by the magnitude of the potential error inherent in the masses of sight records published annually.

Marshall writes in his introduction that the book "is Phillips' Birds of Arizona 'as told to' Marshall and Monson." Phillips "is responsible for the scientific names and classification used." There are numerous deviations from the conventional A.O.U. Check-list nomenclature. *Phainopepla* is placed in the Bombycillidae; *Peucedramus* in the Sylviidae. Surprisingly, the latter and the Turdidae are retained as families, not as subfamilies of the Muscicapidae. Notable is the dismissal of numerous familiar genera such as *Chen*, *Lophodytes*, *Lophortyx*, *Squatarola*, *Columbigallina*, *Platypsaris*, *Iridoprocne*, *Petrochelidon*, *Ixoreus*, *Hylocichla*, *Vermivora* (here = *Helminthophila*), *Richmondena*, *Pyrrhuloxia*, *Guiraca*, *Hesperiphona*, *Chlorura*, *Passerculus*, *Amphispiza*, and *Rhynchophanes.* However, *Passerella* is maintained as distinct from *Melospiza*, and *Setophaga* is not merged with *Myioborus* as some have proposed. *Anas crecca* is considered only "possibly conspecific" with *A. carolinensis.*

The Snow and Blue geese are united under *Anser caerulescens.* The Mexican Duck (*Anas diazi*) is treated as a race of the Mallard. Harlan's Hawk is reunited with the Red-tails. The Arizona Woodpecker is merged with *Dendrocopos stricklandi* of Mexico. The Black-eared Bushtit (*Psaltriparus melanotis*) is considered to be a form of the polymorphic *P. minimus*, with the proportion of black-eared birds increasing southward. *Troglodytes brunneicollis* and *T. aedon* are likewise considered clinal variations of a single species. *Sitta pygmaea* is lumped with *S. pusilla.*

Phillips recognizes only one species of *Colaptes*, combining under *C. auratus* the Yellow-shafted, Red-shafted, and Gilded flickers (which he advocated at least as early as 1947, cf. *Condor*, 49:121) since "the differently colored forms of Flickers interbreed massively wherever they possibly can."

One of the more surprising (and to me the least defensible) lumpings is of the Nashville, Virginia's, and Colima warblers (under the name *Helminthophila ruficapilla*, the "Gray-headed Warbler"). Even if justification could be found for merging the first two, it is stretching a concept too far to place the very different *crissalis* with them in the absence of reasonable proof. Because three forms are allopatric, have similar songs and call-notes, and nest on the ground is no reason for considering them conspecific. Granted that these three birds are more similar to one another than any is to *luciae*, *peregrina*, or *celata*, they are distinctive forms and no valid reasons for lumping them are presented in this work. I disagree that *crissalis*, *virginiae*, and *ruficapilla* "all have the same song"; this is not so. Their call-notes are similar, but this seems a minor point. That all three nest on the ground, whereas Lucy's Warbler nests in cavities, is insufficient evidence of conspecificity. Closely related forms may or may not have similar nesting sites (consider the variation within *Dendroica*, for example). Tail-wagging is cited as still another specific character common to all three forms. Although both Colima and Virginia's warblers indulge in this (as do various other parulids), I do not recall the Nashville Warbler as a "tail-wagger" either as a migrant or on its breeding grounds.

Expectedly, the Baltimore and Bullock's orioles are considered conspecific, as are the Rose-breasted and Black-headed grosbeaks and the Indigo and Lazuli buntings. Vernaculars assigned to these combinations are "Northern Oriole," "Common Grosbeak," and "Common Bunting." However, the familiar common names are also supplied in the account headings, and are used frequently throughout the bunting account. No new evidence to support the conspecificity of any of these forms is presented here. The rosy finches are also merged under the name *Leucosticte tephrocotis*, "Rosy Finch."

The genus Junco is considered to include, in the United States, but two species, the Brown-eyed Junco (*J. hyemalis*) and the Yellow-eyed Junco (*J. phaeonotus*). Although there is considerable merit in this arrangement, I think it is an oversimplification of the complex relationships within this genus. Granting that *hyemalis*, *mearnsi*, and the various races of *oreganus* may be conspecific, it is difficult to include *aikeni*, the White-winged Junco, in this collective "species" without considerably more evidence than is known to me. Very few *mearnsi-aikeni* hybrids are known, and I am aware of no intermediates between *aikeni* and any *Junco* other than *mearnsi*. Although the breeding ranges of those two forms overlap, with a few hybrids resulting, Miller ("Speciation in the Avian Genus Junco," 1941: 353) considered it "remarkable that more hybridization does not occur. . . . Through some factors of habitat preference and specific intolerance, or both, they remain essentially separate, as do species rather than races." This very limited interbreeding makes one question the statement (p. 203) that the brown-eyed juncos, like flickers, indulge in "interbreeding on a large scale wherever and whenever possible." Certainly this is an exaggeration. It is misleading, too, to refer to *aikeni* as "a sort of dull relative of *mearnsi*" (p. 204), for phenotypically *aikeni* is conspicuously nearer to the *hyemalis* group than to any of the *mearnsi-oreganus* complex. Interpretation of species limits in *Junco* is made no easier by the hybridization between *oreganus* and the forms of *caniceps*, but in this reviewer's opinion wholesale lumping is not necessarily the answer. Reflecting all subgeneric relationships on a racial level may obscure, rather than clarify, the picture.

Some readers will lose patience with the emphasis on taxonomic and nomenclatural matters in this book. (Thirty lines are devoted to the merits of the name *Toxostoma crissale* as opposed to *T. dorsale*.) The average reader of a state bird book probably couldn't care less about such matters, but certainly in this way much interesting history is injected into some of the species accounts.

As has already been implied, subspecies receive much emphasis—partly because so many forms usually considered full species are reduced to racial status here. Thankfully, there is likely to be little confusion to the lay reader, for the authors list each "subspecies" separately under the species, with its assigned trinomial and the commonly used vernacular—e.g., "*J. h. caniceps* (Woodhouse). 'Gray-headed Junco.'" followed by a brief description.

There seem to be very few actual errors in the book; it obviously has been proofread with great care.

For all its accuracy and insistence on reliable data, the style of the writing is informal, often chatty, with occasional lapses into slang. I have already commented on the inclusion of occasional exaggerations. In a scientific work it seems out of place, as well as inaccurate, to be told that young female cowbirds have been stimulated to incubate "by shooting them full of progesterone" and, further, that adult cowbirds "stoutly refuse" to respond (p. 173). (And we tell our students to avoid anthropomorphic interpretations!) It is surprising to encounter in a paragraph on *Setophaga-Myioborus* relationships the statement "It is *ruticilla*, with its *Dendroica*-like song, eggs, and tree nesting, which is the odd-ball." Surely there are better ways to word things. Statements such as these detract greatly from the dignity, sincerity, and accuracy one has the right to expect in such a work. Perhaps such writing merely is evidence that languages, like birds, undergo evolution. Certainly the book as a whole is refreshingly readable for a state bird book. No one can complain that The Birds of Arizona is dull reading; this in part compensates for one's annoyance with the occasional "far-out" statement.

The 12 color plates, full-page reproductions of Arizona field sketches by George Miksch Sutton, are superbly reproduced and reflect Sutton at his best. I suspect that not a few copies of the book may be purchased for the plates alone. The 51 color photographs by Eliot Porter are good, though not absolutely first-rate owing largely to inferior reproduction. Most of those in my copy are very dark and dull; a few are too light (as so often is the case with reproductions of flash pictures), with the birds appearing overexposed. A few (e.g., male Phainopepla, Violet-green Swallow) are not good photographically. The birds in the two Bell's Vireo pictures would almost appear to be of two different species. Some (e.g., Lazuli Bunting, Western Tanager) are lovely, and undoubtedly most of the originals are of high quality.

Throughout the book one finds evidence of the authors' concern for conservation of birds and bird habitats in Arizona. For example, they express wonder (p. 25) that the Osprey still survives in the State, "considering that even fish-and-game rangers are instructed to shoot them on sight." (As they do in New Mexico—though officials hesitate to admit it.) Ecological changes are mentioned wherever possible. The plea (p. 42) for preservation of the much-maligned mesquite (*Prosopis juliflora*) as a valuable and necessary component of the riverbottom community should be read by everyone who tills these lands or who hunts White-winged Doves. Long overdue is the declaration that "Grasslands and riparian woods have always been neglected by the conservation movement, which concentrates on preserving mountain forests" (p. 194). This reviewer has maintained for some time that unless ornithologists become truly active in conservation activities future generations will have few natural communities to study in parts of our country. It is reassuring, therefore, to have an authoritative bird book, yet one with a conscience, available to southwesterners. Let us hope that influential Arizonans will not overlook the words of Phillips and Monson at the end of their habitat discussion (p. xvii): "If the state is to remain an attraction to naturalists it is well-nigh past time that action be taken to *preserve* some of its natural beauties. Let us hope that the data presented in this book do not represent the obituary of some of our most interesting birds. Rather may these birds continue to find shelter and safety in a green Arizona!"

In addition to its other assets, this is a handsome, well-made volume. No naturalist who lives in, or has anything to do with, the Southwest can afford to be without it; and it deserves a place on the book shelves of every ranchhouse and schoolroom in Arizona. The authors and the University of Arizona Press deserve a great deal of credit for producing this work.—DALE A. ZIMMERMAN.

AVIAN PHYSIOLOGY. By Paul D. Sturkie. Second edition. Cornell University Press, Ithaca, New York, 1965: $6\frac{1}{8} \times 9\frac{1}{4}$ in., xxx + 766 pp., 116 figs. $15.00.

The appearance of this revised and enlarged edition of Dr. Sturkie's "Avian Physiology" should be welcomed by all workers in this broad field. The organization of the second edition is similar to the first, but there has been a considerable increase in the contents. The revision is over 340 pages longer; each chapter has been rewritten in part and several whole chapters have been written by authors active in specific fields. This has greatly increased the coverage of the material in many areas, but some of the shortcomings of the first edition still exist (see Dawson, 1954, *Auk*, 71:477–497). Among those areas conspicuous by their absence are treatments of the skeletal muscle and the physiology of migration. The book remains oriented heavily towards the physiology of domestic birds, although the coverage of wild birds has been increased significantly. How accurately the lack of information on wild birds reflects our actual lack of knowledge is difficult to estimate.

The book is divided into 22 chapters, each with its own bibliography. The text is not encumbered by numerous typographical errors, the most conspicuous being the inaccurate chemical formula in Figure 90. The book is well printed and the illustrations are adequate and of excellent quality.

Approximately one quarter of the book deals with the blood and circulation. Domestic birds are treated extensively but not exclusively. This is an area of considerable research interest at present and the general treatment is good. As was the case in the previous edition, the chapter on electrocardiography is lucid and instructive.

The chapter on respiration contains both morphological and physiological information, a definite necessity at the current level of our understanding of this system. Unfortunately the most recent citation is 1962 which eliminates several recent pertinent papers and reviews.

Body temperature and energy metabolism are treated in two individual chapters (both by G. C. Whittow). Much of the recent work on water economy and the role of evaporative water loss in adjustments to temperature stress is omitted, but the role of evaporation in temperature regulation is discussed. The discussion of energy metabolism is good and should serve as a stimulating introduction to this area of investigation.

Digestion, carbohydrate metabolism (by R. L. Hazelwood), and the kidneys and urine are treated next. The latter includes a summation of role of the nasal (salt) gland in extra-renal excretion and many functional aspects of the kidney. However, little is said regarding the role of the kidney in the ecological relationships of wild birds. Typically, considerable information of a pharmacological nature is included.

The chapter on the special senses by M. R. Kare is good and includes information of interest to behaviorists. The recent work on olfaction in vultures is omitted.

As might be expected, the chapters on reproduction are quite complete, but rely heavily on information from domestic birds. The coverage ranges from gross histology to the synthesis of egg proteins, and there is a special section on eggshell formation and skeletal metabolism by T. G. Taylor and D. A. Stringer. The remaining six chapters cover the endocrine glands and the nervous system. The latter includes a general introduction to the physiology of nerves, without becoming entangled in a long digression on the chemistry involved, and then proceeds to a consideration of the spinal cord, autonomic nervous system, and the brain.

The chapters on the endocrines are very well done and represent a well balanced approach, which includes histology, biochemistry, and function.

Dr. Sturkie has presented the broad scope of the physiology of birds in a clear, meaningful manner. This is an important contribution and an admirable accomplishment.—ALAN H. BRUSH.

THE SILENT SKY: THE INCREDIBLE EXTINCTION OF THE PASSENGER PIGEON. A Novel. By Allan W. Eckert. Little, Brown and Company, Boston, 1965: 5⅝ × 8¼ in., 243 pp., front. $4.95.

This book belongs in the currently popular category of non-fiction novels. About the now-extinct Passenger Pigeon, its leading characters are a male which became the last collected wild specimen when it was killed by a boy near Sargents, Ohio, in 1900, and Martha, the last of her race and a captive most all her life who died in a Cincinnati zoo in 1914.

There is a continuing fascination about Passenger Pigeons which may have been at their peak of abundance the most numerous species of bird that ever lived. Many scientists regarded it as the finest pigeon in the entire world. Its extinction took place with stunning abruptness. The author has studied and digested observations and records about this pigeon which were made during the Nineteenth Century and until the death of the last survivor early this century.

This tale about a species which became extinct more than half a century ago arouses a sense of outrage against the ruthless destruction of an entire race in so short a time. No one can deny that man in his greed and thoughtlessness hastened the end of the Passenger Pigeon even though its vast numbers probably would eventually have spelled its doom. At this point no man can say whether the species, which habitually wintered, fed, and bred in incredible concentrations, would have been able to change its habits as its numbers diminished naturally, and thus been able to survive.

While the reader is confident that this novel is based on fact and gives a true picture of the Passenger Pigeon and its extinction, it must be pointed out that human traits are sometimes attributed to the pigeons as when, their numbers reduced to a handful on former nesting grounds, a male occasionally approached a female in an embarrassed manner and then quickly lost interest, scanned the sky, and listened for the sound of thundering wings that would come no more.—HELEN G. CRUICKSHANK.

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By Mildred Stewart

This index includes, in addition to names of genera, species, and authors, references to the following topics: anatomy, banding, behavior, distribution, food habits, habitat, incubation, measurements, migration, molts and plumages, mortality, nesting, parasitism, physiology, populations, predation, taxonomy, voice, weather, and weights. Also included are references of biological significance to reptiles and mammals. Names of new forms described in this volume are printed in **boldface** type.

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