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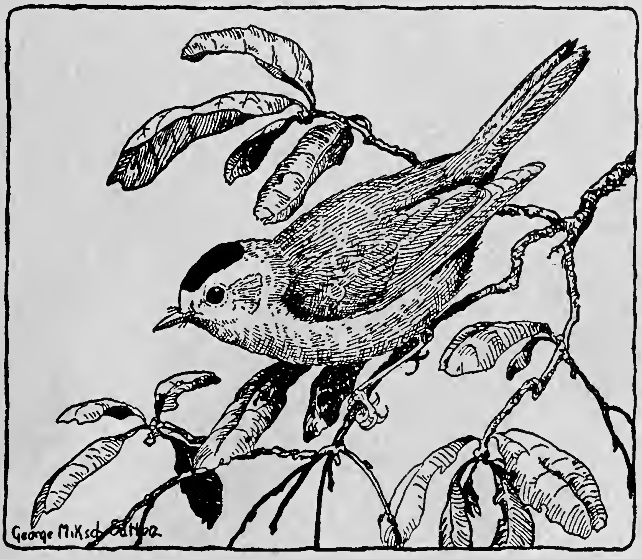

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THE WILSON ORNITHOLOGICAL CLUB

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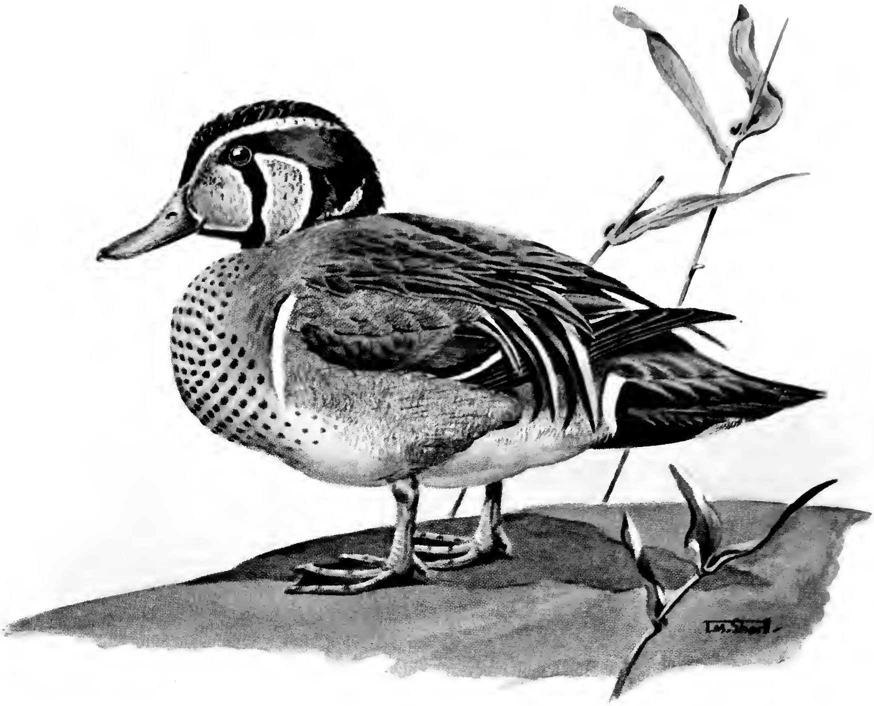

BAIKAL TEAL, Anas formosa

THE WILSON BULLETIN

A QUARTERLY MAGAZINE OF ORNITHOLOGY

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THE FAMILY ANATIDAE

BY JEAN DELACOUR AND ERNST MAYR

A MORE natural grouping of species with a better understanding of their affinities expressed in a simpler taxonomy has been one of our principal objects for many years. Among the most popular groups of birds, the waterfowl, as the Anatidae are known, have perhaps been more arbitrarily classified than any other. Because of the general interest attached to these birds, we have thought that it might be useful to revise the group and to state our views on the relationships within it. Delacour (1933, 1936, 1938) has already published several papers on the subject. But since their appearance our knowledge has advanced considerably, and the present paper is a corrected, expanded, and up-to-date version, in English, of these earlier articles.

For over 20 years Delacour maintained in the park of the Chateau de Clères, in Normandy, the greatest collection of live waterfowl ever gathered. All existing species of swans, geese, tree ducks, and sheldrakes were represented in it; and of all the other ducks, only 26 species were missing. They lived under conditions approaching those of the wild state, and consequently they bred freely and displayed their natural behavior, including their courtship. In addition, we have observed many of the rarer exotic species in their natural habitat, and we have extensively studied museum series at the American Museum and elsewhere.

We also have benefited by the work of many authors, ornithologists, sportsmen, and breeders, particularly by the excellent pioneer studies of Dr. O. Heinroth (1910; 1911; and with M. Heinroth, 1928). For many years, Delacour has exchanged views, notes, and specimens with Dr. K. Lorenz, of Vienna, on the subject of the display and affinities of the Anatidae, with a view to later joint publication. The files kept at Clères were destroyed by a fire in 1939. We know that Dr. Lorenz has since published a paper on the subject, but this is unfortunately not yet available to us (Lorenz, 1941). It will be interesting to compare his conclusions with ours.

The classification of ducks which has been accepted up to the present is more than 50 years old. In spite of criticism by a number of recent authors, it has been more or less followed in all recent works, such as Phillips' "A Natural History of the Ducks" (1922–26); Peters' "Check-List of Birds of the World" (1931); and the fourth edition of "The A.O.U. Check-List of North American Birds" (1931). In fact, Salvadori's classification in the "Catalogue of Birds in the British Museum" (Vol. 27, 1895) is in some ways more acceptable than several later ones. All these systems have the weakness of being based exclusively on a small selection of morphological characters, primarily on the shape of the bill and feet. Nothing could be more misleading, for the form of bill or feet is entirely functional and undoubtedly often recently acquired, representing merely a secondary adaptation that is repeated in widely separate groups. It is useful in distinguishing species but has certainly no deeper phylogenetic significance. Non-adaptive morphological characters are far more useful taxonomically. The most important of these in the duck family are: pattern of tarsus (whether scutellate or reticulate in front), a very fundamental character in the family; plumage pattern in both adults and young, the downy young of most of the nine main groups in the family having a very characteristic pattern; presence or absence of a double annual molt; posture, general body proportions, length of neck, and shape of head, all of which show characteristic differences among the nine main groups; characteristics of the internal anatomy, especially the structure and shape of the syrinx and trachea (as Heinroth has repeatedly pointed out[1]). Similarly, biological characters—almost entirely ignored by the currently adopted systems of classification—are of paramount importance to the classifier, for habits and behavior are deeply rooted and are usually the product of very ancient evolution. In the duck family the main points are pair formation, displays, nesting, and feeding habits. To be satisfactory and reliable, any system must be based on the greatest possible number of known characters, and an overvaluation of a few primarily functional characters has led to great confusion in the taxonomy of the Anatidae.

Several branches, for example, the pochard group, the goldeneye-merganser-scoter group, and the stiff-tailed duck group, have developed into divers par excellence, and are structurally rather similar to one another. However, their non-adaptive characters, such as the general proportions of the body, the color pattern of the downy young, the structure of the syrinx, and the courtship performances, are sufficiently different among the three groups to suggest that the three are not at all closely related.

A further instance is that of the so-called geese. In addition to the typical geese of the *Anser-Branta* group, there are a number of

[1] We refer to his detailed account (O. and M. Heinroth, 1928:226–229). The taxonomic advantage of this structure lies in the fact that its shape is not easily modified by any peculiar adaptations of a given species. It tends to be phylogenetically conservative.

"goose-like" genera such as the Cape Barren Goose (*Cereopsis*), the Pied Goose (*Anseranas*), the Maned Goose (*Chenonetta*), the South American "geese" (*Chloëphaga*), the Egyptian Goose (*Alopochen*), and the group commonly known as sheldrakes ("*Casarca*" and *Tadorna*), all of which are characterized by rather large size and long legs, many by grazing habits. They are the "ungulates" of the duck family. Again the evidence is rather strong that the goose-like features were acquired independently by the several groups. This adaptability poses a problem to the classifier of the duck family which by no means has been solved entirely. However, even though the position of certain species and genera is still uncertain, the study of live specimens and the consideration of previously neglected morphological characters have shed much light on the relationship of the birds included in this family.

This might be an appropriate place to state again our views on the subject of zoological nomenclature. We have always stood for the strict application of the law of priority, but according to the rules and opinions of the International Commission. These provide for corrections in evident cases of misprints, of lapsus calami, and of errors in transcription. There is sometimes a certain difficulty in determining the validity of the evidence for such mistakes, but moderate degrees of common sense and classical scholarship are usually sufficient to enable a zoologist to make up his mind. To retain the original spelling of a name, however wrong it evidently is, constitutes a retrograde solution too easy and too uncritical. It is a great pity that both the A.O.U. and the B.O.U. committees on nomenclature have recently chosen to follow such a course. We are absolutely opposed to it, now as in the past,[2] and consequently we correct all misprints, lapsus calami, and errors in transcription. Also, according to the same rules, the endings of the adjectival species names should agree with the gender of the genus, and Greek endings should not be latinized. Furthermore, we conserve long-used names, unless the necessity for a change is unequivocally established.

We believe in large genera, since it is the function of the generic name to express relationship (as an aid to the memory), not distinctness, which is expressed by the species name. Even Peters, who is certainly not a splitter, recognizes in the family of Anatidae 62 genera for 167 species (an average of 2.7 species per genus), and 42 (70 per cent) of his genera are monotypic. The A.O.U. Check-List goes even further. Such nomenclature comes dangerously close to being mononomial. The modern broadening of the species concept (Mayr, 1942:102–122) necessitates a corresponding adjustment of the genus limits. In the classification here presented we recognize 40 genera for 144 species (3.6 species per genus). It is interesting to find that a number of the vernacular names for the waterfowl—swans, scoters,

[2] See Delacour, 1931, *L'Oiseau*, n. s. 1:438–440.

eiders, mergansers—delimit natural groups more accurately than the generic names currently used by taxonomists. It has been our endeavor to bring the generic nomenclature of the duck family back to an expression of these natural groups. The proponents of generic splitting forget that if morphological difference is acknowledged as an inevitable generic criterion, sooner or later nearly every species will deserve a genus of its own. Generic subdivision carried to extremes not only places an unbearable burden on the memory of the taxonomist, but also completely obliterates the difference between the weak and the really distinct genera. The differences separating *Anser*, *Philacte*, and *Chen; Anas*, *Nettion*, and *Dafila; Aix* and *Dendronessa;* or *Somateria*, *Arctonetta* and *Polysticta*, are certainly very slight compared with the differences separating *Anser*, *Cygnus*, and *Coscoroba;* or *Chloëphaga*, *Alopochen*, and *Tadorna;* or *Anas*, *Malacorhynchus*, *Tachyeres*, and *Stictonetta*. Since no category above the genus can be expressed in the scientific name, the splitter has no way of making a distinction between "weak" and "good" genera. We consider this another strong argument in favor of recognizing only pronounced genera. (Mayr, 1942:280–291.)

A New Classification of the Anatidae

The new classification of the duck family that we propose attempts to do two things: to arrange the species in related groups and in a natural sequence, and to adjust the nomenclature of species and genera to progressive concepts of these categories.

Following the popular classification of this family, the first taxonomists divided the waterfowl into: swans, geese, ducks, and mergansers. As more and more was learned about the anatomy as well as about the habits of members of the family, it was realized that this simple division was unsatisfactory. For example, Linnaeus included in the duck genus *Anas* such widely divergent species as the river ducks of the mallard and teal type, the diving ducks of the scaup-pochard group ("*Nyroca*" = *Aythya*), the diving ducks of the goldeneye-scoter-eider group (Mergini), the tree ducks (*Dendrocygna*), and the sheldrakes (*Tadorna*). Although subsequent classifiers recognized some of these subdivisions, they were guided in their reclassification mainly by the shape of the bill or by the presence or absence of the diving habit.

All the ducks, geese, and swans, including even the most aberrant species, are so much alike in their basic structure and habits that there can be no doubt that those modern authors are right who include all waterfowl in a single family, the Anatidae. Within this family a number of groups of genera can be recognized, but they are clearly arranged in two main groups, which we admit as two subfamilies:

(1) Anserinae. This subfamily includes the swans, geese, and the whistling ducks ("tree" ducks). The attributes of the group are a "goose-like" posture and body shape (with a long neck); a tarsus reticulated in front; a single annual molt; absence of sexual dimorphism in plumage, voice, and structure of the syrinx. Displays are simple and are similar in the two sexes.

(2) Anatinae. This subfamily includes the rest of the Anatidae. The attributes of the group are a tarsus that is scutellated in front (with a few exceptions); a double annual molt; sexual dimorphism in plumage (frequent), in voice and structure of syrinx (usual). Displays are usually elaborate and different in the two sexes.

Within each subfamily further subdivisions are recognizable. We use the term tribes (with the ending *-ini*) for such groups of genera, following a custom that is widespread in entomology. The reasons for the recognition as well as for the delimitation of these tribes will be found in the following discussion. The phylogenetic relationships within the duck family are diagrammed in Figure 1.

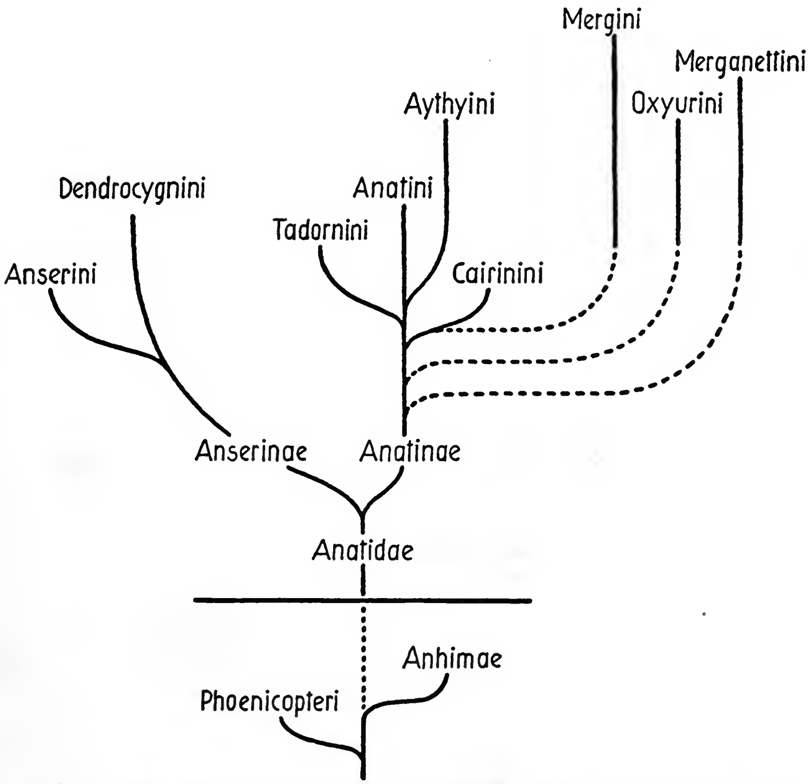

Figure 1. Diagram of the theoretical relationships of the subfamilies and tribes of the Anatidae.

I Subfamily Anserinae

1. tribe anserini. swans and geese

The birds commonly known as swans and geese agree so closely in structure, in pattern of downy plumage, in general behavior and courtship, and in living and nesting habits, that they cannot be separated as two distinct tribes. Swans differ from geese only in their larger size, shorter legs, longer necks, and greater number of vertebrae; none of these characters is taxonomically important, not even the number of vertebrae, since this varies considerably from species to species.

The Anserini differ sharply from most of the other waterfowl. The two sexes are always similar in plumage, and nearly so in voice, the voice of the female being merely a little higher pitched. They never have any metallic colors, and the downy young never have a strongly marked pattern. The nuptial display and mating antics are all simple and vary little among the species; the only courtship consists of stretching the neck and of "dipping." They apparently pair for life, and both male and female always participate in the care of the young. Usually it is the female which incubates, while the male guards the nest. In the exceptional case of the Black Swan (*"Chenopis" atratus*), the male shares to some extent the duty of incubation. Sexual maturity is not attained until the second or third year. Swans and geese have only one annual molt and consequently have no eclipse plumage. They nest on the ground; a few species nest occasionally on ledges or in old nests. Their food is mostly vegetable, obtained by grazing and dipping. Their syrinx is symmetrical and has no bulla.

We consider all swans as congeneric, the fact that some have black in the plumage being of little importance. The most primitive swans are arranged in two pairs of forms: *bewicki* (Old World) and *columbianus* (New World); *cygnus* (Old World) and *buccinator* (New World). As Hartert has already suggested, these are best considered two Holarctic species (*C. columbianus* and *C. cygnus*). The four forms are alike in behavior patterns. Each of the three other species of the genus stands rather alone, although the Mute Swan (*C. olor*) and the Australian Black Swan (*C. atratus*) show certain similarities. The threat behavior of lifting the wings, which is so typical of the Mute Swan and occurs in a less pronounced way in the Black Swan, is absent in the Black-necked Swan (*C. melanocoryphus*) as well as in the four primitive forms.

Pair formation, which occurs in the fall in all temperate-zone swans, takes place without elaborate displays. According to Heinroth (1911), birds that are in the process of pairing swim in close proximity,

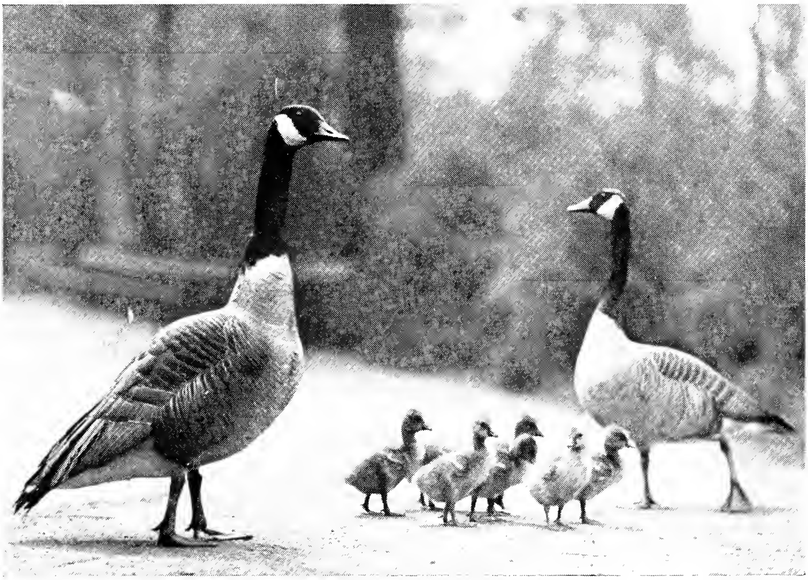

Figure 2. Canada Goose (*Branta canadensis*) with young.

Figure 3. Hawaiian Goose (*Branta sandwicensis*).

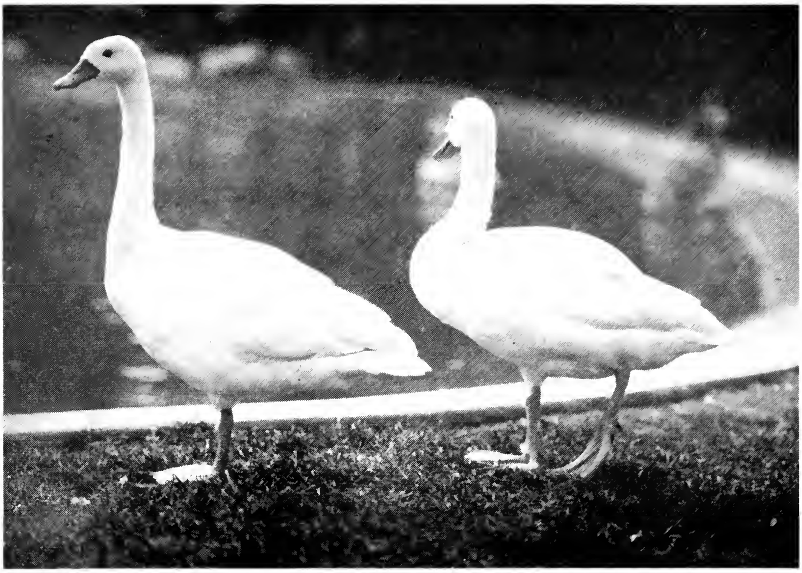

Figure 4. *Coscoroba coscoroba.* Compare with Whistling Duck, Figure 5.

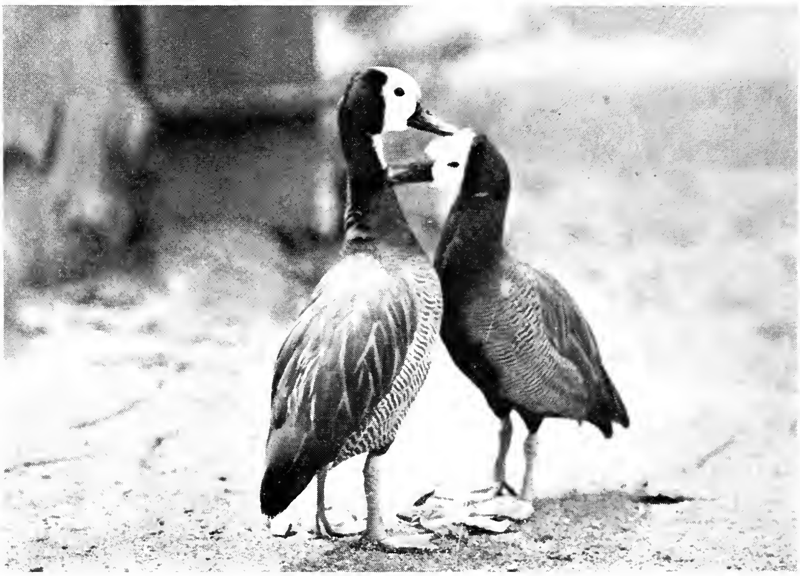

Figure 5. White-faced Whistling Duck (*Dendrocygna viduata*).

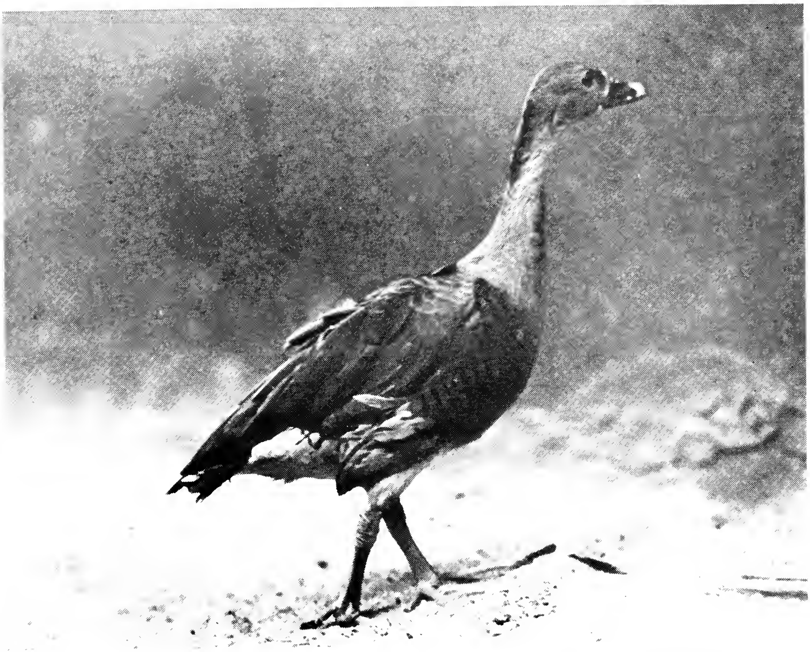

Figure 6. Plumed Whistling Duck (*Dendrocygna eytoni*). Compare body posture with that of Canada Goose in Figure 2.

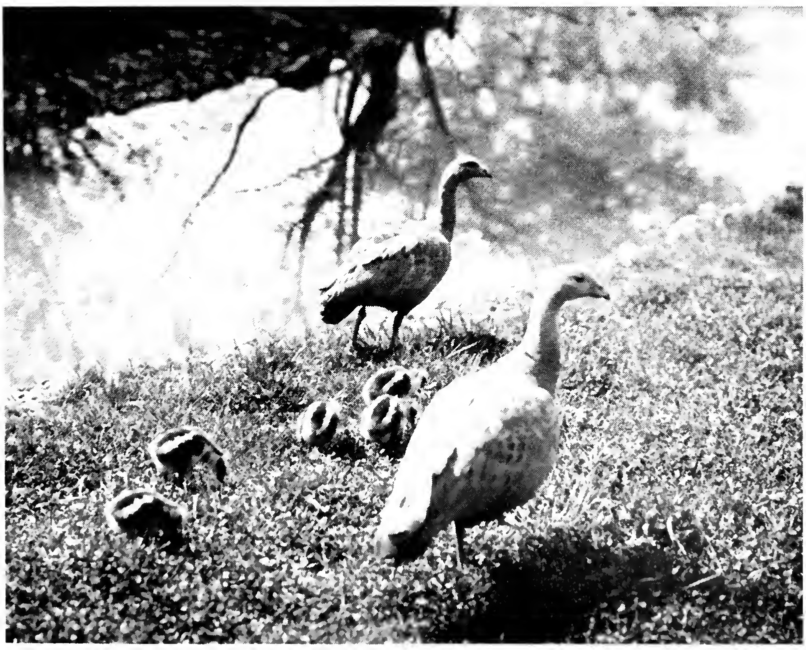

Figure 7. Cape Barren Goose (*Cereopsis novae-hollandiae*) with young. Compare posture of adults with that of Magellan Goose in Figure 8 and pattern of young with young in Figure 9.

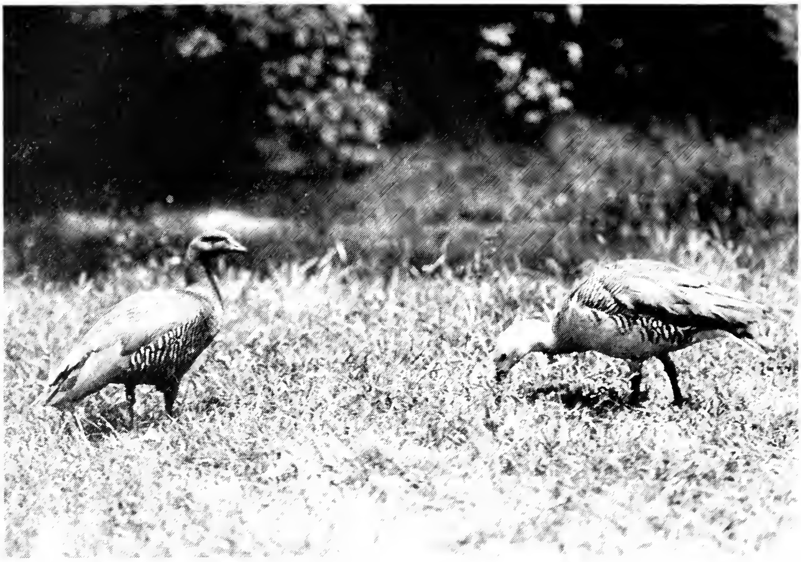

Figure 8. Magellan Goose (*Chloëphaga picta*) walking and feeding. Male on right.

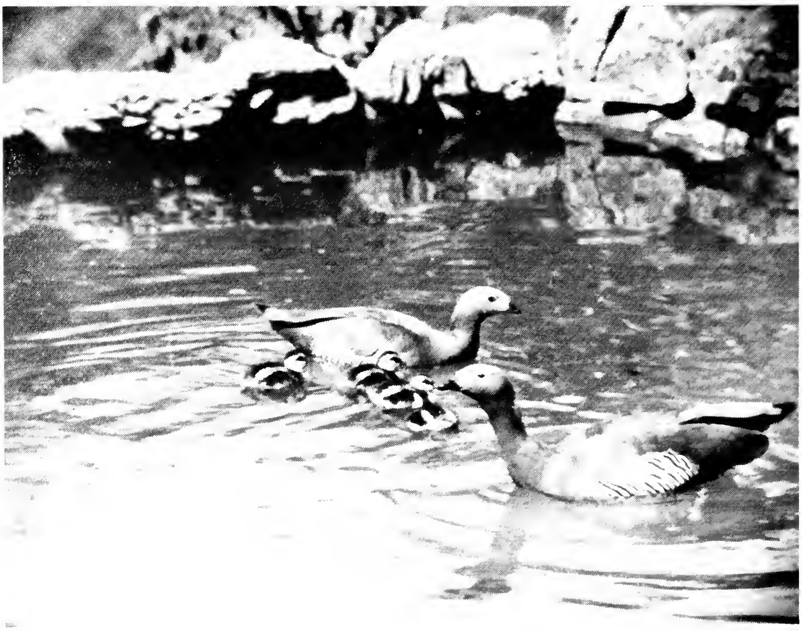

Figure 9. Ashy-headed Goose (*Chloëphaga poliocephala*), pair with young.

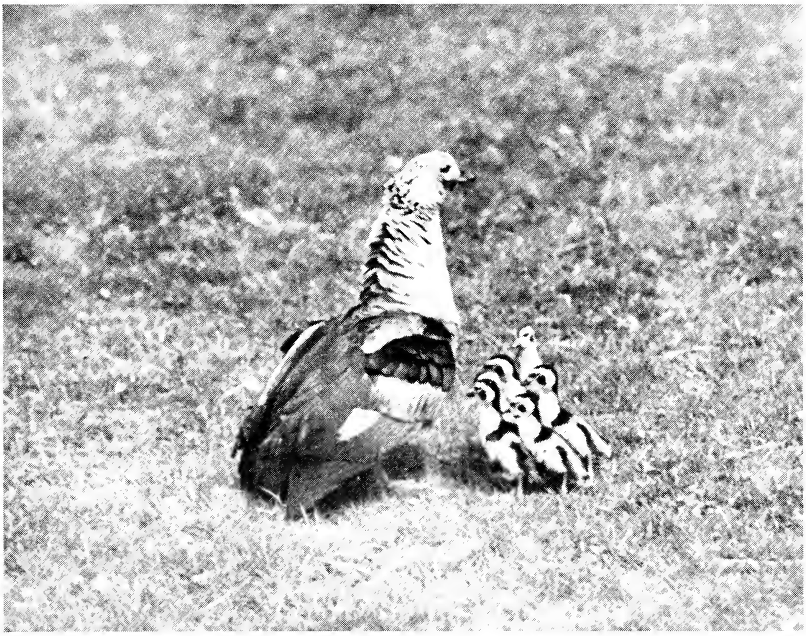

Figure 10. Orinoco Goose (*Neochen jubatus*) with young. Bold pattern of downy young typical for tribe Tadornini.

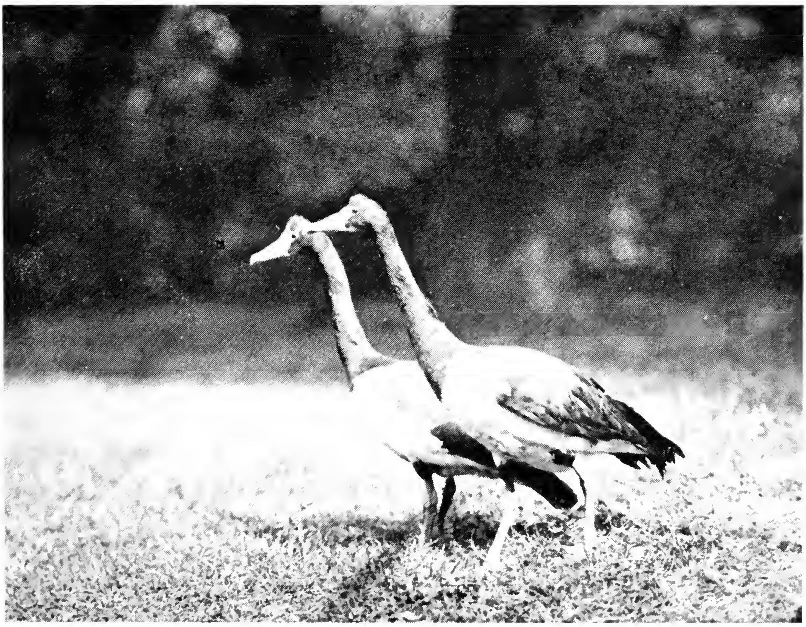

Figure 11. Pied Goose (*Anseranas semipalmata*).

Figure 12. African Spur-winged Goose (*Plectropterus gambensis*).

Figure 13. Comb Duck (*Sarkidiornis melanotos*). Note thick short neck, horizontal body posture, and long tail.

press the plumage close to the body, and hold the neck in a peculiar position, the head appearing thickened. Swans, geese, and whistling ducks (tree ducks) have essentially the same precopulatory display: both birds of a pair repeatedly dip the whole head and neck until finally the female flattens herself out on the water and sinks deeper with the neck half extended. But there are a number of variations; for example, in swans male and female frequently face each other and half rise out of the water, breast to breast. All swans, except the Mute Swan, have been observed diving, although rarely. They seem to be the only Anatidae which have the habit of taking their downy young on the back when the young are tired or cold. This is the usual practice with Mute and Black-necked Swans. It is exceptional in the other species.

Amongst the geese, there is no ground for retaining the genera *Chen*, *Cygnopsis*, *Eulabeia*, and *Philacte*, all the species referred to them being members of the genus *Anser*. All have more or less strong serrations on the sides of the bill. *Branta* is characterized by a more elaborate plumage pattern, a longer and thinner neck, and smaller and smoother bill (Figure 2). The Hawaiian Goose ("*Nesochen*") certainly belongs in this genus (Figure 3). Hybrids from crosses between species of *Anser* are usually fertile, and so are those between species of *Branta*, but hybrids from crosses between the two genera are sterile.

The Russian workers (for references and summary see Ernst Hartert and F. Steinbacher, 1936, "Die Vögel der paläarktischen Fauna", Erg.Bd., Heft 5:433–434) have shown that *brachyrhynchus* and *neglectus* are races of *fabalis*. The extensive breeding ranges of *Anser erythropus* (inland) and *A. albifrons* (coastal) run parallel along the north of Europe and Asia. No overlap of the ranges of the two species is known, and it has therefore been suggested (Witherby *et al.*, 1939) that the two forms be considered subspecies of *erythropus*. Further work may show that this view is correct.

The most characteristic feature of the geese is their closely knit family life. The family migrates as a unit, and the young apparently remain with their parents until the beginning of the new breeding season.

The "triumph ceremony," which is characteristic of the geese, has been described as follows: "After driving off intruder all geese behave similarly; gander hurries back to mate with special 'triumph-note' . . . in which she joins, uttered with neck stretched out and head close to ground. Even downy young take part, assuming same attitudes as parents" (Witherby *et al.*, 1939:182, *after Heinroth*). The same "triumph ceremony" is an important part of the pair-formation display. The courting gander drives away weaker birds and then returns to the chosen goose with the "triumph note." At first, she may not pay much attention to his behavior, but if she answers his call and joins in the display, the pair formation may be considered completed. The gander swims in a peculiarly proud, erect position in the water during this courtship period and may indulge in "dipping displays" even before pair formation. The pre-copulatory display is the same as in the swans.

Geese are highly social, as are most grazing animals. Manifestations of social rank seem to be absent in the wild, but develop in confinement when the source of food is localized. Geese mature in the second year, and pair formation takes place in the second winter. The habits of the various species of *Branta* seem to be essentially the same as those of *Anser*, except that the smaller species feed to a greater extent on water plants.

The very peculiar *Coscoroba coscoroba*, from South America, occupies a special place. It reminds one of a swan by its white color and some of its habits. Particularly, it raises its wings in anger as the Mute and the Black Swan do. At the same time, its voice (a not very loud, trumpeting *cos-côroba*) and its display are entirely peculiar. In some other features (in shape of head, for example) it resembles the whistling ducks, it has their long legs and large feet, their comparatively rounded wings (Figures 4 and 5). The downy young, extremely rare in collections, is, like a cygnet, whitish-gray, but it shows in darker gray, distinctly if weakly, the very special markings of the downy whistling duck, notably the light band across the nape. As in swans, the syrinx is without a bulla, even in the male.

Coscoroba, in fact, seems to be an intermediate, linking the swan-goose group to the whistling ducks, and on that account is of very great interest. On the basis of the scanty information available, the genus *Coscoroba* could be placed in either group. A thorough study of its anatomical features, of its pair formation, and of the participation of the male in incubation and raising of the young is needed before the species can be classified with confidence.

2. TRIBE DENDROCYGNINI. WHISTLING DUCKS ("TREE DUCKS")

Whistling ducks are among the least known of all the ducks. There is not a single good life history of any of the species, nor is there an anatomical comparison of the tribe with other Anserinae. The tribe is composed of a single genus (*Dendrocygna*) with eight species. Whistling ducks have no close relatives except *Coscoroba*. Their high-pitched, squeaking voice and a number of their habits are peculiar to the tribe.

They have a number of features in common with the other Anserinae. Both sexes take care of the young. The male shares (?always) in the duties of incubation, as in the Black Swan; in fact, in *viduata* and *bicolor* the male seems to have the greater share. The two sexes are alike in coloration and similar in voice; they seem to pair for life. There is no metallic color in the plumage. Whistling ducks resemble geese in postures (Figure 6) and display. Their food consists mostly of vegetable material and is obtained by grazing, dipping, or diving. They are expert divers and gather much of their food under water. They nest usually on the ground, in reeds or tall grass, where they build an elaborate nest, well concealed by bent-over stalks; they nest occasionally in holes in trees or in abandoned nests of other birds. Their eggs are white and rather round. The pre- and post-copulatory displays are the same as those of swans and geese, different from those of the Anatinae: male and female face each other, lift the breast out of the water, and slightly raise their wings.

Their syrinx has symmetrical bullae, slightly larger in the male than in the female. The plumage patterns of adults and downy young are peculiar, different from those of all other Anatidae (excepting only *Coscoroba* as noted above). The fully adult plumage is attained the first year. The species of whistling ducks show very little geographical variation.

In spite of their common name these ducks seldom perch in trees. Some species never do, while others perch only occasionally—not nearly so regularly as the members of the tribe Cairinini. Hence "whistling ducks" is a much more appropriate name for this group than "tree ducks."

The eight species of *Dendrocygna* can be divided into three groups: a primitive group (perhaps only one superspecies) consisting of *arborea* (West Indies) and *guttata* (East Indies); secondly the somewhat isolated species *autumnalis* (America); and finally a group of five closely related species, *javanica* (southeast Asia, Malaysia), the superspecies *bicolor* (America, Africa, India) and *arcuata* (Malaysia, Papua, Australia), *eytoni* (Australia), and the specialized *viduata* (America, Africa, Madagascar).

II Subfamily Anatinae

1. Tribe Tadornini. Sheldrakes

The sheldrakes, a name under which we include the related genera *Chloëphaga*, *Cyanochen*, *Neochen*, *Alopochen*, "*Casarca*," and *Tadorna*, form a group of ducks which are not far from the river ducks. The resemblance to the geese, which has led to names like Egyptian Goose, Orinoco Goose, and Blue-winged Goose, is entirely superficial. The South American Crested Duck (*Lophonetta*) is related to the sheldrakes, as are probably also the primitive Australian Cape Barren Goose (*Cereopsis*) and the South American steamer ducks (*Tachyeres*).

Members of this tribe are characterized as follows: bill comparatively short and thick; legs long; neck short; coloration in the two sexes either alike or different, but bright in both; voices of male and female very different; a spur-like bony knob on the bend of the wing (metacarpal joint); a bold color pattern of the downy young (black and white or grayish-brown and white); a white nest-down in many species; wings adorned (except in *Cereopsis*) with a broad metallic speculum, which is formed by the secondaries or greater wing coverts; lesser and median wing coverts of a uniform snowy white (except in *Cereopsis* and *Cyanochen*, where they are light grayish-blue, in *Neochen*, where they are purplish-black, and in *Lophonetta specularioides*, where they are gray). Sheldrakes are very quarrelsome; each pair keeps apart from other individuals of the species.

Females indulge in special "incitement displays" which are important in pair formation. In the Ruddy Sheldrake (*Tadorna* [*"Casarca"*] *ferruginea*) in which this display is particularly well developed, it has been described as follows: "On approach of intruder female makes kind of feigned attack, with neck extended and head close to ground, constantly uttering anger-note, and if it does not withdraw she returns to male, running frantically round him . . . . till he attacks the stranger and if possible drives it off. Male appears to have no courtship, but female takes initiative in attaching herself to a male and inciting him to attack others . . . . Females not yet definitely paired may incite different males against one another, apparently preferring strongest and most bellicose" (Witherby *et al.*, 1939:228, *after Heinroth*). These agitation displays occur in rudimentary form also in the mallard and other river ducks.

The eggs are smooth, not rough as in the geese, and only the females incubate. The males, however, guard the nest from a distance. The Tadornini apparently pair for life, but accurate observations on this point are not available. Members of the genus *Tadorna* nest usually in holes in the ground except *T. radjah*, which nests in tree holes. Accurate records of the nesting habits of *Cyanochen* or of *Lophonetta* in the wild are lacking. *Chloëphaga* and *Cereopsis* nest on the ground. Sexual maturity and the pugnacity connected with it are usually reached at the age of two years. Adults of the tribe dive only when wounded and before coition (*Tadorna*). The pre-copulatory display of *T. tadorna* does not consist of head and neck dipping as in geese, but of a simultaneous dive by the two sexes during which the male mounts the female. In *Alopochen* and *Chloëphaga* copulation may occur in shallow water or even on land. The food of most species consists of grass and water plants (eelgrass, kelp), but a few forms, particularly *T. tadorna*, feed also on mollusks, shrimp, and other water animals.

The grazing habits of the five species of *Chloëphaga* are correlated with a *Branta*-like bill, as in *Cyanochen* and *Neochen*. The color pattern of the downy young, the wing pattern (with metallic speculum) of the adults, the asymmetrical development of the bulla ossea of the syrinx, the sexual dimorphism in voice, the scutellation of the tarsus, and many other features prove the relationship of *Chloëphaga* with the sheldrakes.

The species of this tribe form a graded series from long-legged birds with a narrow bill, as in *Chloëphaga*, to birds which have shorter tarsi and a longer, broader bill with more distinct lamellae, as in *Tadorna*. The gap between the sheldrake tribe and the river ducks seems to be bridged morphologically by such intermediate forms as *Lophonetta specularioides* on one side and *Anas specularis* and *A. acuta* on the other. However, sheldrakes have larger tails than river ducks, and their legs are longer and placed more forward; they also differ strikingly in their habits. It is therefore justifiable to keep them in a separate tribe.

The Cape Barren Goose (*Cereopsis novae-hollandiae*) is a peculiar bird, quite different from typical sheldrakes in many respects, including skull, bill, and color pattern of the adult. The tarsus is reticulate and the syrinx without bullae, both characters indicating a primitive condition. On the other hand, the color pattern of the downy young, the general proportions of the birds, their posture (Figures 7 and 8), as well as their quarrelsome temper, indicate relationship with *Chloëphaga*, as Heinroth (1911) pointed out many years ago. The real place of this primitive genus in the duck family is still somewhat uncertain. The sexes are alike in plumage. The voice of the male is loud and trumpeting, that of the female a low grunt. The bill is short and thick, covered for the greater part by a yellow cere. The nest is placed on the ground.

All the South American "geese" of the genus *Chloëphaga* (Figures 8 and 9) are nearly alike in shape and habits. The males have a high-pitched whistle, the females a harsh quack, very similar among all species. Their breeding display is interesting, distinctly like that of the typical ducks. The male stands erect, throws the breast forward, the neck backward, and calls, while slightly lifting the wings; the female quacks with lowered head and a vertical movement of the neck. In the Andean species (*C. melanoptera*), the display is more elaborate, and both sexes puff out their feathers; the voice is softer. There is an eclipse plumage in *C. poliocephala*, grayer and less bright than the nuptial, between the postnuptial and the late fall molts, affecting both sexes. The sexes are similar in plumage in three species (*rubidiceps*, *poliocephala*, *melanoptera*), different in the other two (*hybrida* and *picta*[3]). The downy young of the various species (Figure 9) are similar to one another in pattern, but some have very dark gray marking (*poliocephala* and *melanoptera*); others are paler and browner (*picta* and *rubidiceps*); while in *hybrida* they are ex-

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[3] We include in *picta* both *dispar* and *leucoptera*. For the use of the name *picta* instead of *dispar* or *leucoptera*, see Hellmayr, 1932, *Field Mus. Nat. Hist. Zool. Series*, 19:319.

tremely pale. The metallic speculum in *Chloëphaga* is formed by the greater wing coverts, while the secondaries are white.

The Abyssinian Blue-winged Goose (*Cyanochen cyanopterus*) could almost be considered congeneric with *Chloëphaga*, differing only in its slightly flatter bill, its more graduated tail, its blue wing coverts, its metallic green secondaries, and its alarm display. The voice in both sexes resembles that of *Chloëphaga melanoptera*, but is still softer. As in *C. melanoptera*, the face of the downy young shows during the first days after hatching a distinct golden tinge, a feature found only in these two species of the tribe. When alarmed, *cyanopterus* puffs out its shoulder feathers and rests its neck among them. Otherwise, it has the same general aspect, habits, and display as the species of *Chloëphaga*.

The Egyptian (*Alopochen*) and Orinoco (*Neochen*) Geese are related, the bill in *Neochen* being slightly, and in *Alopochen* decidedly, flatter and broader than in *Cyanochen* and *Chloëphaga*. The male Orinoco whistles, whereas the male Egyptian emits a husky breathing sound. In addition to this difference in bill and voice, the plumage pattern of adults and the coloration of the downy young are different, as well as the display postures. It may, therefore, be justifiable to recognize the genus *Neochen*. (The Orinoco Goose and downy young are shown in Figure 10.) Both females have harsh quacking voices. Their displays, although special in each case and very elaborate in *Neochen*, recall those of *Chloëphaga*, except that the wings are opened a little more. The nest is placed by preference—particularly by the Orinoco Goose—in a hollow tree or in a hole in the ground, but always in some sheltered site. The sexes in both species are alike.

The typical sheldrakes are usually placed in two genera, *Tadorna* and *Casarca*. The two type species, *tadorna* and *ferruginea*, the European representatives of these groups, are indeed strikingly dissimilar. However, they are connected by a chain of intermediates. The Australo-Papuan species *radjah*, for example, has the body shape, syrinx, and downy plumage of "*Casarca*," the whistling voice of "*Tadorna*" in the male, a bill and plumage pattern intermediate between the two "genera," and it nests in trees, which neither typical *Tadorna* nor typical "*Casarca*" do. The Australian *tadornoides* approaches *Tadorna* in color pattern. It is best for this reason to group all of the typical sheldrakes in a single genus, *Tadorna*, in which we also include "*Pseudotadorna*" *cristata*. This probably extinct Korean form resembles *Lophonetta* in having a slight crest and a rather graduated tail, but in every other respect it agrees perfectly with the other species included in *Tadorna*.

The species of *Tadorna* have a flatter bill (slightly curved, with distinct lamellae) and shorter tarsi than the goose-like species described above. Both sexes in the four species formerly separated as "*Casarca*" (*ferruginea, cana, tadornoides, variegata*) have a loud voice, which they use very often in duets; that of the female is very different from the male's—harsh and quacking. The display resembles that of *Chloëphaga* and particularly that of *Alopochen*. The male moves his erect head backward and forward; the female stretches her neck and keeps her head low as in most other Tadornini. They nest in holes and burrows. An interesting fact is that the juvenal plumage of both sexes resembles that of the adult male. It is always different from that of the female although not conspicuously so, except in one species (*variegata*), in which the female has a distinct, blackish, eclipse plumage.

The Common Sheldrake (*tadorna*) differs from the other species primarily in the whistling voice of the male and the showy black, red, and white plumage. It is also less quarrelsome and more gregarious. If associated with them in captivity, *T. radjah* pairs with *T. ferruginea* (with which it produces fertile hybrids), but completely ignores *tadorna*.

The South American *Lophonetta specularioides* resembles the members of the genus *Anas* in its plumage pattern. But in its quarrelsome, solitary habits, its display and general behavior, and the pattern of the downy young, it is undoubtedly a member of the sheldrake tribe. It provides an obvious link between the tribes Tadornini and Anatini.

The large, robust, and plain-colored steamer ducks (*Tachyeres*) of the austral coasts of South America are difficult to place. We have long observed them at Clères. They have almost no display, and their habits and voice seem to be very simple and primitive. They are great divers and superficially resemble the eiders to which, however, they are obviously not related. They are exceedingly quarrelsome and combative, as are many genera of Tadornini. The color pattern of the downy young is characterized by a broad white stripe (interrupted in *pteneres*) along the side of the head, rather similar to the pattern of the young in *Chloëphaga*. It is possible that the steamer ducks are diving species evolved from the *Chloëphaga* group, and we therefore tentatively associate them with the Tadornini. The male steamer duck helps the female in raising the young, and there is some evidence that steamer ducks pair for life. This habit would also favor classification with the Tadornini. The male has an asymmetrical bulla ossea of the syrinx, like that found in the Tadornini, Anatini, and Cairinini. The secondaries are white, as in *Chloëphaga*.

As Murphy has convincingly demonstrated (1936, "Oceanic Birds of South America," pp. 951–972), there are three species of steamer ducks, a flying species (*patachonicus*) and two flightless ones (*pteneres* and *brachypterus*).

2. TRIBE **ANATINI.** RIVER DUCKS

The river ducks, also called surface-feeding ducks, occupy a central position among the Anatinae, between the sheldrake tribe of mostly grazing species and the diving tribe of pochards. We recognize about 36 species of typical river ducks and 4 aberrant species which we classify with them only tentatively.

River ducks differ from the sheldrake tribe most noticeably in their smaller, more pointed tail; the legs are shorter and are placed farther back on the body, which is the reason for their waddling walk. They go to the shore or ice to rest more frequently than the pochards or sea ducks do. The wings are long and pointed and are beaten less rapidly than among the pochards and sea ducks. The hallux is not lobed. The syrinx of the male has an asymmetrical bulla (always on the left side), which is evenly ossified. The sexual dimorphism of the syrinx is correlated with a pronounced difference in voice between the sexes, the voice of the female usually being louder.

All river ducks have two molts each year. In about half the species the plumages of the two sexes are dull colored and very similar; in a few species (e.g. Chilöe Widgeon, *Anas sibilatrix*) both male and female are brightly colored. There is strong sexual dimorphism in the brighter forms of the northern hemisphere and in some southern forms; in these species the nuptial plumage of the drakes is very different from the eclipse plumage, which resembles that of their females. In the dull-colored species (and in the species in which both sexes are bright), there is very little difference between the nuptial and eclipse plumage (Falla and Stead, 1938). The female and eclipse plumages of the brightly colored species have a hormonal basis. Castrated males and females of such species wear the nuptial plumage of the drake throughout the year. All species have an iridescent metallic speculum. The downy young of all species of the genus *Anas* are very much alike (similar to those of the mallard). They are usually yellow and brown with a dark line across the eye.

Most river ducks live on fresh water, but a few species nest on the seashore; some are found on the ocean during migration. They get most of their food in shallow water, securing it from the surface; or from mud with quick dabbling motions of the mandibles; or, where water is slightly deeper, by "up-ending" (tipping) with head and front part of body submerged and tail in air. Young dive fairly freely, but adults only exceptionally or if wounded. *Anas sparsa* alone among typical river ducks is reported to dive regularly. Only a few species perch in trees and nest in holes. All river ducks breed when one year old. They have larger clutches than the pochards, but the eggs are smaller.

The typical river ducks consist of 14 groups, characterized by minor morphological and biological peculiarities, but all closely related and more or less connected by intermediates. One must either recognize 14 separate genera or unite all these species in the single genus *Anas*. The latter arrangement, originally proposed by Hartert, has largely been adopted by Phillips, Peters, and Witherby, but, curiously enough, all of these authors have kept the shovellers in the separate genus *Spatula*. The extremely close relationship of the four species of shovellers with the three "teal" of the blue-winged group (*querquedula*, *discors*, *cyanoptera*) is, however, evident and has been emphasized by many authors. All these species have an almost identical color pattern of the wing. The peculiar courtship habits, the feeding methods, and sometimes the voices are similar among the species and somewhat different from those of the other river ducks. The only difference between "*Querquedula*" and "*Spatula*" is the larger body and bill in the shovellers. Furthermore, there is good evidence that the shovellers are not even a natural, monophyletic group. In two pairs of species, the South American Shoveller (*platalea*) and the Cinnamon Teal (*cyanoptera*) on one side, and the Australian-New Zealand Shoveller (*rhynchotis*) and the Blue-winged Teal (*discors*) on the other, the "teal" of each pair agrees in plumage color with the "shoveller" to such a surprising degree that the closest relationship must be assumed. This suggests that the shoveller group is polyphyletic, owing its origin to the repeated development of large-sized and large-billed species from the original blue-winged duck stock. Again, as in so many other cases in avian taxonomy, the shape of the bill has been a very misleading character. In addition to *Spatula*, Peters also maintains the genera *Mareca* (for the widgeons) and *Chaulelasmus* (for the gadwalls), but this action is, in our opinion, not consistent with the lumping of the other groups.

The display among the river ducks follows a common pattern, but it shows every degree of elaboration from a few simple performances to a complicated series of displays. These more or less elaborate displays, which are accompanied by distinctive calls, provide excellent clues to the relationships among the various species, even better ones than color patterns and morphological features. Pursuit flight is common with most species.

The most elaborate display is that of the Mallard (*Anas platyrhynchos*). It may be described in detail, to form a basis of comparison with other species. It consists of a series of postures, the principal of which are: (1) Swimming around the female, or sitting on the water with other drakes, with head sunk, the feathers puffed out, and neck resting on the back; tail shaken and raised and head shaken repeatedly. (2) Quick "throw-up" of head and tail, at once followed by No. 3. (3) Neck stretched out over the water, the bird swimming about swiftly in various directions. (4) Following posture No. 1, the bill is suddenly lowered and dipped in water; the bird then stands up and rapidly passes its bill up his breast, producing a jerk which throws up a small jet of water as bill is withdrawn. A whistle is emitted during this display. (5) The drake swims around with neck raised and head slightly turned, as the female displays at his side. The female follows the male, quacking, with head lowered and repeatedly moved sidewise away from the drake as if to defy others to approach her mate. She also assumes posture No. 3 of the males. In all typical Anatini, the precopulation display in both sexes consists of a bobbing up and down of the head, the bill touching the water at its lower course and always remaining nearly horizontal. Finally, the female flattens herself, extends her neck, and is mounted by the male. In species most nearly related, these postures are reproduced with only minor changes or omissions. In other groups, some or most of the postures are lacking, while in still others the display is very simple and primitive or considerably modified (blue-winged ducks).

Making use of all these characteristics, we arrange the 36 species of river ducks of the genus *Anas* in a number of groups which were given subgeneric rank in an earlier publication (Delacour, 1936). In order to avoid complicating the nomenclature, we refrain from listing subgenera here. This does not mean, however, that we do not fully recognize the validity of these subdivisions of the genus *Anas*.

Group 1. The Bronze-winged Duck

The Bronze-winged Duck (*Anas specularis*) of South America, the only member of this group, remains poorly known. We have never observed it in life. Although in its plumage it resembles the Crested Duck (*Lophonetta specularioides*) of the same region, it seems closer to the river ducks in its general proportions. So far nothing is known of the habits, voice, and courtship display of this species. Recent observers report that it is a sociable bird, gathering in flocks. Its present place in our system is tentative.

Group 2. Salvadori's Duck

Salvadori's Duck ("*Salvadorina*" *waigiuensis*), from the mountains of New Guinea, is very close to the birds of the following group in its proportions and color pattern. Its reputed adaptation to life in rapid mountain streams has been greatly exaggerated, and it shows no resemblance to the Torrent Duck (*Merganetta*); the tail feathers are hardly stiffer than those of other ducks. The bill is fairly broad, and the head is entirely black. Otherwise the species agrees very well with birds of Group 3. The habits are those of typical river ducks (Mayr and Rand, 1937, *Bull. Amer. Mus. Nat. Hist.*, 73:9–12).

Group 3. "Tropical Pintails"

A group, inhabiting tropical and subtropical countries, which consists of species that are very near the pintails of Group 4 though less specialized, can be called the "tropical pintails." The tail is pointed but shorter; the male's voice is lower and less melodious; the display resembles that of the pintails of Group 4 but is simpler, lacking the more elaborate postures to a varying degree according to species. Male and female are alike in all species, and the eclipse plumage resembles the nuptial. The following six species belong to the group: *angustirostris*, *capensis*, *punctata*, *versicolor*, *erythrorhyncha*, and *bahamensis* (with subspecies *galapagensis*). They all have a comparatively large head, dark above, pale below; a thin and rather long neck; a narrow and fairly long bill, which is depressed, curved, and always brightly colored. All have a speculum, bronze-green with light-brown borders, except in *angustirostris*, where it is whitish gray. The latter is a pale species, but its shape and general plumage pattern indicate clearly its relationship to the others, particularly to *capensis*. The males of *A. versicolor* and of *A. punctata* are practically voiceless, and the male of *versicolor* has, according to Heinroth (1911), a peculiar enlargement of the middle of the trachea.

Group 4. Pintails

The Common Pintail (*Anas acuta*) is very similar to the mallard in general habits and display. In courtship posture No. 2, the tail is raised vertically; posture No. 3 is usually omitted. The call of the drake is a soft *klyck*, very much like that of the green-winged teals (Group 5). Like the mallard it emits a whistle during Posture 4 of the courtship. Eaton's Pintail (*eatoni*) is colored like the eclipse plumage of *acuta* and is obviously conspecific with it, differing mostly in its smaller size. The close relationship of *acuta* with the mallard is indicated by the frequent crossing of the two species and by the almost unlimited fertility of the hybrids. Pintails seem to indulge in "up-ending" more than any other duck, the greater frequency of this habit being undoubtedly correlated with the longer neck of the species. The South American Brown Pintail (*A. georgica spinicauda*) has a yellow bill and throughout the year a spotted fulvous-brown dress in both sexes. The South Georgian Pintail (*A. g. georgica*) is very similar but much smaller and slightly darker. Voice and display are those of *acuta*.

Group 5. Green-winged Teals

The Green-winged Teal (*Anas crecca*) has the same display as the mallard, and its voice, a soft *klyck*, is emitted during Postures 2 and 4 of the courtship. It is represented in South America by the Yellow-billed Teal (*A. flavirostris*) which resembles in plumage the South American Brown Pintail (Group 4). The two forms, together with *A. undulata* (Group 9), differ from their brightly colored northern representatives (*A. crecca*, *acuta*, and *platyrhynchos*) in a remarkably parallel manner.

Group 6. Baikal Teal

The color pattern (Frontispiece) of the Baikal Teal (*Anas formosa*) indicates that it is related to *crecca*. However, voice and display are entirely different and necessitate its separation in a special group.

Group 7. Falcated Teal

The Falcated Teal (*Anas falcata*) of northeastern Asia also stands rather alone. It is perhaps more closely related to the Baikal Teal than to any other group. Its voice, a triple whistle of the pitch of *crecca*, is given without special display. Head and neck are pressed close to the body, and the remarkable sickle feathers of the male are, curiously enough, never displayed. This species seems to be also related to the Gadwall (*A. strepera*), which it approaches in several ways and whose company it seeks in captivity.

Group 8. Austral Teals

A group standing near the mallards is composed of teals from the South Pacific and the Indian Ocean. The relationship of the two groups is shown in a general similarity in shape and in color pattern. Both include some forms with green-headed, bright males, having a distinct eclipse plumage, and some that are dull-colored. The display of the Austral teals is that of the mallards minus the elaborate Postures 3 and 4. They all have the same wing pattern, with a brilliant dark green and white speculum. It is a perching group, often nesting in trees. It is composed of two species with a marked sexual dimorphism: "*Nesonetta*" *aucklandica*[4] (including *Anas chlorotis* as a subspecies) and *castanea;* and two that have a dull brown plumage: *gibberifrons* (including *albogularis* and several other subspecies) and the small erythristic *bernieri*, a rare bird of Madagascar.

S. D. Ripley (1942, *Auk*, 59:90–99) has recently studied *gibberifrons* and concluded that it was conspecific with *castanea*. It is obvious that both forms are very closely related; but it seems that both often breed at the same locality, and we therefore prefer to consider *castanea* a full species. Hybrids reared in captivity are intermediate and completely fertile.

Group 9. Mallards

The mallard group is composed of the well-known northern bird, with a brilliant nuptial and inconspicuous eclipse plumage, and of many other species spread over most of the world except South America. These other species have a dull brown plumage practically the same in the two sexes and in the two annual plumages. The entire group could almost be considered a single superspecies. It is only in North America and East Asia that the breeding ranges of two species of this group overlap. It appears that this overlapping is of recent date and perhaps brought about by human agency. In general behavior, display, and voice, the mallards are alike. It is

[4] We follow Stead (1938, *Trans. Proc. Roy. Soc. New Zealand*, 68:100–101) in placing *Xenonetta nesiotis* Fleming, 1935, in synonymy here.

however, possible to distinguish several groups among them according to their plumage pattern and general proportions, and we find it expedient to accord specific status to each of these groups.

The Hawaiian Duck, Laysan Teal, and Marianas Mallard (*wyvilliana*, *laysanensis*, and *oustaleti*) are small and have lost in their isolation many of the characteristics of the mallard. Still, they are certainly nothing but dull-colored editions of the Common Mallard (*platyrhynchos*) and therefore conspecific with it; all have the same speculum as the Common Mallard. The East Asiatic-Pacific group, which includes *poecilorhyncha*, *superciliosa*, and *luzonica*, as well as other less distinct forms, also constitutes a single species, all the forms being very similar in plumage pattern and shape. The Madagascan Meller's Duck (*melleri*) stands alone, as does the African Yellow-billed Duck (*undulata*)*;* the latter reminds one of the South American Brown Pintail (*A. georgica spinicauda*) and of the Yellow-billed Teal (*A. flavirostris*) by the colors of its bill and plumage, as noted above. The North and Central American group can also be considered as forming one species (*fulvigula*); it seems obvious that the Mexican and Black Ducks (*diazi* and *rubripes*) are only subspecifically distinct from the Dusky Duck (*fulvigula*).

Group 10. African Black Duck

The African Black Duck (*Anas sparsa*), a forest species, stands quite alone in its behavior and habits. It is a quarrelsome species leading a solitary life. Its display is different from that of the other groups and is simpler; its voice is peculiar. This species is probably less closely related to the mallards than is commonly supposed; it requires further study.

Group 11. Gadwall

The display of the Gadwall (*Anas strepera*) is similar to that of the Mallard but is simpler. Posture 4 is usually absent, and instead, a grunting call is uttered without special body movements except that the head is raised. The display performance is more casual and the voice of the female much less loud than in Groups 2, 3, and 7.

Group 12. Widgeons

The three species of widgeons form quite a special group, not closely related to any other. Their display, although it suggests certain parts of that of the mallards, is peculiar. It consists mostly of a lifting of the long scapulars and the primaries accompanied by loud whistling and vertical movement of the head. It is interesting to note that the South American species, *sibilatrix*, in which the two sexes are nearly similar and both brightly colored, has the most elaborate postures. In the European Widgeon (*penelope*) and the American Widgeon (*americana*), which are very closely related, this display occurs in a more rudimentary form. However, the American species lacks the loud whistle, produced before and during the breeding season, which the European species shares with *sibilatrix*. It seems that in *sibilatrix* the drake helps the female take care of the young, and similar cases have been reported in *americana* and *penelope*, although it does not appear to be the rule with them. This trait is apparently unusual for the genus *Anas*, but parental care of many species of river ducks has been studied insufficiently. The somewhat isolated position of the widgeon is also indicated by the color of the young (which are less yellow than the others) and the apparent sterility of hybrids with other species of *Anas*, except *strepera* (Group 11). The pair among widgeons is a more closely knit unit than in other groups, and although pursuit flight occurs, it is infrequent.

Group 13. Blue-winged Ducks

We now come to a very well-defined group of species which may be called the "blue-winged ducks." They include the birds known as the blue-winged teals (*discors*, *cyanoptera*, *querquedula*) and the shovellers (*platalea*, *smithi*, *rhynchotis*, *clypeata*). The plumage pattern is consistent throughout the group, particularly the blue-gray color of the lesser and median wing coverts. Indeed, as we have said above, some of the species are very similar in plumage and differ mainly in body dimensions and bill size (*discors* and *rhynchotis; cyanoptera* and *platalea*). There are only minor differences in habits and display among the forms. They have a peculiar ceremony in which one or several pairs swim around in a circle, head to tail, merry-go-round-like, with the bill immersed and water running through it as if in a cooperative effort to stir up food. The same performance, in a formalized manner, occurs also as a courtship display. Another type of display is very simple, consisting in a rhythmical raising and lowering of the head by both male and female with the bill kept horizontal. Pursuit flight of several males after one female is of frequent occurrence. In the teals, *querquedula*, *discors*, and *cyanoptera*, the bill is long, but of normal shape; the voice of the drake is a harsh or whizzing clatter. The shovellers are larger and have the well-known huge spatulate bill.

Three species (*clypeata*, *rhynchotis*, and *smithi*) are similar in size, and the voice of the male is a low, short hoot: *took-took*. The South American Shoveller (*platalea*) is smaller and has a smaller bill; the male has a low, whizzing voice. We have found that when the Blue-winged Teal (*discors*) and the Cinnamon Teal (*cyanoptera*) are associated artificially they interbreed freely, producing fertile hybrids; and the stock soon becomes hopelessly mixed. The Common Shoveller (*clypeata*) and the Australian-New Zealand Shoveller (*rhynchotis*), as well as the three allied teals, have an eclipse plumage. The South American Shoveller (*platalea*) and Cape Shoveller (*smithi*) have no noticeable one. The Garganey drake (*querquedula*) is unique in the tribe in not acquiring its nuptial dress until late winter. All Cinnamon drakes have an eclipse plumage, whether they come from North or South America. We made a point of importing birds from both continents to make certain of this fact, which had been questioned. It may be that the blue-winged ducks are linked to other river ducks through *Anas versicolor* (Group 3), whose wing pattern is very like that of the blue-winged group.

Group 14. Ringed Teal

A very puzzling species is the small Ringed Teal (*Anas leucophrys*), of South America. In its shape and general proportions, it is a normal *Anas*. Its plumage pattern and coloration, different in the two sexes, but very elaborate in both, is peculiar. Although the plumage of the male is very bright, it is not changed into an eclipse plumage after the breeding season. This is a perching, hole-nesting duck. In its display and courtship habits, it differs entirely from all other river ducks and resembles the pochards (Aythyini). As in those diving ducks, the female's call is a low, harsh, short, repeated *kur-r-r*. The male has a deep, soft whistle, which he emits while jerking back the neck, which is distended with air. He also indulges in the curious mock pursuit of the female, so typical of the pochards. Because of these strikingly different habits, Delacour (1936:369) placed the species in a special subgenus *Calonetta*. A better understanding of this little-known species may result in its generic separation.

Aberrant River Ducks

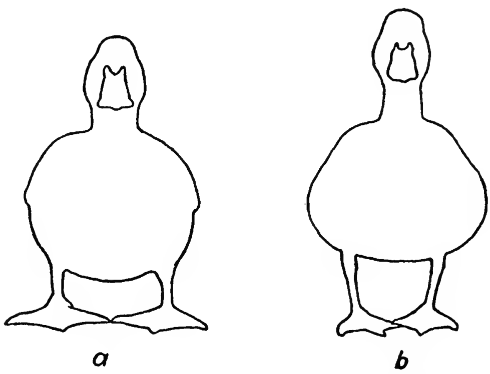
The curious Blue Duck (*Hymenolaimus malacorhynchos*) from New Zealand, with its peculiar coloration and bill, may be merely an aberrant *Anas*. It certainly belongs to the river duck group and shows no resemblance whatsoever to the Torrent Ducks (*Merganetta*). It is difficult to understand how such a suggestion could have ever been made. Its behavior is not well known, but it is reported to be able to dive. The downy young have a dark line through the eye as in the genus *Anas*.

The small Australian Pink-eared Duck (*Malacorhynchus membranaceus*) recalls in its plumage pattern and coloration the tropical pintails (Group 3), particularly the Marbled Teal (*angustirostris*). It has a white, not metallic, speculum. The large, peculiar bill differs widely from that of the shovellers and gives no clue to the systematist. The habits are little known and require further study before this duck can be assigned its proper place in the sequence of species.

Another puzzling species is the rare Pink-headed Duck from India (*Rhodonessa caryophyllacea*). It differs widely in coloration from all other ducks, with its blackish body, reddish-fawn speculum, pink head, pink hind neck, and bill. For many years we were able to observe live specimens in the collections at Clères and at Foxwarren, after Mr. A. Ezra had obtained a number of them from Calcutta.

These captive birds never nested, but they constantly displayed during the breeding season. The display of the drakes was simple: they puffed out the head feathers, with the neck shortened and resting on the back, then stretched the neck upward as they uttered a whizzing noise resembling the whistle of a mallard, though lower and weaker. The females showed in a rudimentary way the usual posture of river ducks. Because of the resemblance in display and posture, we consider this species as belonging to the present tribe. It has certainly no connection with the perching ducks, though one has often been suggested.

The Freckled Duck (*Stictonetta naevosa*), from Australia, is an aberrant, primitive species that defies any attempt at classification. In its general body build it seems to be closest to the river ducks, but the freckled color pattern and absence of speculum are peculiar, and the tarsus is reticulate in front. The trachea is quite different from that of the other river ducks. The bulla is absent, but the trachea has two expansions in the male. The color of the downy young and the various phases of the display have not yet been described. The food is obtained on the surface of the water, not by diving.



Leg position of (*a*) scaup and (*b*) mallard (*after Heinroth*).

3. TRIBE AYTHYINI. POCHARDS

This small tribe is composed of 14 species of fresh-water diving ducks. They are closely related to one another but can be divided into two genera. The color of the downy young and other characters indicate that the pochards are much more closely related to the river ducks than to the sea ducks.

They are characterized by a short, heavy body, a rather big head, and large feet. The legs are placed far back and laterally; the hallux is lobed. Sexual dimorphism is always present, but is sometimes not very pronounced. The males of all the temperate-zone species have an eclipse plumage which is usually intermediate between the nuptial and the female plumage. Metallic colors do not occur on the wing, the speculum being either white or pale. The syrinx of the male has an asymmetrical bulla, but it is quite different from that of the river ducks; it is pointed rather than roundish, is more or less chambered inside, and has membranaceous windows on the outside. The downy young resemble those of many river ducks in color and pattern, but the yellow pigment is usually pronounced, and there is no distinct dark line through the eye. The heads are larger, even in the downy young, the legs and feet sturdier and set farther back on the body. Pochards come on land rather infrequently except for nesting; they walk clumsily. They are good divers although they usually do not stay under water so long as the sea ducks do. The food is primarily vegetable, but in certain species (Tufted Duck and scaups), and at certain seasons, the animal component prevails. All members of this tribe breed in their first year. The nest is placed on the ground among reeds or in the grass.

The display of pochards differs greatly from that of the river ducks and other tribes. The drakes have the curious habit of pursuing their own mates in a rough way. We have already referred to this mock brutality in connection with *Anas leucophrys*. The drakes in most species call very rarely. Females utter a loud *karr*. There is little basic difference among the displays of the various species of the tribe.

Hochbaum (1944:22–45), who describes the display in considerable detail for the Canvas-back ("*Nyroca*" *valisineria*), distinguishes four main postures of the displaying drake: (1) The "head-throw," during which the head is first thrown sharply backward until the top of the head touches the back and the throat points to the sky. Then after a brief, almost imperceptible pause, the head is snapped abruptly forward to swimming position. The call *ick, ick, cooo* is usually uttered during this motion. (2) The "neck-stretch," during which the drake raises his head as high as the stretched neck will permit and parades stiffly before the hen and the other drakes. (3) The "sneak," in which the drake stretches head and neck horizontally on the water. (4) The "threat," in which the drake swims in a crouched position, usually when ready for a fight. The "head-throw," during which the neck seems to be inflated with air, apparently occurs in one form or another in all the species of this genus.

The genus *Netta* is composed of three species inhabiting temperate and subtropical regions. They constitute a bridge between the river ducks and the more specialized pochards of the genus *Aythya*[5] being less well adapted to diving than the latter. The body is longer and narrower, the legs longer and more slender, the bill narrower, than in *Aythya*, and the birds are less heavy and clumsy on land. All three

[5] *Aythya* has priority over *Nyroca* and is not preoccupied by *Aethia* (see Witherby *et al.*, 1939:286).

species have bright red eyes. They are the Red-crested Pochard (*Netta rufina*) of southern Europe and central Asia; the Rosy-billed Pochard of Argentina ("*Metopiana*" *peposaca*); and the Southern Pochard ("*Nyroca*" *erythrophthalma*)[6]. The species *rufina* and *peposaca* are usually placed in separate monotypic genera, while *erythrophthalma* is united with *Aythya* on account of a similarity in color to several species of that genus. But in its proportions and its plumage pattern *erythrophthalma* is obviously close to *peposaca*. The display of these two species is on the whole that of the other pochards, except that *peposaca* sometimes calls with neck vertical and bill pointing skyward. The male Red-crested Pochard (*rufina*) has rather different postures, particularly one in which it spreads its long head feathers, depresses the bill, and rests the neck on the back while uttering a sneezing call. This resembles a simple phase of the display of the mallard. The trachea of *rufina* has two bulbous enlargements.

The genus *Aythya* contains four groups: The first consists of the closely related Canvas-back (*valisineria*), the European Pochard (*ferina*), and the Redhead (*americana*). The European Pochard in coloration is intermediate between the other two, but in the shape of its head it is nearer to *valisineria* than to *americana*. Group 2, the white-eyes, contains the four species, *innotata* (Madagascar), *nyroca* (Eurasia), *baeri* (east Asia), *australis* (Australia and New Zealand), all from temperate and subtropical lands. Although superficially similar, their postures and proportions are different enough to justify considering them separate species. The black and white Tufted Duck (*fuligula*), from Eurasia, and the Ring-neck (*collaris*), from North America, are certainly related to each other, and they form a third group which includes also the New Zealand Duck (*novae-seelandiae*). Group 4 consists of the scaups. The Greater Scaup (*marila*), which ranges all over the northern hemisphere, is the most heavily built bird and ablest diver of the tribe and the only one that spends much time on the ocean. The Lesser Scaup (*affinis*), restricted to America, is closely related. The scaups apparently take a higher proportion of animal food than the other species of the pochard tribe.

4. TRIBE CAIRININI. PERCHING DUCKS

This very peculiar group of ducks had already been separated by Salvadori, as a subfamily (Plectropterinae), and, in our opinion, it was a mistake of modern authors to remove from it the Mandarin ("*Dendronessa*" *galericulata*) and the Carolina Wood Duck (*Aix sponsa*) and place them among the river ducks. In their general proportions and

[6] The Southern Pochard has a curious distribution in East and South Africa and in South America, where it is currently stated to inhabit only the northwestern parts. But it evidently occupies a much greater area, for a number of live specimens were received at Clères in 1938 from the neighborhood of Pernambuco, eastern Brazil.

shape, in habits and behavior, they clearly belong to the perching ducks. To the 14 species listed by Salvadori, several of which we relegate to the rank of subspecies, we have added three more. One of these is the very aberrant Pied Goose (*Anseranas*); peculiar as it is, it resembles the Spur-winged Goose (*Plectropterus*) in general aspect and habits; it appears to be certainly nearer to that than to any other species of Anatidae. We also consider the Brazilian Teal (*Amazonetta*) a member of this tribe on account of the general proportions of its wings and tail, the position of its legs (alike in adults and young), its voice, display, and its living and nesting habits. Finally, we place here, provisionally at least, the small aberrant Australian Maned Goose (*Chenonetta jubata*). It has usually been considered allied to *Chloëphaga* (Tadornini), but its behavior and habits, as well as the pattern of the downy young, which is very similar to that in the Mandarin Duck and totally different from those in the sheldrake tribe, indicate that it would be a mistake to leave it with the sheldrakes.

The nearest relatives of the perching ducks seem to be the river ducks. The two groups resemble each other greatly in the coloration of the downy young and in the structure of the syrinx. Hybrids between species of the two tribes are sterile, but females of the Mallard × Muscovy cross sometimes lay small eggs. Serological tests confirm this relationship (Sokolovskaia, 1936). Species such as *Amazonetta brasiliensis*,[7] *Aix sponsa*, and *Aix galericulata* seem to bridge the gap between the river ducks and the perching ducks.

The perching ducks spend more time in trees than any others, and most of them nest in holes high above the ground. They are decidedly forest ducks. Correlated with these habits are their unlobed well-developed hallux and their sharp, strong claws. The legs are set more forward than in the river ducks, in fact even more than in the geese and the sheldrakes. The length of the tarsus varies from very long (e.g. *Plectropterus*) to extremely short (e.g. *Nettapus*). The bill is rather thick and never depressed, often very strong, with a large nail. The rectrices are wide and long, and the tail is only slightly graduated, never pointed. The wings are very broad and brightly colored. The scapulars, secondaries, and particularly the tertiaries, are notably developed. In a number of species metallic colors occur extensively in the plumage, although there is no sharply defined speculum; the tertiaries and wing coverts are metallic or of a bright color. A bony, spur-like knob at the bend of the wing is more or less well developed in most species. The young are remarkable for their long, stiff tails and their ability to climb. They have no very particular pattern of down; all are brown and

[7] *Amazonetta vittata* Derscheid, 1938, is apparently a synonym (see Zimmer and Mayr, 1943, *Auk*, 60:250).

yellow, except those of the pygmy geese (*Nettapus*), and have an eye-line. With the exception of the two species of *Aix*, perching ducks inhabit the tropics and subtropics. Their display is usually very simple, almost nonexistent, consisting mainly in a forward and backward movement of the head with neck extended.

In general, the voice of the drake is a low, squeaking or aspirated, whistle, and the female quacks harshly. Many species are remarkably silent. Only three species have an eclipse plumage. In most perching ducks, the female is rather similar to the male, but in some cases it is strikingly smaller. Many of the species, if they pair at all, seem to have very weak mating ties.

It is only with great reservations, as we have said before, that we list among these birds the queer and primitive Australian Pied Goose (*Anseranas semipalmata*) in which the two sexes have a loud voice and are alike except for a slight difference in size. There is no sign of a real display in this species. They perch high up, an action facilitated by their semipalmate feet and long hallux, and they spend much time on trees. They appear, however, to nest on the ground, among rushes. They have long legs, a powerful bill, and a bald forehead, resembling *Plectropterus* in most of their features (Figures 11 and 12). *Anseranas* differs from all other Anatinae, except *Cereopsis* and *Stictonetta*, in its reticulated tarsi, thus approaching the Anserinae. It is unique among the Anatidae in having a gradual wing molt. The downy young resembles that of *Plectropterus*.

The African Spur-winged Goose (*Plectropterus gambensis*) is also long-legged, has a bare forehead, adorned with a knob, and big spurs on the bend of the wing. We have seen scores of them perching on small limbs high up in large trees in West Africa. They are reported to lay usually on the ground, but also in old nests in trees. The male has a curious high-pitched voice, which it uses incessantly, though the female seems almost mute. They have a small bulla on the syrinx. They are extremely aggressive and sometimes injure other waterfowl considerably with their sharp spurs.

The Comb Duck (*Sarkidiornis melanotos*) includes two well-marked subspecies, one (*melanotos*) extending from Africa to southeast Asia (Figure 13), the other (*carunculatus*) inhabiting South America. We have observed at Clères that the racial hybrids are not intermediate. In such hybrid broods some birds look like pure *melanotos* and others like pure *carunculatus*. Comb Ducks have legs of moderate length; they perch freely and nest in tree holes. No pair formation seems to exist, the males pursuing and mating with any available female as the Muscovies do. The difference in size between the drake and the duck is truly astonishing. Both sexes are almost mute, the male having a weak whistle and the female a low grunt. The display of the male, which is also his challenge, consists in lifting the neck and chest, with wings slightly raised, the head slowly moved from side to side, the neck curved and dipped downward at frequent intervals. According to Heinroth, the male initiates his pursuit of females often with "dipping" displays such as occur in the geese. The female has no display whatever, according to our observations at Clères. Contrary to current descriptions, the downy young are brown and yellow, much like those of *Cairina* and *Plectropterus*, and have no white or other distinctive head markings. Erroneous descriptions found in the literature seem to have been based on wrongly identified specimens in the British Museum.

We consider that the three large, tropical, short-legged forest species which biologically replace one another in America (*Cairina moschata*), Africa ("*Pteronetta*" *hartlaubi*), and southeast Asia ("*Asarcornis*" *scutulata*) are congeneric. All have the same proportions of the body, wings, tail, bill, and feet. The males of all three have, in the breeding season, a swollen knob at the base of the bill; they agree fairly well in general pattern and perfectly in that their wings all have a showy patch formed by the upper wing coverts. The males are considerably larger than the females, although the difference is not so striking as in the Comb Duck. The two sexes are similar in coloration. The habits of the three species are very much alike; they spend a great part of the day perched on large trees, in the holes of which they nest. They appear to be promiscuous, although more remains to be learned of their behavior in a wild state. They are very quarrelsome. When the characters invoked for the generic distinction of these three species are examined, they appear quite insufficient, and we therefore consider *Asarcornis* and *Pteronetta* as synonyms of *Cairina*.

The Muscovy Duck (*Cairina moschata*), common in Central and South America, is the best known of the three. The voice of the drake is a low blowing hiss; the female has a harsh quack, seldom heard. The male display consists of a rhythmic bobbing forward and backward of the head, with the crest spread, the neck extended, the wings slightly lifted, and the long tail vibrating. The female answers in a similar but less marked way.

The White-winged Duck (*C. scutulata*) has very similar display and habits. The voice is said to be loud in both sexes, but we never heard ours emit any sound other than weak grunts. Both this species and the Muscovy have conspicuous white wing coverts.

The West African Hartlaub's Duck (*C. hartlaubi*) is smaller, but seems to have the same general habits. The loud quacking reported of the species is probably that of the female. We have not made an adequate study of this species in life. In proportions and color pattern, it is very close to the Muscovy and White-winged Ducks. Its upper wing coverts are blue-gray instead of white.

The anomalous Brazilian Teal (*Amazonetta* ["*Anas*"] *brasiliensis*) probably earns its logical place with the Cairinini, for it seems to be a dwarf *Cairina*, resembling that genus in general shape and proportions, and even in habits. Like them, it is a tropical forest bird. The display of the male is so simple as to consist merely in a lifting of the neck, as he whistles loudly. The female quacks briefly and moves her head up and down, slightly sidewise. Male and female differ in plumage and in the color of the bill, but both are rather bright, and there is no eclipse plumage. The downy young looks like a miniature young Muscovy.

The three genera *Chenonetta*, *Aix*, and *Nettapus* have a smaller, smoother, and less flat bill, recalling those of *Branta* and of *Chloëphaga*, but this is of no special taxonomic importance. *Chenonetta* has long legs and looks like a small goose; *Aix* has rather short legs like those in *Cairina*, while *Nettapus* has legs so short that the birds are almost unable to walk.

Because of the great similarity of the females, it seems entirely unnecessary to separate generically the Mandarin and the Carolina Wood Duck, and we combine them in the genus *Aix*. As we have explained above, both these birds have the body proportions, voice, and habits of the tribe, and they are far from all the river ducks. A curious fact to be recorded is the inability of these two allied species to produce hybrids, although when associated in captivity they pair freely. There is a slight but not important difference in the voice and display of the two birds. The Mandarin drake has the more complicated posture: he lifts his wing fans and crest and blows up his chest, slowly lowers his head until his bill touches the water, then jerks his head back quickly with a short, subdued, snorting whistle, *uib*. Several drakes perform together with many short flights and perchings. The female answers with movements of her neck and head. In the Wood Duck, the male just raises his crest, arches his neck, and bows, with softer and more frequently repeated whistles, *jiib, jiib*. He never displays in company with other males. The female behaves much like the Mandarin, but she calls more often and has a softer, more melodious voice. Both Mandarin and Wood Duck form strongly attached pairs (Heinroth, 1910). The downy young of *Aix galericulata* resembles that of *Cairina*, but is paler and duller and has an additional dark stripe below the eye, as in *Chenonetta*.

It is very difficult to assign a place to the small Australian species, *Chenonetta jubata*, usually known as the Maned Goose, but also called locally the Wood Duck. It has a certain superficial resemblance to the species of *Chloëphaga*, but is smaller and differs widely from them in its habits, behavior, and display. Furthermore, the downy young is brown and yellowish and has almost the same shape and color pattern as the young Mandarin Duck, including the dark parallel face lines. This seems to indicate its real affinity. The pattern is totally different from the bold grayish- or blackish-brown and white pattern which is so characteristic of the young in *Chloëphaga* and allied genera.

Like the other members of the present tribe, the Maned Goose is a tree-perching, hole-nesting bird. The voice of the male is a low, whizzing whistle, that of the female a soft quack, drawn out with a special modulation like a mew. The display of the male is simple, consisting in raising the head and neck, as he calls and puffs out his mane; that of the female is *Anas*-like, a sidewise movement of the head with neck extended, as in the Mandarin and Carolina Wood Ducks. The females sometimes engage in "incitement displays," like certain river ducks and sheldrakes. *Chenonetta* has a short, smooth bill, much like that of *Chloëphaga* and *Branta*, but also similar to that of the genus *Nettapus*, and not very different from those of the Mandarin and Carolina Wood Ducks. Its legs are rather long, like those of *Sarkidiornis*, but much more slender, and it walks easily and daintily. It is very gentle in temperament.

The pygmy geese (*Nettapus*) are the smallest members of the family, and also some of the most beautiful. They have small *Branta*-like bills and such extremely short legs that they can hardly progress on land. They perch freely, fly and swim well. All three species are tropical. They have much white and green in the plumage, and the sexes are slightly but clearly different. One species (*N. coromandelianus*) has a well-marked breeding plumage in the male. The downy young of the pygmy geese are of the usual shape for the tribe, but have peculiar dark gray and white patterns. As in the genus *Aix*, the downy young vary from species to species.

The African Pygmy Goose (*Nettapus auritus*) has a thick bill. In both sexes the display is much like that of the Wood Duck, as we have often observed in the wild in Madagascar and in captivity at Clères. Its voice is a soft whistle in the male, a weak quack in the female.

The Green Pygmy Goose (*N. pulchellus*), of Australia, is little known, but seems to be similar in voice and display to the African species.

The Indian Pygmy Goose, or "Cotton Teal" (*N. coromandelianus*), whose range extends from India to Australia, has a flatter bill, is still smaller, and has several peculiarities, notably a breeding plumage which the male assumes for only a few months. The male's voice is a curious rattling cackle, and both sexes have a quick "nervous" jerking of the neck. The display of the male is elaborate, consisting of an arching of the neck, with a partial opening of the wings, showing the white patches on the primaries.

5. TRIBE MERGINI. SEA DUCKS

The various tribes of diving ducks are completely different in proportions, pattern, and habits. The sea ducks show no close relationship with the pochards or the stiff-tailed ducks. Their lobed hallux, a functional adaptation, is of little phylogenetic significance.

Delacour (1936:376), as well as Heinroth and other authors, has pointed out the obvious relationship of the mergansers (*Mergus*) with the golden-eyes (*Bucephala*); and in spite of the wide difference between the extreme forms of the tribe (*Mergus* and *Somateria*), the sea ducks form one of the most closely knit subdivisions of the anatine subfamily. The seven genera are connected with one another by intermediate species. The Hooded Merganser (*Mergus cucullatus*), for example, connects the larger mergansers, through the Smew ("*Mergellus*" *albellus*) and the Buffle-head (*Bucephala albeola*) to the golden-eyes. The Harlequin (*Histrionicus*) is a link between the Old-squaw (*Clangula*) and the scoters (*Melanitta*), as is the Labrador Duck (*Camptorhynchus*) between the Old-squaw and the eiders (*Somateria*).

On the other hand, the golden-eyes, the Old-squaw, and the Harlequin are undoubtedly related, as is proved by the same bold pattern of dark gray and white of all their downy young. The downy young of the White-winged Scoter (*Melanitta fusca*) is also very similar and thus connects the whole group to the other species of the genus (*M. perspicillata* and "*Oidemia*" *nigra*). In turn, the downy young of the last two species link them to the eiders, all being brown above, white underneath, without strong markings. Also, immature Surf (*perspicillata*) and White-winged Scoters closely resemble immature Harlequins in their general color as well as in their white head markings, which are already suggested by the white patch on the sides of the head in the Buffle-head.

The ducks of the tribe Mergini are rather isolated, but, in our opinion, they are closer to the Cairinini than to any others. The nesting habits of the mergansers and the golden-eyes, their long and broad tails and their general behavior are suggestive of a certain affinity between the two tribes, which is corroborated by the attraction that such birds as the Mandarin and Wood Ducks exert on golden-eyes and Harlequins when they are associated on a lake.

The birds of this tribe, with a very few exceptions, spend a part of their time at sea, and animal life constitutes their principal food. They all are great divers. Their bill is strong, with a large hooked nail, and varies from long, thin, and narrow to thick and short, according to their principal food (fish, mussels, etc.). Their wings are short and their flight heavy, and they walk with some difficulty, the eiders being less clumsy on land than the others.

The majority of the species nest in the hollows of trees, in holes and crevices in rocks, or any other sort of deep shelter. Some of the scoters and eiders, however, deposit their eggs on the ground in the open, among grass and bushes.

All male Mergini are brightly colored and have a distinct eclipse plumage, the scoters, which are prevailingly black, and the two dull-colored southern mergansers being exceptions. They are not adult before their second or third year. In some cases, the females show a definite change in colors according to the season. There is no metallic color in the beautiful plumage of the drakes, not even in the speculum. Iridescent gloss occurs only on the head of the golden-eyes and mergansers and on the speculum of Steller's Eiders.

Sea ducks are very silent birds as a rule, even the females; female eiders, however, utter frequently a harsh grunting cackle. Some of the others utter a similar cackle during the breeding season; at that time, the males emit low, subdued, ventriloquial grunts or whistles, differing from species to species. The only noisy drake is the Old-squaw, which calls loudly in all seasons. The sea ducks generally have very elaborate displays which have little resemblance to those of any other Anatinae, except perhaps to some of the postures of the stiff-tailed ducks. All sea ducks live in the cold or temperate parts of the northern hemisphere, with the curious exception of two rare southern mergansers inhabiting Brazil (*octosetaceus*) and the Auckland Islands, south of New Zealand (*australis*).

The four species of eiders ("*Polysticta*" *stelleri*, "*Arctonetta*" *fischeri*, *Somateria spectabilis*, and *S. mollissima*), although closely related to one another, stand somewhat apart from the other sea ducks. The syrinx has a structure like that in the river ducks, and the downy young lack the black cap typical of most sea ducks. We reject the peculiarity of the bill of Steller's Eider (*S. stelleri*) as a valid generic criterion. The four species agree closely in color pattern, and in the nature of their feathers, notably in the velvety-green and grayish-blue ones of the head and the long, curved ornamental secondaries. The peculiar green pigment on the head of the male is a unique feature of this genus. The females of the four species are much alike. All eiders are ground nesters and breed usually near the sea-shore, but also on the arctic tundra, near fresh-water pools. The Old-squaws, Harlequins, scoters, and eiders resemble the mergansers and golden-eyes in voice as well as in display, though the display is simpler, consisting of stretching the neck and calling, with an up-ward jerk of the bill.

The extinct Labrador Duck (*Camptorhynchus*) seems to be about halfway between the eiders and the Old-squaw. The male is colored more like an eider, the female more like a scoter or Old-squaw.

The three scoters (*Melanitta*, including "*Oidemia*") form a very compact group, and it would be misleading to divide the group into several genera merely because each of the three species has certain structural peculiarities (Miller, 1926). The Common Scoter (*M.*

nigra) has an even more strongly emarginate first primary than the male golden-eye. It has about the simplest syrinx, with no bulla and no enlargement of the trachea. The White-winged Scoter (*M. fusca*) and Surf Scoter (*M. perspicillata*) have a big, bulb-like inflation of the trachea.

The genera *Clangula* (Old-squaw) and *Histrionicus* (Harlequin) occupy a central position among the sea ducks. They lead to the scoters and eiders on one side and to the golden-eyes and mergansers on the other. *Clangula* is by far the more vocal of the two, but otherwise the displays of the two genera are very similar. It has been claimed repeatedly that the Old-squaw has two "eclipse" plumages, the first one acquired by partial molt, February–May; the second, also by partial molt, late July–August. However, as Sutton (1932, *Auk*, 49:42–51) has shown, two eclipse plumages are merely simulated by the protracted postnuptial molt. Both species are ground nesters, although the Harlequin is reported to nest occasionally in holes in trees or in cliffs.

The golden-eyes (*Bucephala*) nest in holes in trees and are more partial to fresh water than the previously discussed genera of this tribe. The courtship displays of the males are very elaborate, but on the whole very much like those of the mergansers (see below). In fact, except for the shape of the bill, the golden-eyes are exceedingly close to *Mergus*. Female Common Golden-eyes (*clangula*) and Barrow's Golden-eyes (*islandica*) resemble female mergansers closely in general color pattern; and their downy young are like those of the mergansers except that the black cap extends below the eye and the cheeks are pure white. Hybrids between *Bucephala clangula* on one side, and *Mergus albellus* (Smew) and *M. cucullatus* (Hooded Merganser) on the other side, have been found repeatedly in the wild state, indicating the close affinity of the golden-eyes and mergansers. The syrinx in the two genera, with large bullae, and the inflated bulbs of the trachea, are additional proof of this relationship. The Smew lacks the enlargement of the trachea and has a smaller bulla. We have found no description of the syrinx of the Hooded Merganser or the Buffle-head.

The mergansers (*Mergus*) are well characterized by their long, thin saw-bill. Nothing is known of the nesting of the three rarer species (*squamatus*, *australis*, *octosetaceus*). The Red-breasted Merganser (*serrator*) nests on the ground among rocks and in depressions. The other three species (*albellus*, *cucullatus*, and *merganser*) nest by preference in tree holes. The display varies with each species, but consists generally of the following main features: (1) sudden rapid stretching of head and neck upwards, bill gaping, and quick return to normal position; (2) rising on water, beak touching breast; (3) spasmodic movement of feet, throwing up a spurt of water behind. The whole display is associated with a raising of the crest, bowing, splashing, and chasing. Females have a simpler display, reproducing some of the male's postures in a rudimentary way.

The downy young are dark brown above, white below, with a bold pattern resembling that of the golden-eyes, but they have a rusty tinge on the sides of the head, except in the Smew.

Unlike all other ducks, mergansers are adapted to the chase of moving prey. Their body is more streamlined than that of their nearest relatives, the golden-eyes. This difference in form is particularly apparent in the sternum. In this connection also, the Smew and the Hooded Merganser seem to be somewhat intermediate between the more typical mergansers and the golden-eyes. We cannot see any good reason for a generic division of the merganser group.

6. TRIBE **OXYURINI.** STIFF-TAILED DUCKS

This curious tribe of diving ducks has no apparent close connection with any other. Their rectrices are long and stiff, and their tail coverts are very short. The nail of their broad and depressed bill is hooked and sharp. Their legs are placed so far back on the body that they can walk only with difficulty. The neck is short and very thick. In the northern species, the postnuptial molt produces a dull plumage that is replaced in the spring by a bright prenuptial plumage. The downy young have a peculiar pattern. Stiff-tailed ducks are almost voiceless in ordinary times, but the drakes, during their courtship, emit a variety of squeaking and clucking noises. Their display is striking: they lift their tails, and puff out their chests; then, stretching their necks forward and backward, they slap their bills on their inflated chests. They also press their bills on their lifted and puffed chests, with the tail down in the water, and finally with both feet they kick water, which spurts backwards. The females stretch out their necks with their bills open.

They lay the largest of all known duck eggs. They build large and elaborate nests among reeds and rushes. The male assists his mate in the care of the young. With their small wings, these ducks have a labored flight, but they are marvelous divers. They feed mostly on vegetable material, although they like animal food as well.

The North American Ruddy Duck (*Oxyura jamaicensis*) is migratory, as is the larger and duller White-headed Duck (*O. leucocephala*) which lives around the Mediterranean Sea and in Central Asia. The small Masked Duck (*dominica*) from the West Indies and tropical America is undoubtedly congeneric; no valid character has ever been pointed out to support the genus *Nomonyx* that was proposed for this species. The tropical forms from South America (*ferruginea*, *vittata*), Africa (*maccoa*), and Australia (*australis*) are so similar in every respect that they must be listed as subspecies of *O. australis*. We believe that the ranges of *ferruginea* and *vittata* do not overlap during the breeding season.

The weird Australian Musk Duck (*Biziura lobata*) is certainly a member of this group, in spite of its thick bill and carnivorous habits. Its display is like that of typical members of the group.

The African White-backed Duck (*Thalassornis*), also found in Madagascar, appears very different, but its plumage pattern recalls that of the female Masked Duck. In color pattern, the downy young are somewhat different from those of *Oxyura* but resemble them in shape and structure of the tail. Delacour has observed the species at length, in the wild and in captivity. They are strange little birds, always found in pairs or families, quarrelsome, very sedentary and inactive. We seldom saw one fly, but they dive with great ease. They cannot walk, and they swim slowly. They have no noticeable display, and the two sexes are alike in coloration. Their necks are comparatively long, and they often stretch them to full length. Their voice is a harsh whistle which recalls that of certain *Dendrocygna*. They further differ from *Oxyura* in their very short tails.

Even more aberrant is the parasitic Black-headed Duck (*Heteronetta atricapilla*) from South America. It differs from typical stiff-tailed ducks in that it lacks a lobe on the hind toe, and has a fairly soft, short tail and elongated upper tail coverts, smaller feet and a narrower bill. On the other hand, as Wetmore (1926:84) has pointed out, *Heteronetta* agrees with the Oxyurini "in the full, loose skin of the neck, development of special, distensible sacs about the head in the male, small wings, glossy, shining plumage, and lack of a bulla ossea." The color pattern is very much like that of females of *Oxyura*. They dive as well as members of the genus *Oxyura* do, and swim like them except that the tail is not held at an angle. The eggs are huge, relative to the size of the female, and the parasitic habits of this species are foreshadowed by the semiparasitic habits of other members of the Oxyurini (Friedmann, 1932). The downy young of *Heteronetta* has apparently not yet been described.

7. TRIBE **MERGANETTINI.** TORRENT DUCKS

The Andes are the home of a very curious species of small duck with a narrow bill, a long, stiff tail, and sharp spurs at the bend of the wing. They live along rapid mountain streams, dive with considerable skill, perch on rocks, and nest in crevices. In the present state of our knowledge, it is difficult to assign them a place, but they are certainly not closely related to the mergansers, and may rather be aberrant relatives of the stiff-tailed ducks. The plumage of the adults (different in the two sexes but elaborate in both), and the pattern of the downy young, are striking and peculiar. The structure of the syrinx and the courtship habits are apparently unknown.

The genus has been thoroughly revised by Conover (1943, *Field Mus. Nat. Hist. Zool. Ser.*, 24:345–356). It seems to us, however, that the geographical forms of *Merganetta armata* are not sufficiently distinct to justify the recognition of three separate species. We follow Hellmayr, Hartert, and Peters in considering them conspecific.

A List of the Genera and Species of Anatidae

On the basis of the considerations in the above section of our paper, we propose the following list[8] of genera and species of Anatidae:

I Subfamily Anserinae

1. tribe anserini. geese and swans

Branta
canadensis, Canada Goose
sandwicensis ("*Nesochen*"), Hawaiian Goose
leucopsis, Barnacle Goose
bernicla, Brant
ruficollis, Red-breasted Goose

Anser
cygnoides ("*Cygnopsis*"), Swan-goose
fabalis (inc. *neglectus* and *brachyrhynchus*), Bean Goose, Sushkin's Goose, and Pink-footed Goose
{*albifrons*, White-fronted Goose
{*erythropus*, Lesser White-fronted Goose
anser, Grey-Lag Goose
indicus ("*Eulabeia*"), Bar-headed Goose
canagicus ("*Philacte*"), Emperor Goose
caerulescens ("*Chen*", inc. *hyperboreus* and *atlanticus*), Blue Goose, Lesser and Greater Snow Geese
rossi ("*Chen*"), Ross's Goose

Cygnus
columbianus (inc. *bewicki*), Whistling and Bewick's Swans
cygnus (inc. *buccinator*), Whooper and Trumpeter Swans
melanocoryphus, Black-necked Swan
olor, Mute Swan
atratus ("*Chenopis*"), Black Swan

Coscoroba
coscoroba, Coscoroba

2. tribe dendrocygnini. whistling ducks (tree ducks)

Dendrocygna
arborea, Black-billed Whistling Duck
guttata, Spotted Whistling Duck
autumnalis, Red-billed Whistling Duck
javanica, Indian Whistling Duck
{*bicolor*, Fulvous Whistling Duck
{*arcuata*, Wandering Whistling Duck
eytoni, Plumed Whistling Duck
viduata, White-faced Whistling Duck

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[8] Additional genera and species recognized by Peters are given in parenthesis. Each pair or group of species united by a bracket constitutes a superspecies.

II Subfamily Anatinae

1. Tribe Tadornini. Sheldrakes

Lophonetta
specularioides ("*Anas*"), Crested Duck

Tadorna
cristata ("*Pseudotadorna*"), Korean Sheldrake
ferruginea ("*Casarca*"), Ruddy Sheldrake
cana ("*Casarca*"), South African Sheldrake
tadornoides ("*Casarca*"), Australian Sheldrake
variegata ("*Casarca*"), Paradise Sheldrake
radjah, Radjah Sheldrake
tadorna, Common Sheldrake

Alopochen
aegyptiacus, Egyptian Goose

Neochen
jubatus, Orinoco Goose

Cyanochen
cyanopterus, Abyssinian Blue-winged Goose

Chloëphaga
melanoptera, Andean Goose
poliocephala, Ashy-headed Goose
rubidiceps, Ruddy-headed Goose
picta (=*dispar*=*leucoptera*), Magellan Goose
hybrida, Kelp Goose

Aberrant Species

Cereopsis
novae-hollandiae, Cape Barren Goose

Tachyeres
patachonicus, Flying Steamer Duck
pteneres, Magellanic Flightless Steamer Duck
brachypterus, Falkland Flightless Steamer Duck

2. Tribe Anatini. River Ducks

Anas
specularis, Bronze-winged Duck

Anas
waigiuensis ("*Salvadorina*"), Salvadori's Duck

Anas
angustirostris, Marbled Teal
capensis, Cape Teal
punctata, Hottentot Teal
versicolor, Versicolor Teal
erythrorhyncha, African Red-billed Duck
bahamensis (inc. *galapagensis*), Bahama and Galápagos Island Ducks

Anas
georgica (inc. *spinicauda*), South Georgian and South American Pintails
acuta (inc. *eatoni*), Common Pintail and Eaton's Pintail

Anas
flavirostris (inc. *andium*), Yellow-billed and Andean Teal
crecca, Green-winged Teal

Anas
formosa, Baikal Teal

Anas
falcata, Falcated Teal

Anas
bernieri, Madagascan Teal
gibberifrons (inc. *albogularis*), Gray Teal and Andaman Teal
castanea, Chestnut-breasted Teal
aucklandica ("*Nesonetta*", inc. *Anas chlorotis*), Auckland Island Teal and Brown Teal

Anas
fulvigula (inc. *diazi* and *rubripes*), Dusky Duck, Mexican, and Black Ducks
poecilorhyncha (inc. *superciliosa* and *luzonica*), Spot-bill, Australian Duck, and Philippine Duck
melleri, Meller's Duck
undulata, African Yellow-billed Duck
platyrhynchos (inc. *wyvilliana*, *laysanensis*, and *oustaleti*), Common Mallard, Hawaiian Duck, Laysan Teal, and Marianas Mallard

Anas
sparsa, African Black Duck

Anas
strepera ("*Chaulelasmus*", inc. *couesi*), Gadwall and Coues' Gadwall

Anas
penelope ("*Mareca*"), European Widgeon
americana ("*Mareca*"), American Widgeon
sibilatrix ("*Mareca*"), Chilöe Widgeon

Anas
discors, Blue-winged Teal
cyanoptera, Cinnamon Teal
querquedula, Garganey Teal
platalea ("*Spatula*"), South American Shoveller
smithi ("*Spatula capensis*"), Cape Shoveller
rhynchotis ("*Spatula*"), Australian-New Zealand Shoveller
clypeata ("*Spatula*"), Common Shoveller

Anas
leucophrys, Ringed Teal

Aberrant Species

Hymenolaimus
malacorhynchos, Blue Duck
Malacorhynchus
membranaceus, Pink-eared Duck
Rhodonessa
caryophyllacea, Pink-headed Duck
Stictonetta
naevosa, Freckled Duck
(Removed from *Anas: specularioides*, see *Lophonetta*, Tribe Tadornini; *brasiliensis*, see *Amazonetta*, Tribe Cairinini).

3. TRIBE AYTHYINI. POCHARDS

Netta
rufina, Red-crested Pochard
peposaca ("*Metopiana*"), Rosy-billed Pochard
erythrophthalma ("*Nyroca*"), Southern Pochard
Aythya
valisineria ("*Nyroca*"), Canvas-back
ferina ("*Nyroca*"), European Pochard
americana ("*Nyroca*"), Redhead
innotata ("*Nyroca*"), Madagascan White-eyed Duck
nyroca ("*Nyroca*"), Common White-eyed Duck
baeri ("*Nyroca*"), Baer's White-eyed Duck
australis ("*Nyroca*"), Australian White-eyed Duck
novae-seelandiae ("*Nyroca*"), New Zealand Duck
collaris ("*Nyroca*"), Ring-necked Duck
fuligula ("*Nyroca*"), Tufted Duck
affinis ("*Nyroca*"), Lesser Scaup
marila ("*Nyroca*"), Greater Scaup

4. TRIBE CAIRININI. PERCHING DUCKS

Amazonetta
brasiliensis ("*Anas*"), Brazilian Teal
Chenonetta
jubata, Maned Goose
Aix
galericulata ("*Dendronessa*"), Mandarin Duck
sponsa, Carolina Wood Duck
Nettapus
auritus, African Pygmy Goose
pulchellus ("*Cheniscus*"), Green Pygmy Goose
coromandelianus ("*Cheniscus*"), Indian Pygmy Goose
Sarkidiornis
melanotos (inc. *caruncul atus*), Comb Duck

Cairina
hartlaubi ("*Pteronetta*"), Hartlaub's Duck
scutulata ("*Asarcornis*"), White-winged Duck
moschata, Muscovy Duck
Plectropterus
gambensis, African Spur-winged Goose

Aberrant Species

Anseranas
semipalmata, Pied Goose

5. TRIBE MERGINI. SEA DUCKS

Somateria
mollissima, Common Eider
spectabilis, King Eider
fischeri ("*Arctonetta*"), Spectacled Eider
stelleri ("*Polysticta*"), Steller's Eider
Camptorhynchus
labradorius, Labrador Duck
Melanitta
nigra ("*Oidemia*"), Common Scoter
perspicillata, Surf Scoter
fusca, White-winged Scoter
Histrionicus
histrionicus, Harlequin Duck
Clangula
hyemalis, Old-squaw
Bucephala
islandica, Barrow's Golden-eye
clangula, Common Golden-eye
albeola, Buffle-head
Mergus
albellus ("*Mergellus*"), Smew
cucullatus ("*Lophodytes*"), Hooded Merganser
octosetaceus, Brazilian Merganser
australis, Auckland Island Merganser
serrator, Red-breasted Merganser
squamatus, Scaly-sided Merganser
merganser, Goosander

6. TRIBE OXYURINI. STIFF-TAILED DUCKS

Oxyura
dominica ("*Nomonyx*"), Masked Duck
{*leucocephala*, White-headed Duck
{*jamaicensis*, North American Ruddy Duck
australis (inc. *maccoa*, *ferruginea*, and *vittata*), Blue-billed Duck, Maccoa Duck, Peruvian Ruddy Duck, and Argentine Ruddy Duck

Biziura
lobata, Australian Musk Duck

Aberrant Species

Thalassornis
leuconota, African White-backed Duck
Heteronetta
atricapilla, Black-headed Duck

7. TRIBE MERGANETTINI. TORRENT DUCKS

Merganetta
armata, Torrent Duck

GENERA RECOGNIZED BY PETERS AND SYNONYMIZED HERE

Arctonetta = *Somateria*
Asarcornis = *Cairina*
Casarca = *Tadorna*
Chaulelasmus = *Anas*
Chen = *Anser*
Cheniscus = *Nettapus*
Chenopis = *Cygnus*
Cygnopsis = *Anser*
Dendronessa = *Aix*
Eulabeia = *Anser*
Lophodytes = *Mergus*
Mareca = *Anas*
Mergellus = *Mergus*
Metopiana = *Netta*
Nesochen = *Branta*
Nesonetta = *Anas*
Nomonyx = *Oxyura*
Nyroca = *Aythya*
Oidemia = *Melanitta*
Philacte = *Anser*
Polysticta = *Somateria*
Pseudotadorna = *Tadorna*
Pteronetta = *Cairina*
Salvadorina = *Anas*
Spatula = *Anas*

GENERA RECOGNIZED HERE BUT NOT BY PETERS

Amazonetta von Boetticher (for *Anas brasiliensis*)
Lophonetta Riley (for *Anas specularioides*)

COMPARISON OF CHARACTERS

Our studies have shown that the waterfowl can be divided into about nine groups that are fairly well defined both morphologically and biologically. In addition, there are a number of species and genera that are either intermediate between the otherwise well-defined tribes (e.g. *Coscoroba*) or too poorly known for a safe classification (e.g. *Anas specularis*, *Anas leucophrys*, *Malacorhynchus*, *Tachyeres*); others show peculiarities or a combination of characters that prevent them from fitting well into any of the existing groups. Such genera as the Australian *Cereopsis*, *Anseranas*, *Stictonetta*, and *Chenonetta* could either be made the sole representatives of so many separate tribes or each could be included in the tribe with which it shares the greatest number of similarities. For the sake of convenience we have adopted the latter course, but without forgetting that these genera are not typical representatives of the tribes with which we associate them.

Table 1 lists the more important characters used in our classification of the duck family. Obviously it is impossible in the limited space provided by a table either to describe all characters in detail or to list all the exceptions. The subsequent paragraphs contain some of the information which could not be included in the tabulation.

Morphological Characters

As noted above, one of the most fundamental characters in the duck family is the pattern of the tarsus. All species of the subfamily Anserinae have the front of the tarsus reticulate, but in the Anatinae only the aberrant species *Cereopsis*, *Anseranas*, and *Stictonetta*, all of Australia, show this primitive attribute.

The structure of syrinx and trachea[9] is fairly uniform within each tribe. No special structures are found in the trachea (or syrinx) of the geese, most swans, *Coscoroba*, or *Cereopsis*. The Whooper-Whistling Swan group has the trachea looped through the sternum in both sexes. In *Anseranas* (Cairinini) a large double loop of the trachea is found between the left breast muscle and the skin. This loop is considerably smaller in the female.

The whistling ducks (*Dendrocygna*) have a bulla which consists in an enlargement and ossification of the lower end of the trachea. It is less pronounced n the females.

Most of the Anatinae have strong sexual dimorphism of the vocal apparatus. The male has an asymmetrical bony bulla of the syrinx, big on the left side, small or absent on the right. This structure is absent in the females. Exceptions to this occur in most of the tribes. In *Tadorna tadorna* (and in no other species of this genus) the right bul a is larger than the left. In *Mergus merganser* and *M. serrator* the bulla is exceptionally large. In some Cairinini (e.g. *Sarkidiornis*, and *Plectropterus*), in *Neochen jubatus*, and in two species of scoters it is very small; in *Melanitta nigra* the bulla is absent.

The trachea shows special bulbous inflations among the Anatini (*Anas versicolor*, *Stictonetta naevosa*), the Aythyini (*Netta rufina* and *N. peposaca*), and particularly among the Mergini (*Bucephala*, some species of *Mergus*, *Melanitta*). The bronchi are elongated and inflated in *Melanitta fusca* and in *Somateria*. Oxyurini have no bullae, but their bronchi are inflated; they have curious tracheal or esophageal air sacs. As with all taxonomic characters, the structure of the syrinx sometimes varies independently of the system. This is true particularly in the genera *Cygnus*, *Tadorna*, *Melanitta*, and *Mergus*. Differences in the structure of the syrinx occur in these genera at the species or even at the subspecies level.

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[9] The trachea (and syrinx) of many ducks is still unknown. Collectors should therefore save the syrinx of all the specimens to which they have access. The method of preservation is extremely simple. It consists in cutting off the bronchi from the lungs (below the last bronchial ring) and severing the larynx from the throat. The structure should then be submerged in a solution of peroxide (or if that is not available, in alcohol or any other preserving fluid) until bleached, and finally be stretched and mounted by gluing or wiring it against a cardboard. This will protect the structure against breaking after it has dried.

TABLE 1
COMPARISON OF CHARACTERS IN THE ANATIDAE

SUBFAMILY	ANSERINAE		ANATINAE						
TRIBES	ANSERINI	DENDROCYGNINI	TADORNINI	ANATINI	AYTHYINI	CAIRININI	MERGINI	OXYURINI	MERGANETTINI
MOLTS	One		Two (with a few exceptions)						
ADULT PLUMAGE	Usually plain ♂ like ♀ No speculum	Elaborate	♂ like or unlike ♀ Speculum common		♂ unlike ♀ Nonmetallic speculum	♂ like or unlike ♀ Metallic colors present	♂ very unlike ♀ Nonmetallic speculum common	♂ like or unlike ♀ No speculum	♂ very unlike ♀ Metallic speculum
PATTERN OF DOWNY YOUNG	Faint or absent White and gray or yellow and brown	Strong, unique Pale line across nape	Usually bold White and black (or gray)	Strong. Usually yellowish Fine eyeline	Eyeline absent or faint	Variable line back of eye	Usually strong Usually white and black	Indistinct White and brown (or fuscous)	Distinct White and black Dark eyeline Dorsal spot
FRONT OF TARSUS	Reticulated		Scutellated except in: *Cereopsis*	*Stictonetta*		*Anseranas*			
SYRINX AND TRACHEA	No bulla Tracheal loop in some *Cygnus*	Small symmetrical bulla in ♂ and ♀	Large asymmetrical bulla in ♂ (except in *Cereopsis*)		(bulla only partly ossified)	(tracheal loop in *Anseranas*)	(variable trachea, often inflated)	No bulla Enlargements of trachea	Unknown
VOICE	♂ like ♀		♂ unlike ♀. Voice of ♀ often louder						
DISPLAY	Simple. Alike in ♂ and ♀		Unlike in ♂ and ♀. Elaborate pair-formation displays common						
PAIRING. PARENTAL CARE	Pair for life. ♂ shares care of young	♂ (?always) incubates		♂ leaves ♀ when clutch is complete (except some widgeons)		(no pairing in 2 genera)		Pair for breeding season (?life). ♂ shares care of young	
LOCATION OF NEST	On the ground or: rarely on ledges or in old nests	sometimes in tree holes	in holes in ground or in trees (1 sp.)	in trees (5 species)		Holes in trees except 2 genera	(or hidden on ground)	On the ground: in marshes	among rocks and bushes
HABITUAL DIVING	Absent	Present	Absent except in: *Tachyeres*	*Hymenolaimus*	Present	Absent	Present		
CHIEF FOOD	Vegetable except:		*Tachyeres*		Varies with season	Vegetable	Animal	Vegetable	Animal

Although the presence or absence of a double molt seems to constitute a first-class criterion of relationship, the presence of a distinct eclipse plumage in males of the double-molting species is of very little significance. Birds inhabiting the colder regions usually have two very different seasonal plumages, while those living in or near the tropics look the same the year round. As in other families, there are, of course, a few exceptions to this rule.

Downy Young

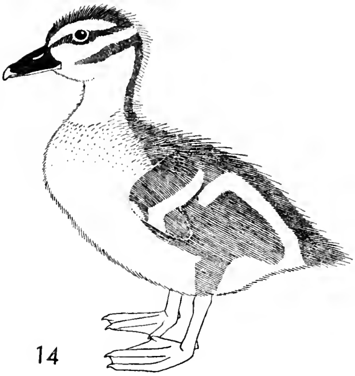
The downy young in most of the nine tribes have a very characteristic pattern and can often be identified as to tribe. Body posture and proportions are also often typical for a tribe. For example, in the Tadornini, and even more in the Cairinini, the insertion of the legs is rather far forward; in the Mergini and particularly in the Oxyurini it is far back. The tails are long in the Cairinini and in most Mergini, and stiffened in the Oxyurini and Merganettini. In the length of the neck and shape of the head there are also characteristic differences between the various tribes. As far as the plumage patterns are concerned, the following short remarks may be useful in conjunction with the semi-diagrammatic drawings (Figures 14–23)[10]. We have refrained from showing the downy young of any of the more common ducks. North American species are figured by Kortright (1942), European by O. and M. Heinroth (1928), in addition to illustrations found in other standard works (Phillips, Witherby, etc.).

Anserini. Plumage pattern absent or faint. When present (*Branta*), it is similar to that of the Anatini, consisting of two lateral spots on the back. There is occasional indication of a dark stripe through the eye (*Anser*). The ground color is usually white, but it is yellowish in some species of *Branta* and *Anser*.

Dendrocygnini. This tribe is characterized by a light line across the occiput, which extends under the eye to the bill. There is a broad dark line through the eye and a light line above it. There are three or four lateral spots on the upper parts. The ground color is either yellowish (e.g. *autumnalis*) or grayish white (e.g. *guttata*, *bicolor*). The same pattern, though showing only faintly, is found in *Coscoroba*. In *guttata* and *eytoni* (Figures 14 and 15) there is a white stripe along the side of the back.

Tadornini. Birds of this tribe are characterized by a conspicuous pattern with sharp contrast (Figures 9 and 10). The upper parts are dark (black or gray), sometimes forming a cap on the head (Figure 16. *Tadorna ferruginea*). There are bold white spots on wing and back, often fusing into a longitudinal stripe. In *Chloëphaga* there is great

[10] The excellent semi-diagrammatic illustrations of the downy young were drawn by Alexander Seidel whose services we gratefully acknowledge.



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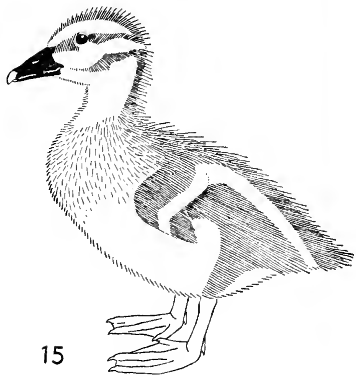

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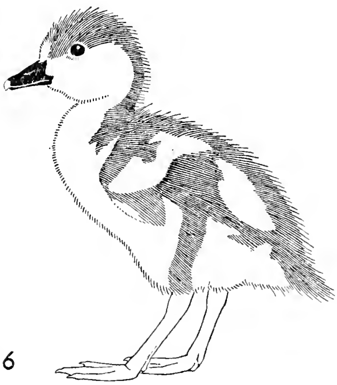

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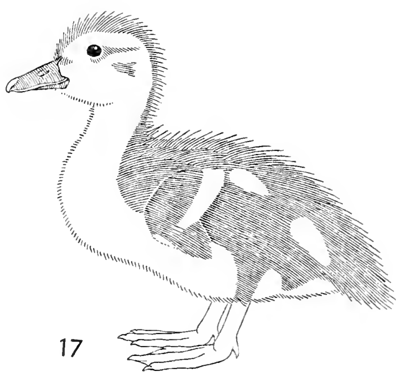

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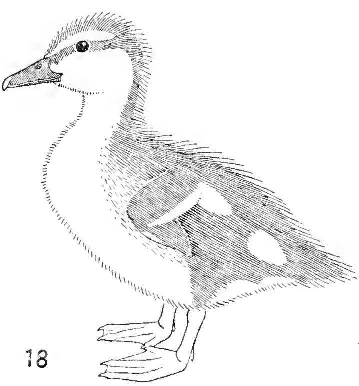

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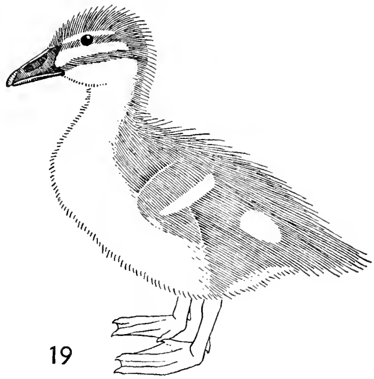
Figure 14. Spotted Whistling Duck, *Dendrocygna guttata.*
Figure 15. Plumed Whistling Duck, *Dendrocygna eytoni.*

Figure 16. Ruddy Sheldrake, *Tadorna ferruginea.*
Figure 17. Salvadori's Duck, *Anas waigiuensis.*
Figure 18. Ringed Teal, *Anas leucophrys.*



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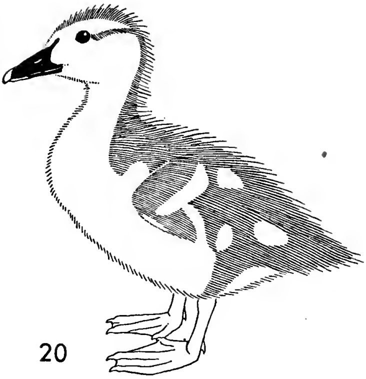

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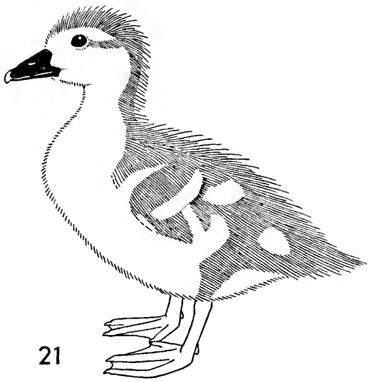

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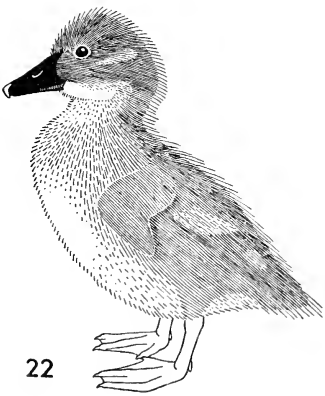

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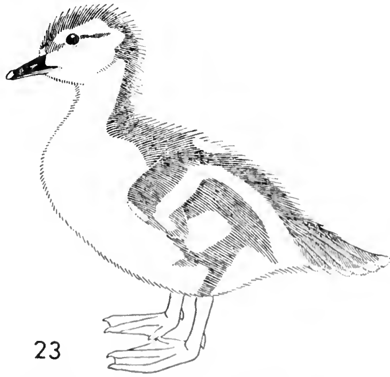

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Figure 19. Maned Goose, *Chenonetta jubata*.
Figure 20. Muscovy Duck, *Cairina moschata*.
Figure 21. Spur-winged Goose, *Plectropterus gambensis*.

Figure 22. Southern Stiff-tailed Duck, *Oxyura australis australis*.
Figure 23. Torrent Duck, *Merganetta armata colombiana*.

variability. Broad white superciliary stripes narrow the dark crown in *picta* to a medial stripe from bill to back. The downy young in *Cereopsis* (Figure 7) is very similar, but it has a black facial mask and very little white on the wing.

Anatini. There is great uniformity of pattern in this tribe, the downy young of all species resembling more or less those of the Mallard. There are two lateral spots on the back, and the ulnar edge of the wing is light. A dark line through the eye is apparently always present, though sometimes interrupted as in *Anas waigiuensis* (Figure 17). Although the adult of *Anas leucophrys* shows many striking peculiarities, the downy young (Figure 18) is much like those of typical species of *Anas*. The ground color is usually pale yellow or yellowish-cinnamon, rarely whitish.

Aythyini. The basic pattern of the downy young of the pochard tribe is similar to that of the Anatini. The yellow wash is usually much stronger, and the dark line through the eye inconspicuous or absent. Young scaup are rather dark, and the size of the spots on the back is reduced. Young Tufted Ducks are blackish.

Cairinini. All perching ducks have a contrasting pattern which is in general fairly similar to that of the Anatini but varies from species to species. There is a very variable dark stripe from the eye to the nape. In *Chenonetta* (Figure 19) and *Aix galericulata* there are two parallel dark lines across the face. There is some white at the ulnar edge of the wing and usually two or three rather small lateral light spots on the back. The ground color is usually yellow, sometimes white (*Nettapus*). The downy young in *Sarkidiornis*, *Cairina* (Figure 20), and *Plectropterus* (Figure 21) are similar to one another.

Mergini. Two major plumage patterns are found among the downy young of this family. The eiders (*Somateria*) have a simplified plumage, dull gray-brown above with white breast and belly. Common and Surf Scoters are similar, but more blackish, with an indication of white cheeks and of a dark cap. The White-winged Scoter, Old-squaw, and Harlequin lead to the typical *Bucephala* pattern. It is boldly black and white. A blackish cap, extending to a line well below the eye, contrasts with the white cheeks. The ulnar edge of the wings and two or three lateral spots on the back are white. The mergansers (*Mergus*) are essentially similar, except that the sides of the face are washed with rufous. Some have a light superciliary.

Oxyurini. The stiff-tailed ducks have a rather aberrant pattern of down; it is indistinct, brownish (or fuscous) and white. (Figure 22. *Oxyura australis*.)

Merganettini. The downy young of *Merganetta* is black and white with a dark line through the eye. It is unique in having long tail feathers and a central white spot on the back. The pattern gives no clue to the relationship. (Figure 23. *Merganetta armata colombiana.*)

Biological Characters

Biological characters are of paramount importance to the classifier, for habits and behavior are certainly deeply rooted and are often the product of a very ancient evolution. In the present family the main points are pair formation, displays, nesting, and feeding habits.

Pair formation and parental care. The pair is a well-knit unit in the Anserini, Dendrocygnini, and Tadornini. In all three tribes the two sexes seem to pair for life, both mates share in the raising of the young, and in some species (*Dendrocygna*, *Cygnus atratus*) the male participates even in incubation. In the stiff-tailed ducks (Oxyurini) and certain widgeons, the male helps in raising the young, but it is as yet unknown whether or not the two sexes are paired for life. In most of the ducks (e.g. most Anatini, all Aythyini, most Cairinini, and all Mergini), male and female pair only for the nuptial season. The drake leaves the duck soon after the beginning of incubation. Random fertilization without pair formation seems to occur among certain genera of Cairinini (*Cairina*, *Sarkidiornis*). Merganettini appear to live in pairs, both sexes taking care of the young.

Courtship and displays. The chronology and significance of display in the Anatidae are still not well known. Roughly there are three main phases of courtship: (a) The prenuptial or pair-formation period. During this period one usually sees small troupes of males perform before one or several females. Finally a single male and female become paired and separate from the rest of the flock. (b) The nuptial period. During this period, which lies between pair formation and egg laying, there is commonly less display. The individual display postures are usually the same as in Phase *a*. Among the Anatini, Aythyini, Oxyurini, the pair-forming Cairinini, and most of the Mergini, the males have elaborate display postures, which, particularly during Phase *b*, are usually answered in a simplified manner by the female. The female often takes the initiative in the display of certain Tadornini, while among certain Cairinini there is no regular display, but merely a pursuit of females by males. (c) Sexual period. Copulation is preceded among swans, geese, and certain ducks by rather elaborate preparatory performances.

Hochbaum (1944) may be consulted for an excellent description and analysis of the phases of courtship among the migratory species of the northern hemisphere, which do not mate for life. Different sequences exist in species that pair for life, in sedentary species which pair on the breeding territory, and in non-pairing species such as Muscovies. However, little accurate information on these is available.

Among the most controversial phenomena of duck behavior are the pursuit flights, so often observed during the courtship season, particularly in the genus *Anas*. Usually a single duck is pursued by two drakes, but sometimes three or four drakes join the chase. Such flights are customarily referred to, even in the most recent literature, as "sexual flights" or "courtship flights." Heinroth (1910, 1911) was the first to point out that these flights take place when a paired female is chased by a different male. The mate of the pursued duck joins the chase in order not to lose sight of her. That these flights are actually territory-defense flights was discovered by Geyr (1924), whose findings have been confirmed by Hochbaum (1944). The pursuing drake is the owner of a territory and defends it by attacking and chasing the female of intruding pairs. True "sexual flights" of the members of a pair also occur, but more rarely. It is certain that most of the pursuit flights described in the literature have nothing to do with pair formation. In addition to these pursuit flights, certain aggressive postures are taken during territorial defense by swimming birds.

Nesting habits. There are four main types of nests in the duck family: (a) open nests on the ground, the prevailing type of nest in all tribes of ducks, except the Cairinini and Mergini; (b) open nests raised above the ground (on rocky ledges, tree stumps, old nests of other birds), the regular or occasional form of nesting among Anserini (*Branta*), Dendrocygnini, Anatini (all *Anas* of the *gibberifrons–castanea* group, *platyrhynchos*, *flavirostris*, *leucophrys*); (c) concealed nests, on the ground under rocks, or in holes in the ground, found in Tadornini (*Tadorna*), Merganettini, and Mergini (*Somateria*, *Melanitta*, usually *Histrionicus*, *Clangula*, *Bucephala islandica*, *Mergus serrator* and ? *M. australis*); (d) holes in trees, found in Dendrocygnini (? which species), Tadornini (*Tadorna radjah*), Anatini (*Anas gibberifrons–castanea*, probably *A. leucophrys*), Cairinini (all except *Anseranas* and *Plectropterus*, which nest on the ground), and Mergini (most species of *Mergus*, *Bucephala*, sometimes *Histrionicus*).

Food and feeding habits. All species of Anatidae, except the Mute Swan, have occasionally been observed to dive when pursued, when bathing, or under other special circumstances. Regular diving in connection with feeding occurs only in five of the nine tribes: Dendrocygnini, Aythyini, Mergini, Oxyurini, Merganettini, and in some of the aberrant genera (*Tachyeres*, *Hymenolaimus*). The prevailing food of most Anatidae is vegetable, and the shape of the bill is usually closely correlated with the type of food obtained. Grazing kinds, such as *Anser*, *Branta*, *Cyanochen*, *Chloëphaga*, and *Cereopsis*, have a "goose"-like bill. Species that sift their food from the surface of the water have a broad bill with strongly developed lamellae, as in *Malacorhynchus*, *Anas aucklandica chlorotis*, and the shovellers. The mergansers (*Mergus*), the only ducks that have evolved into habitual fish eaters, have a long narrow bill with "teeth," especially adapted to catching this type of food. The bill seems to be the most plastic of all the morphological characters of ducks, differing strikingly even among close relatives.

Sterility

It is generally stated that in the duck family hybrids from crosses within the same genus (or even from crosses of related genera) are usually fertile. The problem, however, is not so simple, and there are any number of intermediate degrees between complete fertility and complete sterility. Fertility is sometimes limited to one sex, to a few exceptional cases, or to the production of non-viable gametes in the gonads. This question has been studied by Poll (1911) and by Ghigi, who has made most of his experiments with game birds and pigeons. It appears that the degree of fertility of hybrids is a fairly reliable clue to relationship, but its significance varies a good deal among the various groups, and there are numerous striking exceptions. Such are, for example, the usually sterile crosses between most species of Cairinini. *Anas penelope* produces sterile hybrids with *A. platyrhynchos*, while those from *A. penelope* with *A. strepera* are fertile, as are also those from *A. strepera* with *A. acuta*. Yet *A. penelope* and *A. acuta* have sterile offspring (Poll, 1911). A common hybrid is *A. sibilatrix* × *A. georgica spinicauda;* it is generally sterile, but we had one case at Clères of such a hybrid female producing young with a drake *spinicauda*. The gonads of hybrid *Anas bahamensis* (Anatini) with *Amazonetta brasiliensis* (Cairinini) and of hybrid *Anas leucophrys* (?Anatini) with *Amazonetta brasiliensis* have been found fully functional by Poll. Yet numerous specimens of the former cross obtained at Clères never produced any offspring; they showed much sexual activity, and the females laid, but the eggs were abnomally small, and did not develop. Phillips reports that hybrids *Anas leucophrys* × *Amazonetta brasiliensis* were sterile. Most crosses within the genera *Anser* (except those involving *cygnoides*) and *Branta* are fully fertile, but hybrids from crosses between *Anser* and *Branta* are sterile.

Serology

A few preliminary studies by serologists (Sokolovskaia, 1936) fully confirm the findings of the taxonomist. *Cairina* is found to be not distantly related to *Anas*, and *Alopochen* to be closer to *Anas* than to the geese. "The Chinese Goose [*Anser cygnoides*] and the Gray Goose [*Anser anser*] give in all cases a completely homologous reaction. It permits us to assume that the Chinese Goose should be placed in the genus *Anser* and not be separated generically."

Evolution and Distribution

The fact that the duck family is so rich in aberrant and primitive genera (many of them restricted to Australia) indicates the great age of this family. However, this is by no means proof that evolution has come to a standstill. Many genera, particularly *Branta*, *Anser*, *Tadorna*, *Anas*, and *Aythya*, present convincing evidence of active speciation. Incipient speciation is evidenced by the occurrence of about 25 forms which, though we consider them subspecies, are sufficiently distinct to be listed as full species by other recent authors; nearly completed speciation is evidenced by the occurrence of at least 10 superspecies.

A special problem is posed by the isolated island populations. How did subspecies of a pintail, *Anas acuta*, get to the Kerguelen (*eatoni*) and Crozet (*drygalskii*) Islands in the subantarctic ocean? How did a race of the South American Pintail get to South Georgia (*Anas g. georgica*), or a merganser (*M. australis*) to the Auckland Islands south of New Zealand, or a gadwall (*Anas strepera couesi*) to the Line Islands in the mid-Pacific? The answer is perhaps the arrival on these islands of "castaway" flocks of ducks which have strayed off their normal migration route. Significant in this connection is the report by F. C. Lincoln (1943, *Condor*, 45:232) of a pintail (*Anas acuta*) banded at Bear River, Utah, on August 15, 1942, and recovered with a flock of pintails on November 5, 1942, on Palmyra Island in the Line Island group, 1,100 miles south of Honolulu (3,600 miles from the place of banding). Most of the isolated island populations have developed into races characterized by smaller size and sometimes by darker coloration. This is true, in addition to the above-mentioned ones, of the mallard races *wyvilliana* (Hawaiian Islands) and *laysanensis* (Laysan); also of *Anas a. aucklandica*, the Auckland Island form of the New Zealand Brown Teal (*Anas aucklandica chlorotis*).

The duck family presents numerous other interesting problems of distribution. In addition to the isolated island races, many species have very restricted ranges, e.g. Salvadori's Duck (*Anas waigiuensis*) in the mountains of New Guinea, or some of the New Zealand and Madagascan species. However, even some of the mainland species have a rather limited range, e.g. the Pink-headed Duck (*Rhodonessa*) in parts of India, the Spectacled Eider (*Somateria fischeri*) on parts of the Arctic coasts, and the Cape Shoveller (*Anas smithi*) in South Africa. The opposite extreme is presented by species which show little or no geographical variation though their range extends over several continents. This is true not only for such Holarctic species as the Mallard, the Pintail, and the Gadwall, but also for certain tropical ducks. The Southern Pochard, *Netta erythrophthalma*, is found in tropical South America as well as in the whole southern half of Africa; the White-faced Whistling Duck, *Dendrocygna viduata* (tropical South America, south of the Sahara in Africa, Madagascar), and the Fulvous Whistling Duck, *Dendrocygna bicolor* (America, Africa, Madagascar, India, Ceylon, and Burma), are even more widespread. These are not strong-flying, migratory ducks, and the hypothesis of trans-oceanic colonization therefore faces great difficulties. Every other theory so far presented is, however, even more unlikely.

History and Future Discoveries

The accompanying diagram (Figure 24) give the dates of description of the 143 species of ducks. By 1850 only a handful remained undiscovered; the last three species to be described were *Anas waigiuensis*, 1894 (mountains of New Guinea); *Aythya innotata*, 1894 (Madagascar); and *Tadorna cristata*, 1917 (Korea). The last-named species, in spite of its rarity, had been known since 1877, but had not been described because it was believed to be a hybrid. It is obvious

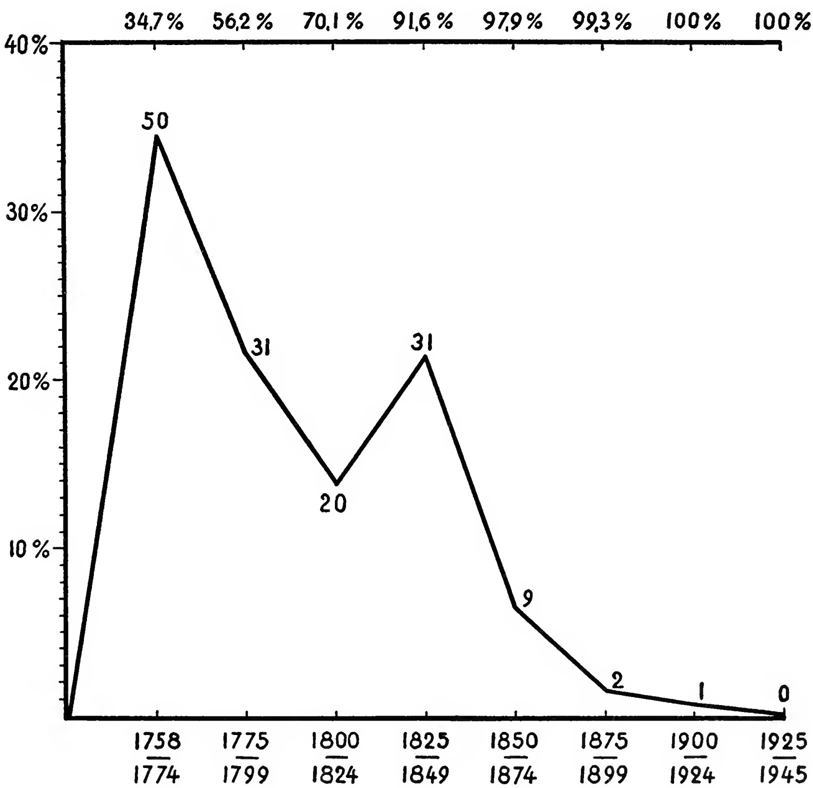

Figure 24. History of the discovery of the Anatidae. The figures on the graph give the number of species discovered in each period of time (their equivalent in percentage can be read from the scale at the left). The figures in the top line give the percentage of species known at the end of each period. More than a third of the species were known within 17 years after the beginning of zoological nomenclature (1758). By 1849 no less than 91.6 per cent of the 144 species were known. In few other families of animals was the discovery and description of species so largely completed in this early period.

from these dates that the probability of the discovery of additional species of Anatidae is very slight. In every respect except the inventory of the species, the family is still insufficiently known. Many of the downy young are still to be described, particularly those of the rarer, more aberrant species, such as *Heteronetta atricapilla*, *Stictonetta naevosa*, *Rhodonessa caryophyllacea*, and *Malacorhynchus membranaceus*. The internal anatomy of ducks is a completely neglected field. There are a few scattered reports on the anatomy of one or the other species, but no comparative study of the various tribes and subfamilies was ever undertaken. The trachea of many species is still unknown. In a survey of the literature (admittedly quick, and by no means exhaustive) we have failed to find the description of the vocal apparatus of such common ducks as the Hooded Merganser and Buffle-head, not to mention rarer birds, such as the Torrent Duck, the Blue Duck of New Zealand, the Crested Duck, Ringed Teal, Pink-headed Duck, and others.

The biology of the ducks is even less known than their morphology. It is remarkable how much new information Hochbaum (1944) was able to give on some of our most common ducks. The various phases of courtship, the relative frequency of various types of pursuit flights, the intensity of the bond between male and female, the possible share of the male in the raising of the young (widgeons, whistling ducks) are still very insufficiently studied. A golden opportunity awaits the student of these problems.

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AGE GROUPS AND LONGEVITY IN THE AMERICAN ROBIN [1]

BY DONALD S. FARNER

THE published accounts of age studies and observations on birds are generally classifiable into three groups. The first group contains those observations, derived largely from records kept by zoos, of ages of birds kept in captivity. Among the more important compilations of this type are those of Gurney (1899), Mitchell (1911), Flower (1926, 1931), Brown (1928), and Groebbels (1932). Such data are valuable in that they give indications of the *potential longevity* of the species.

The second group is that which deals with *potential natural longevity*. This type of information is scattered in innumerable papers and notes and in bird-banding reports. Some of the more comprehensive sources of such data are the compilations of Mortenson (1926), Nichols (1927), Lafranchise (1928), Groebbels (1932), and the numerous reports of Thomson in *British Birds,* Schenk in *Aquila,* Thienemann in *Vogelzug* and *Journal für Ornithologie,* Drost in the same journals, Cooke and Lincoln in *Bird-Banding,* and Jägersköld in *Götesborgs Musei Arstryck.*

The third type of study deals with the *average natural longevity,* survival and mortality rates, and the age-group composition of populations. Because studies of this type must be based on large numbers of recoveries of birds of known age (i.e., banded as young), they have been necessarily limited in number. The most thorough analyses of bird ages from a population standpoint are the excellent study of Kraak, Rinkel, and Hoogerheide (1940) on the Lapwing (*Vanellus vanellus*) in Holland, and the studies of Lack (1943 *a, b, c, d*), which give statistics on several species of British birds including the Blackbird (*Turdus merula merula*) and the Song Thrush (*Turdus ericetorum ericetorum*). In this country, Hoffman (1929) has calculated the longevity of the Blue Jay (*Cyanocitta cristata*); Magee (1928, 1936) and Whittle (1929) have made longevity estimates for the Purple Finch (*Carpodacus purpureus*); Harold and J. R. Michener (1933) have recorded age data on the House Finch (*Carpodacus mexicanus frontalis*); and Nice (1937) has studied the longevity and age-group composition of a local population of Song Sparrows (*Melospiza melodia euphonia*). Leopold *et al.* (1943) have given data on the annual mortality rate in Ring-necked Pheasants (*Phasianus colchicus*) in the University of Wisconsin Arboretum; Sumner (1935), Emlen (1940), and Richardson (1941) have published the results of similar investigations on the Cali-

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fornia Quail (*Lophortyx californica*). The data of Austin (1942) on the Common Tern (*Sterna hirundo*), unfortunately, do not give information on the average longevity of this species because many of these birds do not return to the breeding grounds where they were banded until the second season following hatching. Thomas (1934) made observations on the life span of the Starling (*Sturnus vulgaris*) but did not compute an average longevity or survival rate.

Methods and Materials

The American Robin (*Turdus migratorius*) was selected for the present study because of the relatively large number of available banding records and because of the certainty with which the young can be distinguished from adults. Since only records of birds banded as young north of the Ohio and Missouri rivers and north of the southern boundaries of Pennsylvania and New Jersey were used in this study, it is assumed that all the records apply to the northern race, *Turdus migratorius migratorius,* although it is possible that a few records of the southern race, *achrusterus,* may be included. All records of birds banded within the range of the western races *caurinus* and *propinquus,* were discarded.

The prime assumption in this study, as in those of Lack and of Kraak *et al.*, is that *a group of birds of a species which were banded as young and subsequently recovered constitutes a normal sample of the entire population of the species.* An objection may be raised to the validity of such an assumption on the grounds that (since the number of birds banded varies considerably from year to year) the conditions of the years in which large numbers of birds have been banded will be reflected disproportionately in such samples. The situation is further complicated by the possible variations in activities, such as shooting and trapping, which lead to "recoveries" and "returns"[2] of banded birds. The possibility of variations from true means because of these factors cannot be denied, but in this study no noticeable variation attributable to them has been detected.

A further objection can be raised on the grounds that some of the "causes of death" may have differential rates according to age and that the number of returns and recoveries of birds whose death is attributable to a given cause may not be proportional to the total number of deaths in the whole population due to that cause. Lack (1943*c*) has shown that in some non-passerine species shooting is differential according to age, that is, the chance of a first-year bird being shot is greater than that of an older bird. In the present study of American Robins, it is certainly unlikely that, in the case of each

[2] These terms, although not adapted to this type of study, are here used in the same sense as in migration studies, where "Returns" are banded birds taken dead or alive at the station where banded, and "Recoveries" are banded birds taken dead or alive elsewhere. The verbal form "recovered," however, is used in this paper to indicate the obtaining of banded birds *anywhere,* dead or alive; it is not used in a specialized sense.

cause of death, the number recovered is proportional to the number actually dying from this cause. However, data presented subsequently (Table 9) will show that there are probably no important differences in death rates according to various causes of death once the young birds have begun their first migration.

The records which were analyzed in this study are from the bird-banding files of the Division of Wildlife Research, United States Fish and Wildlife Service. All reports on Robins (a total of 855) which had been banded as young in the range of *Turdus m. migratorius* and subsequently recovered (either alive or dead), and for which there were adequate data were used. They extend through the period 1920–1940.

All estimates of age and longevity in this paper are calculated from the first November 1 of the bird's life and (except where specifically adjusted) refer to the time lived after that date. There are two reasons for the selection of this arbitrary date: (1) Most of the reports used are those on birds banded as fledglings, not as nestlings—making an exact estimate of age impossible. (2) There is a strong possibility (suggested by the banding data themselves) that a bird which dies near the place where it was banded prior to its first migration is more likely to be recovered than one that dies after the beginning of the first migration; hence the use of recoveries made before the beginning of the first migration would give a disproportionate weight in the sample to those young birds which die before this time. Lack (1943*a*) selected August 1 as the date upon which to base his longevity and life-expectancy calculations. It appears that there is a strong possibility that the lower life expectancy (1.6 years) on the first August 1, as compared with that (1.9 years) on the second August 1, in *Turdus merula,* for instance, may be because the *rate of recovery* of first-year birds that die near the banding stations is greater than the rate of recovery of those dying elsewhere. It must be conceded, nevertheless, that this is a more difficult problem in the case of *Turdus merula* because a relatively small part of the population is migratory. Kraak *et al.* (1940) used January 1 as the basic date in their calculations for the Lapwing. In the studies described in this paper no differences in expectancy calculations were noted between those as of January 1 and those as of November 1. November 1 was therefore selected in order to reduce the period between the nest and the date of calculation as much as possible and yet allow for the banded young to be dispersed from the nesting localities.

It is unfortunate that, because of the reasons stated above, the data do not allow a direct calculation of the mortality during the critical period from the nest to the first November 1. However, a crude estimate (see below) of this mortality can be made by the use of data on the number of clutches, number of young produced per clutch, together with data on the replacement rate necessary to maintain a constant population. This estimate is obviously more accurate than one based on banding returns and recoveries.

Age-Group Composition

In calculating the general age-group composition of the Robin population, the total 855 recoveries and returns mentioned above were used and were classified according to year of life in which the individual was recovered. ("First year" birds are those recovered between the first and second November firsts of the bird's life; "second year" birds are those recovered between the second and third November firsts of the bird's life, etc.) It is assumed, as stated previously, that these recoveries and returns constitute a normal sample of the population. The records are classified into three regions according to banding localities (to which in almost all cases the banded young return as breeding adults). For the purposes of this study, three areas are used: (1) *Central* (Iowa, Illinois, Indiana, and Ohio), (2) *Northwestern* (Alberta, Saskatchewan, Manitoba, North and South Dakota, Minnesota, Wisconsin, and Michigan), and (3) *Northeastern* (Pennsylvania, New York, New Jersey, New England, and the Maritime Provinces). The data on age groups are summarized in Tables 1a and 1b.

TABLE 1a

General Age-Group Composition

Banding area	Total All ages	Year of life						Ratio Adult: Young	Survival rate[1]
		1st	2nd	3rd	4th	5th	6th+		
Central	293	150	80	46	9	6	2	95:100	49
Northwest	295	172	64	36	15	7	1	71:100	42
Northeast	245	116	67	34	21	4	3	111:100	53
Others[2]	22	16	4	1	0	1	0		
Total—All areas	855	454	215	117	45	18	6	88:100	48

[1] Per cent per annum after the first November 1, assuming a *stable* population. Survival rate = 100 — mortality rate. In a stable population the annual mortality rate equals the ratio of surviving first-year birds to the total population, since the number of young surviving from each year (taken in this study as those alive on their first November 1) is equal to the number of second-year and older birds which have died during the year, provided that the mortality rate is the same for each age group.

[2] Records from eastern Montana, eastern Wyoming, Ontario, and other localities within the range of *Turdus m. migratorius* but falling outside the three main geographical divisions of the range as defined in the text.

TABLE 1b

General Age-Group Composition
(Data from Table 1a expressed in percentage)

Banding area	Year of life						Ratio Adult:Young	Survival rate
	1st	2nd	3rd	4th	5th	6th+		
Central	51	27	16	3	2	1	95:100	49
Northwest	58	22	12	5	2	0	71:100	42
Northeast	48	27	14	8	1	1	111:100	53
All areas	53+	25+	14−	6−	2−	1−	88:100	48

It is obvious from the tables that the reduction in numbers from one age group to the next is fairly constant. That is, the apparent mortality rate is not differential according to age, at least in the first three age groups. Definite statements cannot be made about the older age groups because of the small number of records.

Nice (1937:194) has calculated the theoretical age-group composition for stable populations, basing the calculations on the annual survival rates and assuming that there is no difference in death rate among the various age groups. Since data presented subsequently in this paper, as well as the data in Table 1a, indicate that the mortality rate for Robins is approximately the same in all age groups, Nice's theoretical table is applicable to *Turdus migratorius*.[3] Table 2 gives the theoretical composition of populations with survival rates within the order of magnitude which may apply to this species. A comparison of Tables 1b and 2 shows that there is a reasonable similarity between the theoretical calculations and calculations from banding data.

TABLE 2

THEORETICAL AGE-GROUP COMPOSITION ACCORDING TO ANNUAL SURVIVAL RATES[1]

Survival rate[2]	Per cent of total according to year-groups						Average longevity
	1st	2nd	3rd	4th	5th	6th+	
40	60	24	10	4	1	1	1.7 years
45	55	25	12	5	2	1	1.8 years
50	50	25	13	6	3	3	2.0 years
55	45	25	14	8	4	4	2.2 years

1 Adapted from Nice (1937:194).

2 Per cent per annum (after first November 1, as applied to Robin populations in this study).

The markedly lower survival of birds banded in the Northwest area is interesting and, if the sample is reliable, may be interpreted as indicating a higher reproductive rate in this area,[4] since recoveries of banded birds indicate no influx of Robins reared in other areas. However, if trapping data (data from birds recovered alive) are not used, the difference between Northwest and Northeast is not so marked, suggesting that a higher rate of trapping of first-year birds in the Northwest area or a higher rate of trapping of older birds in the Northeast area may enter the picture. Subsequent data in this paper show that these discrepancies are probably not important.

3 Nice states that her table (from which Table 2 is adapted) is applicable only to species which breed during the first year, but it appears to be applicable to any species in which the death rate is the same for all age groups. Actually a decision on this point is probably not necessary insofar as this study is concerned, since all the available evidence indicates that Robins breed during the first year.

4 It would be interesting to compare the average clutch sizes and numbers of broods of the three areas, but data are lacking in the literature, emphasizing again the need of *quantitative* observations on the life history of many of our common species of birds.

Of further interest is the comparison of the population of the wintering area with that of the breeding area (Tables 3a and 3b). For the former, Robins banded as young in the range of *Turdus m. migratorius* and recovered (either alive or dead) during December, January, and February in the Carolinas, Georgia, Arkansas, and the Gulf States, are used as the sample (a total of 303 records). These can safely be regarded as winter residents at the time and place of recovery. Robins banded as young in the northern states and recovered at or near the same locality during a subsequent breeding season (March to September) were assumed to constitute a sample of the Robin population (excluding the young of the year) in the breeding area (447 records). Birds recovered during the migration seasons were omitted from these samples.

Exact data are lacking, but available observations indicate that, exclusive of young of the year, a very large part of the breeding-area population of Robins as well as of many other passerine species are breeding birds. The data from trapping alone are analyzed separately to allow comparison with the data from all returns (Tables 3a and 3b). Table 3b presents no striking differences with the theoretical figures given in Table 2. It emphasizes the fact that for at least three years,

TABLE 3a

Age-Group Composition Among Winter-Area and Breeding-Area Robins

Population	Total All ages	Year of life 1st	2nd	3rd	4th	5th	6th+	Ratio Adult:Young	Survival rate[1]
Winter-area	303	153	73	46	22	9	0	98:100	49
Breeding-area[2]	447	229	118	65	21	8	6	95:100	48
Breeding-area[3]	153	90	37	18	6	0	2	70:100	41

1 Per cent per annum after the first November 1.
2 All birds recovered in the breeding area, whether alive or dead.
3 Birds recovered alive in the breeding area.

TABLE 3b

Age-Group Composition Among Winter-Area and Breeding-Area Robins
(Data from Table 3a expressed in percentage)

Population	Year of Life 1st	2nd	3rd	4th	5th	6th+	Ratio Adult:Young	Survival rate[1]
Winter-area	51	24	15	7	3	0	98:100	49
Breeding-area[2]	50	26	14	5	2	2	95:100	48
Breeding-area[3]	59	24	12	4	0	1	70:100	41

1 Per cent per annum after the first November 1.
2 All birds recovered in the breeding area, whether alive or dead.
3 Birds recovered alive in the breeding area.

after the first November 1, there is no differential mortality rate in respect to age among Robins.

Of particular interest is the comparison of the age-group composition of the wintering-area and breeding-area populations. The close similarity of these data indicate that migration mortality, at least during the northward migration, is the same in all age-groups. The larger percentage of first-year birds in the trapped sample is difficult to interpret; its significance may be questioned because of the small size of the sample, but a possible explanation is that the first-year birds are more easily trapped, as has been previously suggested in reference to the apparently lower survival of birds in the Northwest area. Data are lacking, however, to support this suggestion. An explanation based on a differential mortality rate must be rejected because it is not supported by data on birds recovered dead (Table 9).

General Mortality and Survival Rates

The mortality and survival rates for adult Robins (all birds past their second November 1), already calculated in Table 1a from the ratio of first-year birds in the sample to the total sample, may also be compared with these rates as obtained from an analysis of records of Robins banded as young and recovered dead subsequent to their first November 1 (Table 4).

TABLE 4

Age-Group Composition of Robins Recovered Dead

Banding area	Total All ages	Year of life						
		1st	2nd	3rd	4th	5th	6th	7th+
Central	201	103	52	32	6	6	1	1
Northwest	207	110	50	26	12	7	0	2
Northeast	160	73	50	16	18	2	1	0
All areas	568	286	152	74	36	15	2	3

TABLE 5

Survival in Robins

(Data derived from Table 4)

Banding area	Number alive on Nov. 1 of each year								Survival rate[1]
	1st	2nd	3rd	4th	5th	6th	7th+	Total	
Central	201	98	46	14	8	2	1	370	46
Northwest	207	97	47	21	9	2	3	386	46
Northeast	160	87	37	21	3	1	0	309	48
All areas	568	282	130	56	20	5	4	1065	47

[1] Per cent per annum.

In deriving the adult mortality rate from the data in Table 4, cumulative totals of all birds alive on the various November firsts were computed (Table 5). The computations take into consideration the fact that the number of birds alive on the fourth November 1, for example, are those which were recovered in the fourth, fifth, sixth, and seventh years; those alive on the fifth November first are those which were recovered during the fifth, sixth, and seventh years, etc. The total number of birds alive on the various November firsts represents the composite strength of the sample. Adult mortality rate is then obtained by dividing the total number of deaths (first column, Table 4) by the composite strength of the sample (total number alive on all November firsts).

The survival rates in Table 5 are more accurate than those in Tables 1a and 1b since the calculations in the former take into account the age differences in mortality whereas those in Tables 1a and 1b assume it to be constant. This may account for the greater geographic uniformity in the rates in Table 5, although there is the possibility that the greater divergence in the rates in Table 1a may be due in part to age selectivity in trapping since no trapping recoveries or returns are used in the calculation of the rates in Table 5.

It is important to emphasize that these calculations are based on a small sample scattered over 20 years and over a broad geographical area. Whereas the figures may approximate true means for the entire

TABLE 6

Comparison of Survival Rates for Various Passerine Species

Species	Survival rate[1]	Source
Turdus migratorius American Robin	47	This paper, Table 5
Turdus merula merula European Blackbird	52[2]	Lack (1943*a*)
Turdus ericetorum ericetorum Song Thrush	47[3]	Lack (1943*b*)
Melospiza melodia euphonia Song Sparrow	45–60[4]	Nice (1937)
Erithacus rubecula melophilus English Robin	33[3]	Lack (1943*d*)
Sturnus vulgaris Starling	50	Kluijver (1933, 1935)
Sturnus vulgaris Starling	50[3]	Lack (1943*b*)

[1] Per cent per annum.

[2] Lack's statement that "about 40 per cent of the adults die each year" appears to cover birds after they had reached their second August 1. His survival data are here recalculated to include all birds after they had reached their first August 1. The method of calculation is that used in Table 5.

[3] Lack's data recalculated according to the method used in Table 5.

[4] The higher survival rate represents a period of optimum conditions; the lower, a period in which the cover was largely removed.

area, it must be remembered that all natural populations fluctuate both geographically and temporally. These fluctuations are accompanied by changes in the age-group composition, in survival and mortality rates, and in mean longevity. Detailed knowledge of these fluctuations in Robins must await the accumulation of much larger numbers of recoveries of Robins banded as nestlings or fledglings as well as extensive investigations at individual banding stations throughout the breeding range of *Turdus migratorius*. An idea of the nature of temporal fluctuations in a passerine species can be obtained from the studies of Nice (1937). It is of interest to compare the survival rates (per cent per annum) of the various passerine species for which they have been recorded (Table 6).

It is interesting to compare the rates compiled in Table 6 with those obtained in studies on non-passerine species. Because of differences in sampling methods and other variables, such comparisons must be made with caution, but it is probable that the figures indicate general similarities or differences in survival rates. Among the galliform species Sumner (1935), Richardson (1941), and Emlen (1940) have found survival rates of 27, 28, and 33-48 per cent respectively for California Quail in California. Leopold *et al.* (1943) gave a survival rate of 30 per cent among Ring-necked Pheasants in the University of Wisconsin Arboretum.

Likewise several studies give rates for charadriiform species. Kraak *et al.* (1940) calculated a survival rate of 60 per cent for the Lapwing. Lack's data (1943*c*) for the same species (recalculated by the method in Table 5) indicate a rate of 64 per cent. In these studies all types of recoveries and returns were used. Laven's (1940) studies with banded Ringed Plover (*Charadrius hiaticula*) indicate a survival rate of about 50 per cent. A recalculation of the data of Lack (1943*c*) for the European Woodcock (*Scolopax rusticola*) gives a survival rate of 54 per cent. Lack's sample consisted largely of birds recovered by shooting; he assumed that the older birds were shot as easily as the young but admits that this assumption is unproved.

Lack (1943*c*) also gives a survival rate of 67 per cent (58 per cent when recalculated) for the Black-headed Gull (*Larus ridibundus ridibundus*). Lewis (1930) calculated that the annual survival rate in a breeding population of Atlantic Murres (*Uria aalge aalge*) was about 95 per cent.

Williams (1944:253) has made an interesting study of the Redhead (*Nyroca americana*) based on birds banded as young and shot by hunters. The data show that 87 per cent of the birds taken were less than one year old. These data, if the birds were considered to constitute a normal sample of the population, would indicate a survival rate of only 13 per cent. Lack (1943*c*) has shown that samples obtained by shooting in some of the larger non-passerine species are not normal samples but contain disproportionately large numbers of first-year birds. Because of the number of variables involved, no generalizations can be made concerning the selectivity of shooting as a sampling method. Actually, each species will require separate investigation on this point. Data from Hochbaum's (1944:133) careful investigation likewise would indicate a low survival rate (8 per cent per annum) if a shooting sample (92 per cent juveniles) is accepted as normal for the population. Hochbaum's data on other species of ducks give somewhat lower percentages of young in shooting bags—from 56 per cent juveniles in the Pintail (*Anas acuta tzitzihoa*) to 87 per cent juveniles in the Canvas-back (*Nyroca valisineria*). Until trapping or other types of data verify these ratios it is, as indicated above, unsafe to use them in calculations of longevity or as an index to survival rates and age-group composition of duck populations.

Longevity

For the purposes of this study, several terms involving longevity are used. *Potential longevity* is the maximum life span that can be attained by an individual of the species. The best indications of potential longevity are obtained from the records of longevity under optimal or near-optimal conditions such as in zoos. *Natural potential longevity* is the maximum life span that can be attained in nature. The best estimates of this can be obtained from the greatest ages attained by banded wild birds. The *turnover period* (Leopold *et al.,* 1943) is the time required for a year class (i.e. the birds hatched during a single season) to shrink to statistical zero, or the reduction of any single year class to the point where it no longer constitutes a significant portion of the population. Individual birds may outlive the turnover period but do not represent a significant portion of the population. In the case of the American Robin a general idea of the turnover period can be obtained from Table 1b, which indicates that this period is about six years. Separate compilations for year classes tend to verify this figure, although a more precise determination must await a larger accumulation of data on birds banded as young.[5] *Average natural longevity* is the mean age attained by members of the species in nature. In this paper it is based on birds that have survived the first November 1. Average natural longevity for a population of birds can be obtained in one of two ways: (1) By calculating the mean age of birds recovered dead, regarding them as a normal sample of the population. (2) By calculation from the ratio of young birds to adults which, in a stable population, indicates the annual adult mortality rate. Burkitt (1926:97), in his studies on the English Robin (*Erithacus rubecula melophilus*), pointed out that if the population remains constant and if the annual mortality rate (M) is known, the average natural longevity (Y) can be calculated, that is, $Y = \frac{1}{M}$. Burkitt corrected the formula as applied to *Erithacus rubecula* to allow for the non-breeding portion of the

[5] Leopold *et al.* (1943:390) found the turnover period in a local Pheasant population to be five years.

population, but since similar data are not available for *Turdus migratorius*, a discussion of the complete formula is not included here. Burkitt calculated the average natural longevity of *Erithacus rubecula* to be 2.8 years. However, Lack (1943*d*:130) has indicated that an erroneous assumption was probably made in estimating the number of young in relation to the number of adults and that the average natural longevity is about 1.1 years for those birds that survive to their first August 1.

Because the age calculations in this study are based on the first November 1 of the life of the bird, and because most of the birds had been banded as fledglings rather than as nestlings so that their precise ages are not known, it has been necessary to estimate an average age for the young on their first November 1. A careful consideration of the data compiled by Howell (1942:546) on nesting dates leads to an estimate of five months (0.4 years) as the average age of young Robins on their first November 1.[6] This figure has been added to the average

TABLE 7
AVERAGE NATURAL LONGEVITY (*Y*) IN ROBINS
(Based on birds surviving to their first November 1)

Area	Calculation A[1]		Calculation B[2]		Mean age of birds recovered dead		
	Mortality rate[3]	*Y*	Mortality rate	*Y*	No.	*Y* 1st Nov. 1[4]	Total *Y*[5]
Central	54	1.85 yrs.	51	1.9 yrs.	207	1.3 yrs.	1.7
Northwest	54	1.85 yrs.	58	1.7 yrs.	201	1.3 yrs.	1.7
Northeast	52	1.9 yrs.	47	2.1 yrs.	160	1.4 yrs.	1.8
All areas	53	1.9 yrs.	52	1.9 yrs.	568	1.3 yrs.	1.7

1 Using survival rate from Table 5.
2 Using survival rate from Table 1a.
3 Per cent per annum.
4 Calculated by averaging time in months elapsed from first November 1 to date when recovered for all birds in sample and converting to years.
5 By addition of 0.4 years, the estimated mean age of Robins on their first November 1 (see text).

longevity as calculated from the first November 1. Table 7 gives the figures for average natural longevity calculated from the mortality rates and by averaging the ages at death of birds banded as young.

There is an average discrepancy of 0.2 years between the average longevity (*Y*) as calculated from the mortality rate and as com-

6 Howell's data, based on 147 nesting records at Ithaca, New York, indicate that the nesting season (as determined by the laying of the first egg) extends from about April 10 to July 24, with May 21 as the average date for the laying of the first egg of the clutch. Allowing 16 days for the completion of the clutch and for hatching would give the average hatching date as June 6, and an average age on November 1 of about five months. Howell's compilation from the literature for other states in the breeding range of *Turdus m. migratorius* gives similar figures.

puted from the recoveries of dead birds of known age. There are at least two possible explanations: (1) the average age of young birds on the first November 1 may be greater than the estimated 0.4 years; (2) more deaths may occur in the first part of the November 1-October 31 year than during the latter part. The second explanation is possible because part of the fall migration and all of the spring migration occur between November 1 and May 1. Furthermore, severe weather conditions are more frequent during that part of the year. The data tend to support the second explanation, though these may indicate merely that more birds are recovered during the first part of the year rather than that more birds die then.

Average natural longevity data are available for a few other species. These are compiled in Table 8. Because of the variety of methods used

TABLE 8

AVERAGE NATURAL LONGEVITY (*Y*) OF SOME SPECIES OF BIRDS

Species	No. of records	*Y* in years	How obtained	Reference
Turdus migratorius American Robin	855	1.7	R	This paper
Turdus migratorius American Robin	568	1.9	C	This paper
Turdus merula merula European Blackbird	352	1.8	C	Lack (1943*a*)
Turdus ericetorum ericetorum Song Thrush	374	1.7	C	Lack (1943*b*)
Erithacus rubecula melophilus English Robin	130	1.3	C[1]	Lack (1943*d*)
Melospiza melodia euphonia Song Sparrow	64	2.7	R[2]	Nice (1937)
Melospiza melodia euphonia Song Sparrow	144	1.5	R[3]	Nice (1937)
Carpodacus purpureus Purple Finch	621	2.0	E	Magee (1928)
Sturnus vulgaris Starling	205	3.0	C[4]	Kluijver (1935)
Sturnus vulgaris Starling	203	2.0	C	Lack (1943*b*)
Vanellus vanellus Lapwing	1333	2.5	C[5]	Kraak *et al.* (1940)
Vanellus vanellus Lapwing	460	2.8	C[5]	Lack (1943*c*)
Scolopax rusticola European Woodcock	203	2.2	C[5]	Lack (1943*c*)

R = longevity (*Y*) obtained by averaging the ages at death of birds banded as young and subsequently recovered dead.

C = longevity (*Y*) obtained by calculation from mortality rates as given in Table 6. Mortality rate (M) = 100 — survival rate. $Y = \frac{1}{M}$

E = estimated longevity (*Y*) based on returns of birds banded as adults.

[1] Verified by observation.

[2] "Normal conditions."

[3] "Unfavorable conditions." Cover removed. Nice states that the figure may be too low.

[4] This is for breeding birds only and is too high for the general population.

[5] Includes relatively large numbers collected by shooting.

in these studies, comparisons should be made with considerable care. In general, these data give average natural longevity for birds that have survived the critical fledgling period and have reached an age when the mortality rate is about the same as that of the adult birds. Thus the estimates for *Turdus migratorius* are based on those birds that have survived the November 1 following hatching; Lack's calculations are based on the birds alive on the August 1 following hatching; those of Kraak *et al.* on the birds of the January 1 following hatching; and those of Nice on the birds alive at the beginning of the first breeding season. Also, it should be noted that the longer the time between hatching and the date of calculation, the greater the figure for the average natural longevity becomes because of the elimination of the records of those birds that die early. If *all birds hatched* were included, the figure for the average natural longevity in all cases would, of course, be much lower.

Average Natural Longevity Compared with Potential Longevity

An idea of the potential natural longevity can be obtained from the greatest ages attained by banded birds. Among the records used in this study are one of a Robin recovered dead in its ninth year and one in its sixth year. Cook (1942:114, 1943:73) lists one record of at least eight years, two of at least seven years, and three of at least six. Her previous list (1937:61) contains records of one Robin at least seven years old, and one which was at least six years old at the time of recovery. Similar data are available for other species of the genus *Turdus*. For *Turdus ericetorum,* Lack (1943*b*:196) gives one eight-year record as well as records of one seven-year and two six-year birds. He also (1943*a*:168) gives two records of at least nine years for *Turdus merula,* two of at least eight years, and five of at least seven. On the other hand, reports from the continent do not give ages which approach these. For example, the oldest *Turdus merula* reported by Drost (1930:82) is "at least" four and one-half years; Schenk (1924:153) gives none over "at least" two years.

Very few data are available on the potential longevity of *Turdus migratorius*. Mitchell (1911:470) gives the maximum age attained by this species in captivity. Eleven individuals had an average "zoo-longevity" of 5.1 years. The greatest age attained was 12.9 years, which was also the greatest attained by any of the 68 Turdidae recorded by him. In none of these cases was the age of the bird at the beginning of captivity known. Records are available for other members of the genus *Turdus*. Gurney (1899:35) gave two records for *Turdus merula* of at least 20 years; he also lists records of 15 and 17 years for *Turdus musicus* [=*ericetorum*]. Flower (1926:1371) states that *Turdus ericetorum philomelus* can survive 15 to 17 years in captivity and *Turdus merula* up to 20 years.

In view of these data it seems safe to assume that the potential natural longevity of *Turdus migratorius* is at least 9 or 10 years. The potential longevity is at least 12 years, and, considering records of other members of the genus, it may be as much as 20 years. Obviously, the average Robin lives through only a fraction of its potential life span. This fact may, to some degree, eliminate both experience and physiological old age or senescence as factors in age-group composition of populations and may explain the apparently non-differential death rate. In other words, it is possible, if mortality rates in Robins are affected by experience over a period of years or by physiological old age, that the vast majority die before they reach the age at which these factors become effective.

Life Expectancy

Life expectancy (*e*) as used in this paper is the mean time elapsed between the selected date(successive November firsts in Table 9) and the time of death (actual date recovered dead) for all birds alive on the selected date. In other words, it is the expectancy of further life for the average Robin on the selected date. Expectancy data are tabulated according to geographical areas and according to samples in which death was due to shooting and predation by cats (Table 9). In general, the expectancy calculations beyond the third November 1 cannot be regarded as reliable because of the small number of records available. The expectancy for the fourth November 1, based on 56 records, was one year.

Table 9 demonstrates that, for first-, second-, and third-year Robins, life expectancy is about the same (1.1 to 1.4 years). Also, mortality rates are similar for all age groups in the samples in which death was

TABLE 9

Life Expectancy (*e*) on Successive November Firsts

Description of sample			*e* in years[1]		
Area	Cause of death	Number dead	1st Nov. 1	2nd Nov. 1	3rd Nov. 1
Central	All causes	201	1.3	1.1	1.1
Northwest	All causes	207	1.3	1.3	1.1
Northeast	All causes	160	1.4	1.2	1.3
All areas	All causes	568	1.3	1.2	1.2
All areas	Shot	61	1.3	1.2	—
All areas	Killed by cat	55	1.4	1.2	—

[1] For each Robin recovered dead the time elapsed between the selected November 1 and the date of death (actual date recovered), was calculated to the nearest month from its card in the United States Fish and Wildlife Service files. The expectancy for any particular November 1 was then obtained by calculating the mean period from the selected November 1 to date of death for all birds which were alive on that November 1. For convenience in comparison with other authors the means were then expressed to the nearest tenth of a year.

due to shooting and predation by cats, suggesting uniform mortality rates regardless of the cause of death. This is an important point since, if there are no age-differentials, it is not necessary to attempt to weight the components of the sample. Death in Robins, as well as in other passerine species, is apparently a matter of chance and largely independent of age once the birds have survived the critical fledgling period. Taking the sample as a whole, it can be said that after the first November 1 slightly more than 50 per cent die each year.

In this country Thomas (1934:126) has shown that very few Starlings reach the age of five years; a "fair number" live four years; and considerable numbers live three. Hoffman (1929:56) states that 28 per cent of the young of the Blue Jay survive to breed once and 9 per cent to breed twice. The calculations were based on the assumption that all birds banded as young and still alive were retrapped, and therefore the resulting figures are probably too low. Nice's excellent study (1937) does not give sufficient data on exact ages at death to permit a calculation of life expectancy. The data of Harold and J. R. Michener (1933) on the House Finch indicate a life expectancy which may be somewhat higher than that of *Turdus migratorius*. For comparison the expectancy figures for *Turdus migratorius* are given in Table 10 with Lack's figures for other species. (The data given by Austin, by Williams, and by Hochbaum are not usable for comparison here for the reasons given above.)

TABLE 10

Comparative Life Expectancy (*e*) Chart for Several Species of Birds

Species	First day of year	No. alive 1st day of year	*e* in years on 1st day of successive years					Reference
			1st	2nd	3rd	4th	5th	
Turdus migratorius American Robin	Nov. 1	568	1.3	1.2	1.2	1.0	—	This paper
Turdus merula merula European Blackbird	Aug. 1	352	1.6	1.9	1.7	1.9	1.8	Lack (1943*a*)
Sturnus vulgaris Starling	Aug. 1	203	1.5	1.4	1.4	—	—	Lack (1943*b*)
Turdus ericetorum ericetorum Song Thrush	Aug. 1	374	1.4	1.6	1.4	1.3	—	Lack (1943*b*)
Erithacus rubecula melophilus English Robin	Aug. 1	130	1.1	1.3	—	—	—	Lack (1943*d*)
Vanellus vanellus Lapwing	Aug. 1	175	2.4	2.5	2.5	2.5	2.2	Lack (1943*c*)
Larus ridibundus ridibundus[1] Black-headed Gull	Aug. 1	130	1.8	2.4	2.4	2.2	2.9	Lack (1943*c*)

[1] Records of shooting recoveries not included.

Calculation of Mortality Among Young Prior to November 1

There are no data available that can be used to fix accurately the mortality rate among young Robins from the time of fledging until the following November 1. The calculations in this section are indirect and to a certain extent hypothetical. They are intended only to indicate broadly the mortality for this period. It is hoped that actual observations will eventually verify or modify these calculations.

The ratio of young to adults in the Robin population as determined from the data in Table 1a is 100 young to 88 adults. This means that in a stable population the breeding survivors of each 100 adults alive on November 1 must produce a number of young alive on the following November 1 sufficient to maintain this ratio. A conservative estimate of the adult mortality between November 1 and the breeding season is 25 per cent, since the mortality rate is slightly more than 50 per cent for the entire year. Hence 75 of each 100 Robins alive on November 1 survive to breed during the following breeding season. Furthermore, of each 100 Robins alive on November 1, only 47 are alive on the following November 1. Therefore the estimated 75 (37 pairs) alive during the breeding season must produce 53 (1.4 per pair) young alive on the following November 1 in order to maintain the ratio. The calculations may be summarized as follows:

November 1	47 adults, 53 young
May 1	75 breeding birds (37 pairs)
November 1	47 adults, 53 young (1.4 young per breeding pair)

Mason (1943:75) found the average number of nestlings in 86 nests at Groton, Massachusetts, to be 2.86 per nest. Assuming that each pair rears two broods per year, each pair would produce, theoretically, 5.7 young per season. Howell (1942:594) estimates that each pair rears 3.9 young per season (based on data from 74 nests). It is not clear whether he refers to nestlings or fledglings. Should the reference be to fledglings, his results are close to those of Mason, since it is reasonable that 5.7 nestlings would result in 3.9 fledglings. Another estimate can be obtained by combining the observations of Mason and Howell: three nesting attempts times 54 per cent success (Howell, 1942:594) times 2.86 nestlings per successful nest (Mason, 1943:75) gives 4.6 nestlings per pair per season.[7] Thus it seems reasonable to assume that from somewhat less than four to slightly more than five young may be fledged per average pair per season. The mortality from the time of fledging to the first November 1 would then be about 70 per cent.

Since the annual mortality rate after the first November 1 is 52 per cent, about 25 per cent of the young alive on November 1 must die before May 1, so that only about 20 per cent of the fledged young

[7] Nice (personal communication) found an average of 4.4 young per nest for *Turdus migratorius achrusterus* in Oklahoma.

actually survive to breed. Nice (1937:186) estimated that 15 to 25 per cent of the fledged Song Sparrows survived to breed. Similar results were recorded by Kendeigh (1934) and Kluijver (1935) for the House Wren (*Troglodytes aëdon*) and the Starling respectively, although in the latter case the calculations are complicated by the fact that not all Starlings breed during their first year.

Summary

Data from 855 Robins (*Turdus migratorius migratorius*) banded as young and subsequently recovered were studied from the standpoint of age groups, longevity, and life expectancy.

The age-group composition of the Robin population throughout the range of the northern race (excluding young that have not reached their first November 1) was found to be as follows: 1st year birds, 53 per cent; 2nd year, 25 per cent; 3rd year, less than 14 per cent; 4th year, less than 6 per cent; 5th year, less than 2 per cent; and 6th year or older, less than one per cent.

The ratio of adults to young of birds throughout the range was found to be 88:100. In the northeast area, it was found to be 111:100.

The mortality rate for all birds that have passed their first November 1 is slightly more than 50 per cent per annum. The mortality rate is probably the same for all age groups.

The age-group composition in the wintering-area population is similar to that in the breeding-area population, indicating that there is no differential mortality rate according to age during spring migration.

The adult survival rate of *Turdus migratorius* (47 per cent per annum), as determined in this study, is slightly lower than that of other members of the genus for which it has been determined.

The average natural longevity of Robins that survive their first November 1 is about 1.7 years. This is comparable with the figures for other passerine species.

The average natural longevity (1.7 years) is only a fraction of the potential natural longevity (at least 9 years) and of the potential longevity (at least 13 years, perhaps as much as 20 years).

The turnover period is about six years.

Life expectancy from the first November 1 to the third November 1, and hence for more than 90 per cent of the population, is 1.2 to 1.3 years and apparently does not change with the age of the bird. These results are in agreement with those for European passerine species.

Life-expectancy figures calculated from the number of birds shot and from the number of birds killed by cats were similar to those calculated from the total sample.

A hypothetical calculation indicates that the mortality rate from the nest to November 1 (an average of about 5 months) is probably 70 per cent, as compared with an estimated adult mortality rate of about 25 per cent for the same five-month period.

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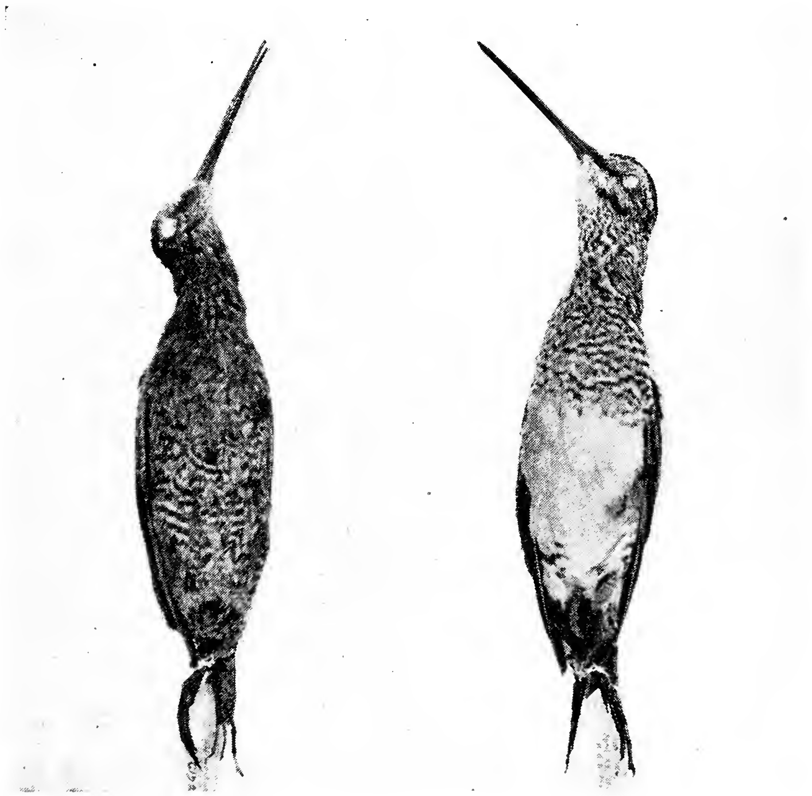
4926 CASS, OMAHA 3, NEBRASKA

GENERAL NOTES

A melanistic specimen of Wilson's Snipe.—The University of Michigan Museum of Zoology received from William G. Fargo an interesting melanistic specimen of Wilson's Snipe (*Capella gallinago delicata*). The snipe, which Fargo reports was a fat, and apparently healthy, female, was shot near Jackson, Michigan, on October 10, 1929, by Frank Havens.

As shown by the accompanying photographs, the specimen is strikingly darker than normal snipe. It is almost solidly brownish black above. Though it has a stripe through the crown and light edgings on most of the back feathers, scapulars,



Melanistic   Normal

and upper wing coverts, these markings are very narrow and are all buff instead of pale buff and white as in the normal Wilson's Snipe. The tail is like that of normal snipe except that the terminal and subterminal bars are narrower and darker (about Mikado Brown of Ridgway, 1912), the terminal bar showing no white at all; the upper and under tail coverts are black, barred with buff. (The tail was damaged by shot, and some of the rectrices are missing, but the outer tail feather that remains measures 8 mm. in breadth at 20 mm. from the tip, confirming the identification of this specimen as a true Wilson's Snipe—cf. Witherby, *Brit. Birds,* 17, 1925:283.) The sides of the head, the neck, throat, and breast are dull black, mixed with a large amount of Sayal Brown, but no white. The chin is buff. The belly, instead of being plain white as in normal Wilson's Snipe, is definitely brown, heavily barred with brownish black. The only pure white on the specimen is under the wing: the under wing coverts as well as the underwing side and flank feathers are narrowly tipped with white, and the axillars are very narrowly barred with white.

There seems to be no previous record of a dark-plumaged Wilson's Snipe, but Barrett-Hamilton recorded 55 melanistic specimens of the European subspecies, *Capella gallinago gallinago,* as early as 1895. N. A. Vigors (*Trans. Linn. Soc. London,* 14, 1825:557, pl.) described the first recorded specimen as a new species, *Scolopax sabini,* but the name was later placed in the synonymy of the Common Snipe, and modern papers on snipe usually dismiss it briefly as "a melanistic variety" (e.g. A. C. Meinertzhagen, *Ibis,* 1926:486). However, the case is not so simple as that. Pycraft (*Ibis,* 1905:289–291) pointed out that there is more than one kind of "melanistic snipe." Some specimens differ from the normal only in the intensity of their pigmentation. This is largely true in the case of a "Sabine's Snipe" lent to me by the American Museum of Natural History (No. 740894. Leadenhall Market, London. Jan. 13, 1894). In general, the pattern of this bird is normal, but all of the lighter markings are buff instead of white or pale buff; also the throat and belly are nearly uniform with the rest of the plumage, instead of being white or nearly white. There is, however, one important difference in pattern: the belly, instead of being unmarked, is definitely streaked—though less so than the rest of the underparts. (It is interesting to note that Vigors' plate of *"Scolopax sabini,"* although rather crudely drawn, also shows a definite pattern of dark marks on the belly.) The only place on the Leadenhall Market specimen where pure white occurs is under the wings: the axillars and under wing coverts are marked with white, though the bars are as narrow as those of the normal Wilson's Snipe.

The second kind of "Sabine's Snipe," described by Pycraft and by Witherby ("Handbook of British birds," 4, 1940:203), seems to differ from the kind described above in having the crown black and unstreaked; the scapulars and mantle without broad longitudinal streaks; the belly uniform sooty brown (not streaked or barred?); the axillars and under wing coverts uniform sooty black (with no pale markings).

Dark phase specimens (*"sabini"*) occur with some regularity in the range of *C. g. gallinago;* they are more common in certain parts of the range, particularly in Ireland. However, as remarked above, the specimen figured here is apparently the first melanistic snipe to be recorded from the range of the American subspecies. It is noteworthy that Wilson's Snipe has long been described as much less variable in plumage than the Common Snipe (e.g. Seebohm, "The geographical distribution of the family Charadriidae," 1887:487).

Our dark phase Wilson's Snipe differs from the Leadenhall Market specimen of *"sabini"* in the strong black barring on the belly (perhaps an exaggeration and extension of the breast-barring that is one of the subspecific characters of *delicata*) and in the greater extent of black markings throughout the plumage.—Josselyn Van Tyne, *University of Michigan Museum of Zoology, Ann Arbor, Michigan.*

New records for northcentral Oklahoma.—A Western Grebe (*Aechmophorus occidentalis*) was shot by a duck hunter at Cushing Lake, Payne County, Oklahoma, on November 17, 1942. The specimen, a female in winter plumage and in good flesh, was deposited in the collection of the Zoology Department, Oklahoma Agricultural and Mechanical College, by J. A. Heuston. The species has not previously been listed for the state.

On May 14, 1944, I saw two male Lark Buntings (*Calamospiza melanocorys*) in a cornfield seven miles northwest of Stillwater in Payne County. They were in full breeding plumage. Margaret M. Nice (1931, "The Birds of Oklahoma," *Okla. Biol. Surv.*, 3, No. 1) lists a number of records of the species for the western part of the state but knows of no records for central Oklahoma (letter).

I flushed an American Woodcock (*Philohela minor*) two and a half miles northwest of Stillwater on November 8, 1944, and observed another on the Lake Carl Blackwell Project seven and a half miles northwest of Stillwater on November 25, 1944. "The Birds of Oklahoma" lists several records of the species from the eastern, but none from the central, part of the state.—Frederick M. Baumgartner, *Department of Entomology, Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma.*

Ring-billed Gulls fly-catching.—The literature contains few references to the Ring-billed Gull (*Larus delawarensis*) capturing flying prey. On four evenings between September 13 and 30, 1944, we observed flocks of 18 to 82 gulls fly-catching over South Bass Island, Ottawa County, Ohio. We record here only the observations made on September 20 because the behavior of the gulls was the same on all four evenings. On September 20 a group of 70 to 80 Ring-billed Gulls fed from two hours before sunset until sunset. Throughout their feeding the gulls remained in a roughly circular flock-formation about 100 yards in diameter; all were on approximately the same plane, 15 to 30 yards from the ground. The evening was warm and humid; a faint breeze barely ruffled the water's surface, and the anemograph at the Stone Laboratory registered a wind velocity of 0-3 m.p.h. Probably because of the absence of a strong breeze, and perhaps also because of humid conditions, the flight of the gulls was awkward and labored.

Immense numbers of insects were flying about, ranging in size from large dragonflies to small gnats. We observed the gulls eat only flying ants and beetles, all less than three-quarters of an inch in length. When capturing an insect, the gulls opened their mouths to apparently the widest extent, then vigorously snapped the mandibles shut. They captured comparatively few insects from directly in front of them; usually they stretched their necks to the utmost, right or left, to capture their prey. We saw none of the gulls swoop downward to make a capture, but many would fly until almost directly below an insect, abruptly check their flight by flapping their wings and fanning their tail, rise three to eight feet, and snap at their prey. This awkward "climbing" after insects was the most spectacular part of the feeding performance and quite unlike the graceful flight of this species while capturing flying grasshoppers as described by A. C. Bent (1921, *U. S. Natl. Mus. Bull. No.* 113:137).

Only seven of the gulls were juveniles; the others were in adult or intermediate plumage. No Herring Gulls (*Larus argentatus*) were in the flock although many were flying overhead or sitting on the waters of the bay.

Once a fishing boat passed, with several Herring Gulls following it. Immediately about 20 of the Ring-billed Gulls that were nearest the boat began moving slowly and gradually away from the feeding flock. They flew about a third of the distance to the boat, then turned about and hurriedly rejoined the flock.—Milton B. Trautman and Mary A. Trautman, *F. T. Stone Laboratory, Ohio State University, Put-in-Bay, Ohio.*

WILDLIFE CONSERVATION

North American Wildlife Conference

The tenth North American Wildlife Conference, which was to be held in New York City February 26 to 28, was canceled following the request of the Office of Defense Transportation for cancelation of all meetings that involve fifty or more persons and do not contribute directly to the war effort. Papers prepared for reading at the Conference will be published in the 1945 *Transactions*.

DDT and Wildlife

The discovery of the insecticidal value of the chemical popularly known as DDT has led to grandiose and ill-planned schemes for its widespread use which have raised serious misgivings in the minds of those interested in the welfare of wild plants and animals. Too little is known about the potential effects of this chemical to warrant its unrestricted use. The American Association of Economic Entomologists, following their meeting in New York during December, 1944, issued a statement concerning DDT whose expressed object was to summarize the results of individual research with DDT as reported at the meeting and to correct "misunderstanding, over-optimism and distorted impressions." Unfortunately this sober statement of the facts has not been widely publicized. After pointing out the unquestionable value of DDT in the destruction of malaria mosquitoes and other pests, the report continues: "DDT will not kill all the important insect pests. It will kill many beneficial insects which are allies of mankind against the destructive species. Because of its toxicity to a wide variety of insects, its large-scale use might create problems which do not now exist. To illustrate, it is a superior insecticide for control of codling moth on apples, but in some sections at least will kill certain natural enemies and thus release other insects which may then become major problems.

"We do not know enough about effects on plants, animals and soils. . . . DDT is toxic to animal life when large amounts are taken internally or absorbed through the skin from oil solutions, but reports indicate a reasonable margin of safety. In the light of our present knowledge, heavy deposits on edible parts of plants should be avoided. Reports show definite toxicity to cold-blooded animal life including fish and frogs.

"More and larger-scale experimentation is needed."

It is thus apparent that all wildlife conservationists, particularly those charged with research programs, should give serious thought to the determination of the necessary safeguards in the use of this material.

Conservation Department in Ohio

The Ohio Postwar Program Commission has proposed the formation of a unified state conservation department which will coordinate the now separated activities of soil, water, mineral, forest, and wildlife conservation and parks and recreation. A bill (S.B. 22) covering this proposal has been introduced in the current session of the legislature.

Clear Streams Bill

A bill (H.R. 519) has been introduced in the National House of Representatives providing for national control of stream pollution. The bill provides for the establishment of a governing board giving representation to the Secretaries of the Interior, Agriculture, War, and Navy, and to the Surgeon General. Two members of the Senate and two of the House are also included. This should insure a well-balanced approach to the problem. The Izaak Walton League of America is supporting the proposed bill.

WILDLIFE CONSERVATION COMMITTEE
Charles A. Dambach, *Chairman*

EDITORIAL

George B. Thorp and the members of his Endowment Committee are to be congratulated on the outstanding success of their Life Membership campaign. The addition to our roll of eighteen new Life Members since 1941 gives reassuring promise of stability and permanence for the Club's program. We hope that our members will continue to give this Committee their support.

We are indebted to Terence M. Shortt of the Royal Ontario Museum of Zoology for the privilege of publishing his fine painting of the Baikal Teal as a frontispiece to this number of the *Bulletin.*

The Baikal Teal breeds in eastern Siberia and winters in Japan, Formosa, and China. It was added to the North American avifauna following the capture of a specimen at Wainwright, Alaska, in 1921 by Alfred M. Bailey and Russell W. Hendee, but it is not included among the illustrations of any recent publication on North American waterfowl.

The article on the Anatidae to which we have devoted much of this issue is an especially appropriate contribution to *The Wilson Bulletin* because it is such a remarkable demonstration of the fundamental importance of life history studies —a type of bird study long emphasized in this journal. The modern taxonomist, seeking to classify birds in accordance with their true relationships, considers habits no less significant than anatomical structure.

Ornithological News

On January 12, Alexander Wetmore was appointed Secretary of the Smithsonian Institution—the sixth to hold that post in the 98 years since its founding.

Lt. Col. W. P. C. Tenison has taken over the compilation and editing of the *Aves* section of the *Zoological Record.* He may be addressed in care of the British Museum (Natural History), Cromwell Road, London, S.W. 7, England.

The Stanley G. Jewett collection of birds and mammals has been acquired by the Natural History Museum at San Diego, California. The specimens—10,821 birds and more than 2,000 mammals—were taken for the most part in the territory between California and Alaska.

Alden H. Miller, Director of the Museum of Vertebrate Zoology, and Associate Professor of Zoology at the University of California at Berkeley, is spending two months in Colombia collecting specimens for the Museum.

Wilson Bulletin Reprints

Since our readers often send us requests for reprints of *Wilson Bulletin* articles, we are arranging, beginning with this volume, to have a limited number of reprints made of our longer papers. Reprints of the article on the Anatidae which appears in this issue, will be thirty cents each, including postage. Please send in your orders immediately so that we may know how many copies will be required. Orders should be addressed to the Editor and should be accompanied by payment (in stamps if preferred).

ORNITHOLOGICAL LITERATURE

Birds of the Southwest Pacific. A Field Guide to the Birds of the Area between Samoa, New Caledonia, and Micronesia. By Ernst Mayr. Macmillan Co., N.Y., 1945:5 × 7⅜ in., xix + 316 pp., 3 col. pls., 16 figs., 1 map. $3.75.

The war has greatly broadened the horizons of American bird students. Most of us now have relatives or friends living in the south Pacific on islands of whose very existence we were hardly aware a few months ago. As a result, there has been a tremendous increase of interest in the fauna of these islands, and museums have had many requests for information. In response to this demand, Ernst Mayr, the leading authority on the birds of the southwest Pacific, has prepared this excellent field guide. He describes the 388 species and lists the 415 additional subspecies of birds that are known to occur on the following groups of islands: Samoa, Tonga, Fiji, New Caledonia, Loyalty, New Hebrides, Banks, Santa Cruz, Solomon, Marshall, Caroline, Mariannas, and Palau. It should be emphasized that, although the book will be useful to visitors to almost any part of the southwest Pacific, it does not attempt to treat the avifaunas of the Philippines, New Guinea, or even the Bismarcks.

The author has solved very cleverly the difficult problems presented by the necessity of describing the varied bird faunas of a dozen archipelagos. The wide-ranging sea birds and shore birds are covered in the first two chapters. Then a chapter is devoted to a very good family-by-family description of the land and fresh-water birds of the whole area. The rest of the book treats consecutively the land and fresh-water birds of seven geographical subdivisions. The avifaunas of many islands are separately listed in the most condensed form possible by using only the serial numbers of the species (as given in the preceding account). In this ingenious fashion all the known resident birds of Guadalcanal, for example, are listed in five lines. For most of the archipelagos the author gives a brief history of the ornithological exploration and references to pertinent scientific papers.

The three color plates by Jaques depict 37 species, including at least one representative of each of the more characteristic bird families of the region. In addition, Alexander Seidel has contributed very good black and white drawings of 23 other species. The original paintings were excellent, but they have not been particularly well reproduced, and the printing of the explanatory legends many pages away from the plates will interfere with their convenient use.

Fortunately the author calls attention to the great need for information on the habitats and ecological relations of these birds. An outline in the introductory section and additional indications all through the text will show any interested amateur how to make important contributions to scientific knowledge.

This volume will be invaluable to any naturalist stationed in the southwest Pacific and will provide a tremendous stimulus to ornithological research in the area for many years to come.—J. Van Tyne.

Woodcock. By John Alden Knight. Alfred A. Knopf, New York, 1944:5½ × 8½ in., x + 161 + ii pp., 6 col. pls., 17 photographs. $4.00.

This is the first strictly popular book dealing solely with the American Woodcock. However, ornithologists will readily question whether it is, as the publishers claim, the first "full and up-to-date account" of the species. The book is written specifically for sportsmen. Four of the eleven chapters deal with hunting methods and equipment, dogs, guns, and suitable cover for good shooting. The other chapters, except two which are anecdotal in character, give a popularized résumé of recent findings on the habits, life cycle, migration, and ecological relationships of the species. The chapter on "Fight for Survival" is a laudably clear-minded appraisal of the Woodcock's precarious status as a game bird.

Persons desiring authoritative information on Woodcock hunting will find the book of real worth; serious students of birds and game management will obtain little, if any, important information about the bird that is not already available in papers published during the last six years. The book is illustrated with six handsome color plates from paintings by Edgar Burke and seventeen photographs. There is a brief index, but there is neither a bibliography nor a direct acknowledgement of the publications which were the source of much of the information.—Olin Sewall Pettingill, Jr.

THE PRAIRIE CHICKEN IN MISSOURI. By Charles W. Schwartz. Missouri Conservation Commission, Jefferson City, Missouri, 1944:9 × 12 in., 176 pp., 85 pls. (1 col.), 1 map. $5.00.

"The Prairie Chicken in Missouri" is primarily a book of photographs with just enough text to suggest interpretation and link them together. It is a charming book—in this respect, perhaps more than in any other, it differs from the usual management book and from most species studies. The natural simplicity of the author's style makes for good reading, and he has succeeded in touching on most of the salient points of Prairie Chicken life history and management in Missouri. "The photographs were selected from many hundreds taken." It might also have been added that the text has been similarly selected from a wealth of information and direct observation not included in the book. The short, direct statements tend to carry equal weight. Had they been expanded, some would have gained by qualification, and others would have led to interesting channels for speculation.

Schwartz is not alone in describing the booming call as three ascending notes; however, the many Prairie Chickens I have listened to in Wisconsin habitually had the second note of the call the lowest.

The photographs of Prairie Chicken life history, including a spectacular series on courtship, are beautiful. Not only is each photograph a trophy, but no phase of the Prairie Chicken's elaborate courtship display is omitted.

The use of pictures in this book as a technique of conservation education is unparalleled and stimulating. It seems unfortunate, therefore, that "The Prairie Chicken in Missouri," even before publication, was considered in the limited edition class.—Frances Hamerstrom.

GAME BIRDS OF AMERICA. Figured by Lynn Bogue Hunt. Text by Ray P. Holland. Field and Stream, New York, 1944: 13 × 16 in., 12 colored plates, 24 text pages. $5.00 (Agent: Frank J. Lowe, 80 West 40th St., New York 18).

The twelve color plates in this portfolio figure thirty-eight species of game birds: five geese, eighteen ducks, two doves, six quail, five grouse, the Turkey, and the Woodcock. Both male and female are pictured in twenty-five species in which the sexes are differently plumaged.

As usual, the artist has been handicapped by the necessity of placing a number of species on nearly every plate, but the grouping has been wisely done, and the species on most plates belong together ecologically. In the case of the "Lesser Geese," the best picture in the series, the result is completely convincing. The colors of the plates are pleasing, and ornithologists will probably feel that most of the bird colors are well within the range of variation allowed to artists and printers. The only marked exception is that commonly misrepresented bird, the Band-tailed Pigeon.

The plates, apparently intended for framing, are printed without legends. Brief accounts of the species figured are given on the text pages beside small black and white copies of the plates. Bird students will find little new information in these brief columns, which were written primarily for hunters, but they will all be interested by the biographical sketch of the artist.—J. Van Tyne.

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AFFILIATED SOCIETIES

The Inland Bird Banding Association held no meeting in 1944, and the officers of the past year continue in office. As a cooperative project in 1944, the Association collected banding data on the Robin. Results of the study were published in the June, August, and October issues of the *Inland News;* 15,000 banded Robins were represented in the compilations.

The Association has continued during the year to distribute literature on banding to public schools. Between August 1940 and January 1944 such literature was sent in response to 225 requests from 37 states.

An exchange of news letters with the Eastern Bird Banding Association has proved of benefit to both organizations. All the members of each association receive both news letters, and thus a helpful exchange of ideas and information is maintained.—O. A. Stevens, *Secretary.*

The Virginia Society of Ornithology found it impossible, because of wartime conditions, to hold an annual meeting in 1944. However, individual members and local groups have carried on their activities and observations, and *The Raven* has continued to appear with reports on new or rare bird visitors, census lists, and other notes. During the past year *The Raven* published "The Birds of Rockbridge County," an extended study by J. J. Murray.—Florence S. Hague, *Secretary.*

ANNUAL REPORTS

REPORT OF THE TREASURER FOR 1944

Balance as shown by last report, dated Dec. 31, 1943 ...$	593.31	
Receipts, Jan. 1 to Dec. 31, 1944		
Dues:		
Associate	1288.35	
Active	1178.85	
Sustaining	275.65	
Subscriptions to *The Wilson Bulletin*	223.65	
Sale of back numbers of *The Wilson Bulletin*	167.00	
Income from Endowment Fund	71.87	
Contribution for the printing of the colored plate	120.13	
Contributions and miscellaneous receipts	18.10	
Total receipts		$3936.91
Disbursements		
The *Wilson Bulletin:* printing, engraving, mailing ......$	1920.75	
Editor's expense: postage, mailing, secretarial aid	162.87	
Secretary's expense: stationery, postage, clerical aid	126.21	
Treasurer's expense: stationery, postage, printing, express charges	71.37	
Membership Committee expense: postage, printing	68.81	
Bank charges and foreign exchange	20.69	
Bad checks returned	27.00	
Reprints	7.21	
Incorporation fee	10.00	
Transferred to Endowment Fund account	1000.00	
Total disbursements		$3414.91
Balance on hand in Ohio National Bank, Columbus		$ 522.00

Endowment Fund

Cash balance in savings account, Dec. 31, 1943	$ 209.55		
Received during year:			
Interest on U. S. Bonds	44.50		
Life Membership payments	350.00		
Interest on savings account and miscellaneous	13.06		
Transferred from checking account	1000.00		
Total		$1617.11	
Transferred to checking account (interest and appreciation of bonds)	71.87		
Purchase of U. S. Savings Bonds, Series G, Dec. 20, 1944	1500.00		
Total		1571.87	
Balance in savings account, Ohio Natl. Bank, Columbus			$ 45.24
Bonds in safety deposit box, Ohio Natl. Bank, Columbus:			
U. S. Postal Savings Coupon Bonds, dated July 1, 1935			780.00
U. S. Savings Bonds (maturity value May 31, 1945: $900.00) purchase value			675.00
U. S. Savings Bonds (maturity value Aug. 1, 1948: $1075.00) purchase value			806.25
U. S. Savings Bonds, Series G, dated Sept. 1, 1943			1000.00
U. S. Savings Bonds, Series G, dated Dec. 20, 1944			1500.00
Total Endowment Fund			$4806.49

Respectfully submitted,

December 31, 1944 — Milton B. Trautman, *Treasurer*

Approved by Auditing Committee
T. H. Langlois
Charles F. Walker

ELECTION OF OFFICERS

The Secretary reports that the mail ballot resulted in the election of the Officers and Members of the Council proposed by the Nominating Committee (published in *The Wilson Bulletin* for September, 1944, page 177). The full report of the Secretary will appear in the next issue of the *Bulletin*.

WILSON ORNITHOLOGICAL CLUB CONSERVATION COMMITTEE 1944

Rudolf Bennitt
George H. Breiding
Paul L. Errington
Ludlow Griscom
Frederick N. Hamerstrom, Jr.
Harrison F. Lewis
Miles D. Pirnie
Richard H. Pough
Gustav Swanson
Herbert L. Stoddard
Milton B. Trautman
Leonard F. Wing
Douglas E. Wade

Charles A. Dambach, *Chairman*

NEW LIFE MEMBER

Jean Theodore Delacour graduated from Lille University in 1914 and served in the French army throughout World War I. His great aviaries at Villers-Bretonneux were destroyed in the battle for Amiens in the spring of 1918, but the next year he acquired the Chateau de Clères in Normandy and began another great collection of live birds. His trip to the West Indies and South America in 1921 was the first of a series of expeditions to many parts of the world. Seven expeditions to French Indo-China resulted in the publication of a series of faunal and taxonomic papers, which were summarized in the great four-volume monograph, "Les oiseaux de l'Indochine française," by Delacour and Jabouille, published in 1931. For twenty years Delacour edited the principal French ornithological journal, *L'Oiseau.* He is an Honorary Fellow of the American Ornithologists' Union, and the only foreign member of the Council of the Zoological Society of London. He now lives in New York where he is Technical Adviser to the New York Zoological Society and Research Associate of the American Museum of Natural History.

Wilson Ornithological Club Library

The following gifts have been recently received. From:

George A. Ammann—1 reprint
Elizabeth B. Beard—1 journal
David E. Davis—1 reprint
Charles R. Goslin—37 journals
J. J. Hickey—3 reprints
Lynds Jones—29 journals
Leon Kelso—1 pamphlet
Harry A. McGraw—42 pamphlets
Ernst Mayr—1 book
Margaret M. Nice—4 reprints
S. Dillon Ripley—1 book
A. W. Schorger—1 reprint
R. W. Sheppard—2 reprints
Gustav Swanson—1 book
J. M. Winterbottom—1 reprint
Anonymous—178 journals

The Wilson Bulletin Publication Dates

The actual dates of publication of the four numbers in 1944 were: March 30, July 26, October 28, December 22.

TO OUR CONTRIBUTORS

Our members are asked to submit articles for publication in the *Bulletin*. Manuscripts will be accepted with the understanding that they have not been published or accepted for publication elsewhere.

Manuscript. Manuscripts should be typed on paper of good quality and of letter size (8½ x 11). Write on one side only and use double spacing. The title should be brief and carefully constructed so as to indicate the subject clearly. Ordinarily the scientific names of the birds treated should be given and should appear early in the article. Most articles should have a brief summary at the end.

Bibliography. Literature referred to in the text should be cited by author's name, year of publication, and exact pages of the particular reference. Such citations should ordinarily be listed in full at the end of the paper.

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The Wilson Bulletin

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THE WILSON BULLETIN

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THE WILSON ORNITHOLOGICAL CLUB

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DOWITCHER

Limnodromus griseus

Sketch in water color drawn by Peter Rindisbacher, 1829 or earlier. What remains of the original (now 5 x 6½ inches in size) is shown here in its entirety; unfortunately the tip of the Dowitcher's bill was at some time removed by trimming.

Reproduced by courtesy of Dr. Edward P. Alexander, Director of the Wisconsin Historical Society.

THE WILSON BULLETIN
A QUARTERLY MAGAZINE OF ORNITHOLOGY
Published by the Wilson Ornithological Club

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BIRD PORTRAITS BY PETER RINDISBACHER

BY A. W. SCHORGER

RECENTLY Dr. Edward P. Alexander, Director of the Wisconsin Historical Society, asked me to identify a water color sketch of a bird by Peter Rindisbacher. The drawing, in the possession of the Society, is now reproduced for the first time (Plate 8). Careful examination of the portrait has convinced me that it represents a Dowitcher (*Limnodromus griseus*) although it is lighter than any individual I have seen of that species and has interesting points of resemblance with Wilson's Snipe (*Capella delicata*). For example, the pose of the pictured bird, unlike any pose I have observed in the Dowitcher, is very characteristic of Wilson's Snipe when suspicious or belligerent. Further, the original drawing shows on the back of the bird dark brown markings characteristic of the Snipe but lacking in all the Dowitcher specimens I have so far examined. However, other characters, particularly the absence of the white edge on the outermost primary (which is so noticeable in Wilson's Snipe), seem to bear out the identification of the bird as a Dowitcher.

On the front of the drawing is written in an unknown hand, "Pattashgas of the Wisconsin"; on the back appears in German script, "Padaschgaas," followed by "Chippeway." The German script is evidently in the artist's hand.

Recorders of the Indian languages spelled the words phonetically so that literal agreement between authors is not to be expected. Cooke [1] does not include Dowitcher in his list of bird names; he gives *pa-dash'-ka-an'-ja* as the name of Wilson's Snipe in the Chippewa tongue, and *kitchipadashkaanja,* "big snipe," as the name of the Woodcock, Bishop Baraga [2] gives: snipe, *padashkaanji;* woodcock, *padashkaaaji;* curlew, *pataskhanje*. He also omits the Dowitcher.

What is known of the life and works of Rindisbacher is due largely to Grace Lee Nute.[3] He was born in 1806 in Upper Emmenthal, Canton of Berne, Switzerland. In 1821, the Rindisbachers emigrated to America, landed at York Factory, Hudson Bay, and after a gruelling trip arrived at Lord Selkirk's colony at Pembina on the lower Red River. Discouraged by the great flood of 1826, they started southward, arriving at Fever River, Jo Daviess County, Illinois, in November of that year. The following spring they moved to the lead region of southwestern Wisconsin, where they remained about three years. Peter Rindisbacher then went to Saint Louis, where he died on August 13, 1834, aged 28 years. The death notice described him as a miniature and landscape painter. Prior to 1829, when Rindisbacher went to Saint Louis, most of his drawings related to Indians and their activities.

Some history of the sketch reproduced here has been given by Alice Smith.[4] She reports that while Lyman C. Draper was superintendent of the Wisconsin Historical Society, he broadcast a request for paintings and other contributions; on July 25, 1854, Caleb Atwater of Circleville, Ohio, wrote Draper that he was sending "4 drawings of my favorites, natives of your region of the country." Among them was the "Pattashgas of the Wisconsin." Atwater had attended the Treaty at Prairie du Chien, Wisconsin, in 1829.[5] While there he acquired these drawings, among others, from Rindisbacher. Miss Smith informs me that Atwater, on starting back to Ohio in his wagon, took the artist part way to Saint Louis.

Three pictures by Rindisbacher which are of interest to ornithologists appeared in the *American Turf Register and Sporting Magazine:*

"Grouse." Vol. 3 (1832):589;

"Wilson's Pinnated Grouse." Vol. 4 (1833):605;

"Wild Turkey Trap." Vol. 5 (1834): 108.

The "Grouse" is the Prairie Sharp-tailed Grouse, *Pedioecetes phasianellus campestris,* the second illustration of *campestris* to appear, it having been preceded by that of Bonaparte in 1828; the "Wilson's Pinnated Grouse" is the Greater Prairie Chicken, *Tympanuchus cupido pinnatus.*

The determination of the locality in which the drawings were made was an interesting problem. The text accompanying the "Grouse" lithograph is signed "R." It might be possible to obtain further information on the author by examination of the early volumes of the magazine, but these were not available to me. "R" states that the drawing was sent to the editor by Mr. Rindisbacher. The text accompanying the "Wilson's Pinnated Grouse" is not signed; since it did not contain any new information on the grouse, it was probably prepared by the editor. The introductory sentence reads: "For the drawing of the 'Pinnated Grouse,'. . . . we are indebted . . . . to Major Mason and Lieut. Holmes, of the army of the United States; at whose instance Mr. Rindisbacher had the kindness to make the sketch for the American Turf Register and Sporting Magazine." Capt. Richard B. Mason was with the 1st Infantry and was stationed in Louisiana in 1828, when he was transferred to Fort Crawford, Prairie du Chien, and he was at this station in 1833 when he was promoted to Major of Dragoons. Lt. Reuben Holmes [6] was stationed at Jefferson Barracks, Saint Louis, for most of the period between April 1827 and early 1832. Both officers participated in the Black Hawk War in 1832.[7] It seems altogether probable that Major Mason had met Rindisbacher after coming to Prairie du Chien, while Lieutenant Holmes knew him at Saint Louis and induced him to publish the drawing of the Sharp-tailed Grouse. Since it is very unlikely that specimens of this bird would be available in Saint Louis, it is probable that the sketch of the Sharp-tail (as well as that of the Prairie Chicken) was made in southwestern Wisconsin prior to Rindisbacher's departure.

In a recently published paper [8] on the early history of these two species of grouse in Wisconsin, I established the southern limit of the Sharp-tailed Grouse at Chicago (lat. 42°N) and the northern limit of the Prairie Chicken at Green Bay, Wisconsin (lat. 44° 30'N). "R" states that the Sharp-tail "is not seen below the 42° of north latitude," that the Prairie Chicken ranges below 42°; and that "between 42° and 43°, is common ground." He may have been living at Prairie du Chien (lat. 43°), in which case he would have observed no Prairie Chickens for some distance northward since the terrain was entirely unsuitable for them. "R" very evidently resided in the "common ground," for he mentions seeing a large mixed pack of the two species between latitude 42° and 43°; and says that if possible, the following fall, he would send the editor live specimens of the two species so that he could determine whether they could be crossed.

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6. *Wis. Hist. Soc. Coll.* 12 (1892):257, 287–288. [R. G. Thwaites, the editor of this volume, is in error (p. 287, note 4) in identifying the "Lieut. Holmes", mentioned in the published letter, as Theophilus H. Holmes, who was in the South and Southwest during the entire period under consideration.—See Gen. G. W. Cullum. Biographical register of the officers and graduates of the U.S. Military Academy. Boston (1891). vol. 1, p. 446.]
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TRANS-GULF SPRING MIGRATION OF BIRDS AND THE COASTAL HIATUS *

BY GEORGE H. LOWERY, JR.

FORTY years ago Wells W. Cooke suggested that many birds which migrate across the Gulf of Mexico in spring do not stop on reaching the coast of the United States but instead fly some distance inland before alighting. Notwithstanding the importance of Cooke's brief but pointed statements (1904:13, and 1915:33), surprisingly little attention has been given the matter by subsequent writers. Cooke's original postulation was based on meager evidence supplied by a few scattered field observers; his later comments were apparently prompted by the knowledge that two competent ornithologists had spent an entire spring on the northwestern coast of Florida without finding a single example of many regular trans-Gulf migrants such as the Yellow-breasted Chat, Redstart, and Indigo Bunting. Since abundant data from the lower Misssissippi River valley and from along the Gulf coast of the United States are now available for analysis, Cooke's postulate may well be re-examined.

To the many ornithologists who study migration of species that use the trans-Gulf flyway, and to those who think of the Mississippi delta as the region where myriads of weary transients immediately alight upon sight of land, the following statement may come as a surprise: During clear weather, trans-Gulf spring migrants that do not breed on the Gulf coast or in the lower Mississippi River valley proceed inland several hundred miles before coming down. That stretch of coast which one might suppose to be teeming day after day during the spring with multitudes of migrants which have just completed the over-water passage from Yucatan or Campeche is, in actuality, *during fine weather,* an "ornithological vacuum" so far as many migrants are concerned. Many species of common trans-Gulf migrants are rare or absent at certain coastal stations throughout an entire spring migration period. *During inclement weather,* however, all trans-Gulf migrants are precipitated on the first available land, and this results in enormous concentrations of migrants on wooded coastal islands and cheniers.[1] When the weather clears, most migrants immediately resume their northward flight.

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* Since some readers may be surprised that Mr. Lowery makes no reference here to George G. Williams' very stimulating article on trans-Gulf migration that appeared in the January 1945 *Auk,* it seems desirable to explain that the present paper was submitted to the *Bulletin* in May 1944, and technical difficulties have delayed its publication until now. It is interesting to compare the data presented by Williams with that assembled by Lowery and to note their very different conclusions.

Mr. Lowery now informs me that he made in May of this year a very interesting trip on a slow boat to Progreso, Yucatan, and gathered important additional evidence of trans-Gulf migration. This, with new migration data collected along the coast, on the Gulf, and in Yucatan, by boat crews and others he has interested in the problem, will be included in a report he is now preparing for the press.—Ed.

Some writers have gone so far as to assert that the state of the weather at any point has little, if anything, to do with the arrival of migrating birds, and the belief of observers who have thought that they could foretell the appearance of various species by a study of weather conditions has received little or no support. Nevertheless, the state of the weather in the lower Mississippi valley and along the Gulf coast is of tremendous importance in determining the arrival of migratory species at any given place in those areas, and will, therefore, be given detailed consideration in the present discussion.

Effects of Polar Fronts

Inclement weather on the northern Gulf coast in the spring most frequently results from the movement of cold polar air-masses down from the north or northwest and their subsequent contact with warm air that is approaching from the south. Advances of such cold air masses are usually described in Louisiana as "northers" or "northwesters." Along the forward edge (the polar front), the warm and humid air is

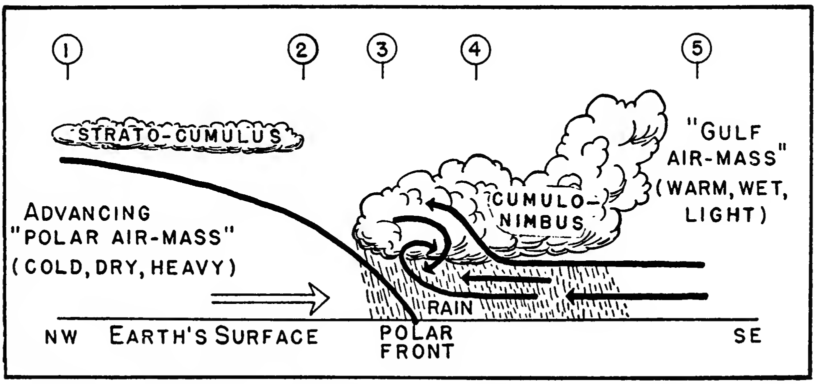


Figure 1. Idealized vertical section in atmosphere showing conditions associated with an advancing polar front. The scale varies with individual fronts; the above might represent a distance of 100 miles horizontally and 10 miles vertically. The rate of advance varies from 5, or 10, to 60 miles per hour. Point 1 lies in polar air; light to medium northerly or northwesterly winds and dry air are typical here. Point 5 lies in warm, humid Gulf air. Point 4 has heavy cloud cover, precipitation, and violent, gusty winds. Electrical storms are typical along this "squall line." Higher and thinner clouds, with less precipitation, characterize Points 2 and 3. At Point 2 there may be only a high cirrus haze.

forced to rise as a result of being under-run by an increasingly thick wedge of cold air. Under the decreased pressure at higher levels the warm air expands and cools. Condensation and precipitation result. At

[1] In coastal Louisiana a *chenier* is a wooded ridge running through the low marshes parallel to the Gulf.

the edge of the cold front the forced ascent of warm, moist air is violent and intermittent, and is accompanied by squally winds, not infrequently by rather severe twisters. The clouds are of the cumulo-nimbus type (Rossby, 1941:634).

What happens when birds crossing the Gulf of Mexico through the warm air-masses lying over the whole Gulf-Caribbean region encounter the forward edge of air masses descending from the north (see Figures 1 and 2), with the accompanying headwinds, squalls, and generally

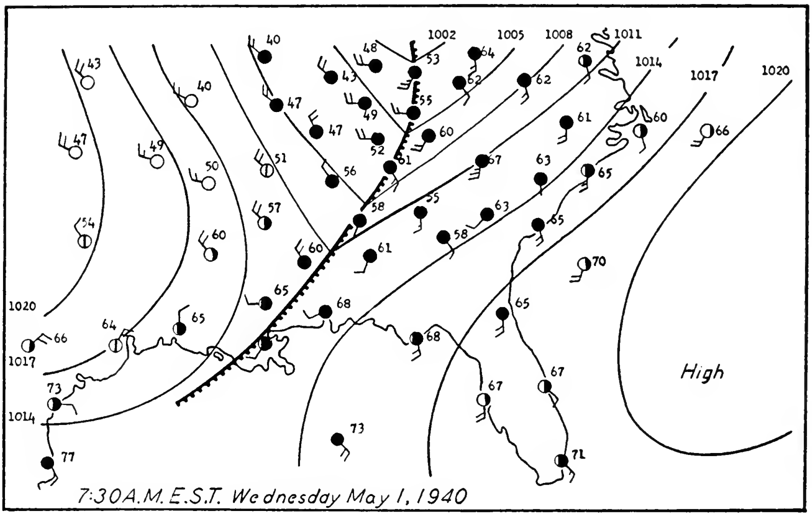
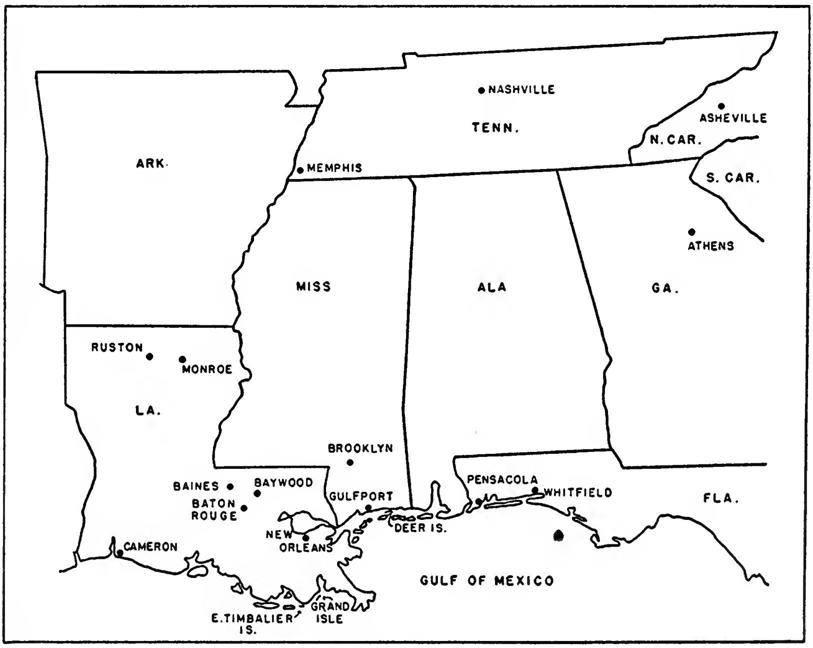


Figure 2. Position of a polar-front wave over the southern United States on May 1, 1940 (from Rossby, after Haynes). The cold front is indicated by the barbed line; the warm front (over the northern states) is not shown. The eastern part of the country lies in warm, humid air, the western part in cold, dry air. This may be seen by the temperatures (in °F.) at each station. The direction toward which the wind is blowing is shown by the arrows pointing to the circles representing the stations. Wind velocity is indicated by the cross-bars on the arrows, one full bar denoting approximately 5 miles per hour. The degree of cloudiness is indicated by the extent to which the station ring is filled with black. Figures on solid lines show pressure in millibars.

stormy conditions, will be discussed in detail later, but it is obvious that when the polar front extends southward beyond the northern edge of the Gulf, migrants must turn back to Yucatan or try to reach the land ahead, either by flying through the storm or by ascending above it. To fly above the storm would be possible for only a short distance. The height of a cold front, even comparatively near its forward edge, doubtless exceeds the upper flight limit of most (if not of all) migrants. That migrants would under any circumstances retreat to the point of their departure, especially after having covered more than half the distance across the Gulf, is supported neither by evidence nor by logic. Various observations show that when migrants reach the "squall area" just ahead of the polar front they drop close to the surface of the Gulf, possibly in an attempt to escape the buffeting effects of higher wind currents, and then exert their full energies toward beating their way through the headwinds and squalls to the shelter of land.

Frazar (1881) describes the efforts of many small birds to reach shore against a severe "norther" on the afternoon of April 22, 1881,[2] 30 miles off the coast of Louisiana. On numerous occasions I have witnessed similar phenomena. On April 7, 1937, I found almost no migrants on Grand Isle, Louisiana, a small narrow island 40 miles west of the mouth of the Mississippi River (Figures 3 and 4, Map 1). On April



Map 1. The northern Gulf coast.

8 a strong "norther" developed. At 2:00 P.M. we stood on the front beach and observed several small flocks of Purple Martins (*Progne subis*) and Eastern Kingbirds (*Tyrannus tyrannus*) appear from over the Gulf flying very low. These birds immediately settled in the trees

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[2] Frazar's article gives the date as April 2, but this may have been a typographical error. Cooke (1904:25) refers to the same observation under the date April 22, probably from notes furnished him directly by Frazar. Certain birds mentioned by Frazar are definitely the kinds which he might have encountered late in April and not ones which appear so early as the first part of that month.

just behind the front beach. Later in the afternoon we saw a larger bird approach the island and followed it with binoculars until it came to rest within a short distance of us on the beach. We identified it as a Green Heron (*Butorides virescens*). The bird was obviously fatigued and we nearly succeeded in catching it before it struggled ahead of us a few feet to the safety of the near-by trees. All during the afternoon of April 8, birds continued to appear in great numbers in the trees on the island. The morning of April 9 was particularly notable for the great abundance of Cerulean Warblers (*Dendroica cerulea*), which are rather rare spring transients on the Louisiana Gulf coast. The trees were literally filled with this and other species of birds.

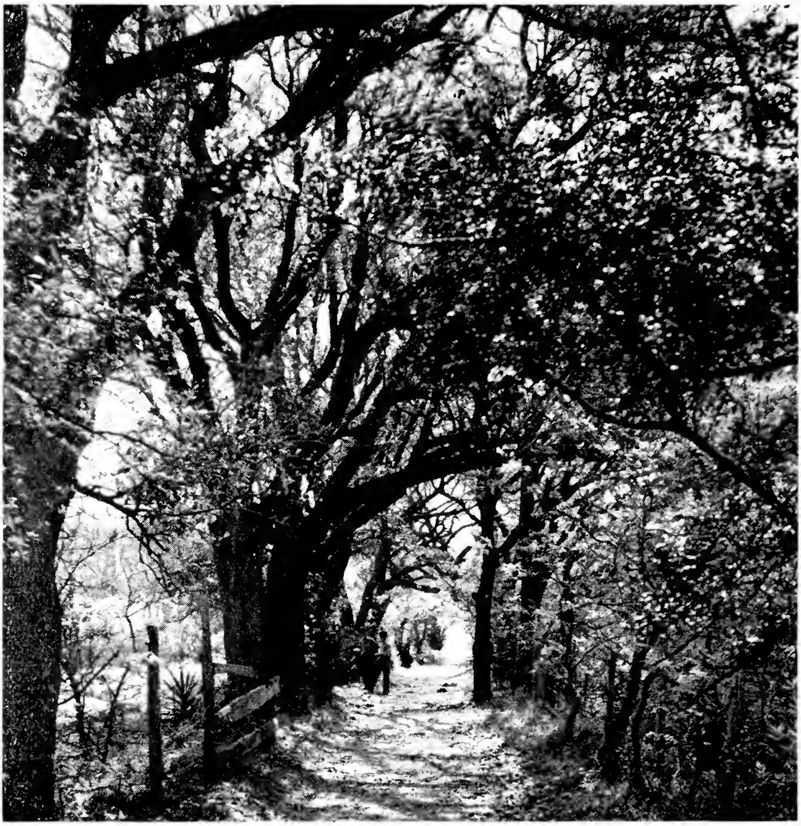
Incoming migrants that are attempting to reach land in the face of a storm are not always fortunate enough to make contact with the coast at points where wooded areas provide refuge from the wind and rain. In Louisiana, particularly, there are vast stretches of coastal marshes, sometimes 40 to 50 miles in depth, in which transients would find little shelter from the elements. That storm-battered migrants do, nevertheless, take refuge in such barren areas is evident from numerous observations. In April, 1940, for example, I had planned to cross Timbalier Bay from the mainland to East Timbalier Island. But my companions and I were detained at the mouth of a small canal emptying into the Bay by a "norther" which came up on the night of April 11. Because of the high winds, our boat was tied up on the edge of the marsh throughout April 12. We went ashore and found the short marsh grass and low-growing mangrove bushes teeming with small birds, notably Acadian Flycatchers, Red-eyed Vireos, Cerulean, Yellow, and Kentucky Warblers, American Redstarts, and Orchard Orioles (*Empidonax virescens, Vireo olivaceus, Dendroica cerulea, Dendroica aestiva, Oporornis formosus, Setophaga ruticilla,* and *Icterus spurius*). They were feeding energetically in the low growth and apparently working in a general northerly direction.

Islands and cheniers along the coast, on occasions such as just described, may be literally flooded with small migrants. No printed description can possibly convey a full appreciation of the sight. The bird observer is often bewildered by the number of birds on mornings following the advent of a "norther." On several occasions, Grand Isle, Louisiana, has been the refuge of such great hordes of incoming migrants that practically every bush on the island contained birds. Warblers have been observed perching on the porches of houses and fluttering in numbers through open windows; they have presented such concentrations that an observer could stand in one spot and count a hundred or more small birds close at hand.

Thomas D. Burleigh (*in litt.*) describes a similar observation made on Deer Island, on the coast of Mississippi, on April 26, 1940. He noted 20 species of warblers alone, and the number of individuals of all migrant species ran into the thousands. This was preceded and accom-

Fonville Winans

Figure 3. Aerial view of Grand Isle, Louisiana. In the foreground, the Gulf of Mexico; in the background, Barataria Bay. The island is about nine miles in length, but only the central part is covered with vegetation as shown here.



Fonville Winans

Figure 4. Close-up of vegetation on Grand Isle, taken near the center of the area shown in Figure 3. It is isolated areas of shelter such as this that frequently serve as refuges to swarms of migrants arriving on the northern Gulf coast during adverse weather.

panied by the advance of a polar front that extended over part of the Gulf of Mexico. (See Table 5.)

Many incidents similar to those just described, illustrating the kind of weather prerequisite to the appearance of great waves of trans-Gulf migrants in Gulf coast regions, could be drawn from my notes and those of other recent observers.

Departure of Birds Following Polar-front Storms

The weather immediately following polar-front storms in the Gulf coast region is usually characterized by clearing skies and rising temperatures. Winds generally shift back to the south or southeast a few days after the arrival of a cold front.

Contrary to opinions expressed by some writers, migrants which arrive on the Gulf coast are not so completely fatigued as to require long periods of rest before advancing northward. Flocks of migrants which seem to remain in one locality for several days probably represent several successive waves. Burleigh, at Gulfport, Mississippi, and Weston, at Pensacola, Florida, concur (*in litt.*) in the assertion that as the weather clears following a "norther" the swarms of migrants immediately begin to disappear. Should the weather clear on the morning following the passage of a polar front, the concentrations are usually maintained throughout the first day. On the second day, however, only a few are found, and even those may be individuals composing the rear-guard of the initial flight which did not reach shore until sometime during the preceding day.

Of course many observations support these statements and analyses but the events of March 27-29, 1942 are especially typical and conclusive. Thomas R. Howell and I reached Grand Isle, Louisiana, in the late afternoon of March 27. The wind was out of the north, and the sky was heavily overcast. Although the western end of the island consists chiefly of sand dunes, marshes, and mud flats, one of the several small birds we found feeding on the treeless sand dunes by the side of the road was a Yellow-throated Warbler (*Dendroica dominica*). An arboreal species such as this feeding among sand dunes or other treeless places is a characteristic occurrence when migrants are forced by the weather to descend on the first available land.

We made a brief survey of the wooded section of the island before nightfall. Trees and bushes were filled with birds. The wind grew stronger near midnight. Early on the morning of March 28 we began a systematic inspection of the bird life in a stretch of live oaks about three-quarters of a mile long and 200 yards wide. The number of birds present was incalculable. Throughout the day we worked slowly back and forth through this woodland. There was an amazing number of small migrants; standing in any one spot, we could easily count several hundred birds within view. The predominant species were the White-eyed Vireo and the Black and White, Prothonotary, Parula, and Hooded

Warblers. The earliest Louisiana arrival dates for four species—Cerulean and Blackburnian Warblers (*Dendroica fusca*), Oven-bird (*Seiurus aurocapillus*), and Redstart—were established on March 27 or 28, a point which will serve to illustrate subsequent discussions under the heading of "Average Arrival Dates."

The weather cleared completely on March 28, and the temperature rose rapidly throughout the day. On March 29, after a completely clear night with moderate easterly winds, only a few birds could be found, proving beyond any question that most of them had resumed their flight during the first night following the abatement of the storm. (See Tables 1 and 6.)

TABLE 1

Comparison in Number of Individuals of Certain Migrants Seen at Grand Isle, Louisiana, on Two Successive Dates

	March 28	March 29
White-eyed Vireo, *Vireo griseus*	100	6
Yellow-throated Vireo, *Vireo flavifrons*	10	3
Black and White Warbler, *Mniotilta varia*	300	30
Prothonotary Warbler, *Protonotaria citrea*	300	30
Parula Warbler, *Compsothlypis americana*	300	30
Yellow-throated Warbler, *Dendroica dominica*	25	0
Louisiana Water-thrush, *Seiurus motacilla*	8	1
Kentucky Warbler, *Oporornis formosus*	25	3
Hooded Warbler, *Wilsonia citrina*	200	35

Francis M. Weston, in a recent letter to me, stated: "You may be interested in an observation that extends your statement . . . about the resumption of northward flight after a period of bad weather. I have seen on at least two occasions the behavior of swarms of delayed migrants on the last day of their enforced stop-over. Each time the weather was clear and mild, with no wind. Toward sunset, the birds congregated in the tops of the tallest trees, where the last rays of the sun made them very conspicuous. I have never seen so many Summer Tanagers and Orchard Orioles as on these two occasions. From the tops of the trees, small groups occasionally made short flights upward, returning to the trees. They continued to do this as long as the light lasted and I could see them and, presumably, they continued to do this even after dark until the electric moment for departure arrived, for in the morning they were gone and the woods were deserted."

Burleigh, who has made observations on the Mississippi coastal islands over a period of eight years, informs me (*in litt.*) that his experiences have been similar. That is, when the weather clears following the passage of a polar front, migrants immediately begin to disappear from the coastal areas, indicating resumption of northward flight. Transient migrants remain on the coast only so long as disturbed weather conditions and strong north winds continue.[3]

The correlation between local weather conditions and the appearance of trans-Gulf migrants has so far been considered only for the times when polar fronts extend to or even beyond the Gulf coast. Often the polar air masses do not reach the Gulf before losing their forward momentum. The weather along the coast may be highly inclement with overcast skies and fresh winds, but when the winds do not shift to the north or northwest, there is but slight precipitation of trans-Gulf migrants in coastal areas. In other words, most of the birds pass over the coastal region and are precipitated when the actual front is reached.

An analysis of a specific set of observations might serve to illustrate the point in question. George M. Sutton, James H. Bruns, and I arrived on the coast of Cameron Parish in the late afternoon of April 21, 1942. We spent the following week in studying the bird life of the region, particularly that found on the island-like oak ridges or cheniers paralleling the coast. The weather conditions during the period were for the most part unsettled with occasional rains, but at no time did a "norther" develop. There were practically no migrants, except for the small number present on our arrival. Inquiry among residents at the time, and a check later with Weather Bureau reports, indicated that we had arrived too late. A "norther" had developed a few days prior to our arrival; hence, the migrants present during the initial part of the period of observation were a carry-over.

Although the unsettled weather continued, no new cold fronts developed. Fresh winds blew out of the south, southeast, and east, but never from the north or northwest. Notwithstanding our location in the path of trans-Gulf migration at the height of the migration period, we found only negligible numbers of trans-Gulf migrants. It must follow that they were passing over the coast at that point. Several times during the day of April 27, the low-flying clouds broke overhead, and clear, blue sky was visible beyond. Since the unfavorable weather phenomena were occurring especially close to the earth's surface, there is not much doubt that the birds were flying above the adverse forces. Actually, weather conditions at those heights might even expedite northward flight. But as already stated, the distance that the birds could progress northward above the adverse weather conditions would depend on where the height of the squall area or the actual polar front exceeded that to which birds could ascend. When that threshold was reached, the birds would be forced to descend. Since successive waves of migrants would be precipitated in the same general area, a tremendous concentration of migrants would result there.

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[3] The Veery (*Hylocichla fuscescens*) and the Olive-backed and Gray-cheeked Thrushes (*H. ustulata* and *H. minima*) do sometimes linger longer than other birds because of the attraction afforded by the fruit of the red mulberry (*Morus rubra*) of which they are very fond and which is very prevalent in the coastal plain region.

If we had any method of determining the altitudinal limits to which birds might ascend before being forced to face the vicissitudes of the inclement weather below, we might, by study of weather charts plotting the movements of air masses, actually predict the areas where great concentrations of migrants could be expected in the lower Mississippi valley.

The Baton Rouge Region

I first became aware of phenomena that suggested an extensive coastal hiatus before reading Cooke's brief remarks on the subject. I had spent several years observing bird migration in extreme northern Louisiana, at Monroe and Ruston. Since 1932, when I established residence at Baton Rouge, in south-central Louisiana, I have had the opportunity to make observations both there and in extreme southern Louisiana and to compare the patterns of spring migration on the coast, in northern Louisiana, and at Baton Rouge.

The Baton Rouge region is probably one of the best worked areas in the South if the number of field observers, the amount of time spent in the field, the large number of extralimital species collected, and the total number of species and subspecies recorded are accepted as criteria for evaluating the intensity with which a given area has been worked.

Baton Rouge is located on the banks of the Mississippi River almost directly in line with the center of the trans-Gulf flyway. In one direction the coast lies less than 70 miles away. The physiography of the country surrounding Baton Rouge is extremely diversified and should be attractive to birds. North of Baton Rouge are hills cut deep by ravines and forested with dense stands of mixed hardwoods, including holly, beech, magnolia, and several kinds of oaks; to the west, across the river, lies the extensive Atchafalaya River swamp with hundreds of square miles of mixed bottomland hardwoods and cypress; to the east, stretch equally large expanses of long-leaf, loblolly, and slash pines; and below the University, the battures [4] of the Mississippi River are lined with cottonwood, willow, red gum, and sycamore.

Yet in spite of the location and apparent physical attractiveness of the Baton Rouge environs, and in spite of the thoroughness with which the area is worked, most of the trans-Gulf migrants that do not breed on the Gulf coast or in the lower Mississippi valley have been recorded rarely or not at all in the Baton Rouge region during the spring (see Table 2). The comparatively few records for those species which have actually been noted at least once in the Baton Rouge area are in virtually every case directly attributable to prolonged periods of inclement weather which caused an accumulation of migrants in the coastal region.

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[4] A *batture*, in current usage, is the area between the levee and the channel of the stream. Originally, before the building of the levees, the term was used to designate the high ground next to the channel. Sometimes considerable land lies between the levee and the river, especially where the levee does not follow the meanders of the river channel.

Observations recorded on April 30 and May 1-3, 1940, are notably significant in this connection. (See Table 5.) The latter part of April was decidedly unsettled throughout most of the central Gulf coast region. Burleigh (*in litt.*) recorded a great wave of migrants on the Mississippi coast on April 26. It was stormy at Baton Rouge on the night of April 29, and 2.44 inches of rain fell. The weather on April 30 was very unsettled, and we obtained the first Baton Rouge spring record for the Chestnut-sided Warbler. May 1 (see Figure 2) was cloudy in the forenoon with light rains, but the skies had cleared by 11:30 A.M. The woodlands 15 miles north of Baton Rouge were filled with migrants. The Golden-winged, Blackburnian, and Canada Warblers were each recorded in the vicinity of Baton Rouge for the first time in the spring. Second spring records were obtained for the Black-billed Cuckoo and for the Black-throated Green Warbler (Table 2). To ornithologists who know these species as abundant spring migrants in the Mississippi valley, their rarity at Baton Rouge must appear inconceivable.

Observations in the spring of 1943 are also illustrative of the rarity of transient migrants at Baton Rouge. My associates and I were in the field 42 of the 47 days between March 20 and May 7. A. W. Burdick,

TABLE 2

SPRING STATUS AT BATON ROUGE OF CERTAIN TRANS-GULF MIGRANTS 1933–1943

	Number of Records[a]
Black-billed Cuckoo, *Coccyzus erythropthalmus*	3
Alder Flycatcher, *Empidonax traillii*	None
Least Flycatcher, *Empidonax minimus*	None
Philadelphia Vireo, *Vireo philadelphicus*	None
Golden-winged Warbler, *Vermivora chrysoptera*	4
Blue-winged Warbler, *Vermivora pinus*	5
Nashville Warbler, *Vermivora ruficapilla*	None
Yellow Warbler, *Dendroica aestiva*	A few yearly
Magnolia Warbler, *Dendroica magnolia*	9
Cape May Warbler, *Dendroica tigrina*	None
Black-throated Green Warbler, *Dendroica virens*	4[b]
Blackburnian Warbler, *Dendroica fusca*	3
Chestnut-sided Warbler, *Dendroica pensylvanica*	6[c]
Bay-breasted Warbler, *Dendroica castanea*	6[d]
Black-poll Warbler, *Dendroica striata*	3
Oven-bird, *Seiurus aurocapillus*	4
Northern Water-thrush, *Seiurus noveboracensis*	1
Canada Warbler, *Wilsonia canadensis*	2
Scarlet Tanager, *Piranga olivacea*	5
Rose-breasted Grosbeak, *Hedymeles ludovicianus*	4

[a] One "record"=one or more individuals of a given species seen on one day.

[b] One bird for each "record" except on May 1 and 2, 1940, when a number were seen. See text discussion of April 30–May 3, 1940.

[c] Three of these were on April 30–May 2, 1940; another was of a bird that struck the State Capitol light on May 17, 1940.

[d] Three of these were on April 30–May 2, 1940.

an able field observer who assisted me for several years at Baton Rouge, spent the period of April 22 to May 12 at Memphis, Tennessee, for the express purpose of collecting comparable data. During the whole period, only four species of transient trans-Gulf migrants were found at Baton Rouge, and these were represented by a total of only seven individuals: one Blue-winged Warbler, April 18; two Yellow Warblers, April 24; two Scarlet Tanagers, one on April 16 and one on April 24; two Rose-breasted Grosbeaks, on April 24. From April 18 to 24 and from April 25 to May 7, absolutely no transient trans-Gulf migrants were found. Yet on April 22 at Memphis, Burdick recorded 15 species (13 species of warblers and 2 thrushes) of transient trans-Gulf migrants, and during the period April 22 to May 9, he recorded a total of 26 species of transients. Some were recorded throughout the period, for example, the Olive-backed Thrush (6 to 35 individuals daily), and the Black-poll Warbler (8 to 25 individuals daily). The Nashville Warbler, for which there are no spring records at Baton Rouge, was seen by Burdick from April 22, when he recorded 75 individuals, to May 5. (Cf. Burdick and Tucker, 1943; see also Table 9.)

An occurrence on the night of April 20, 1933, is of particular interest. Between 8:30 and 9:00 P.M. a thunder storm accompanied by considerable hail occurred at Baton Rouge. The resulting damage to local bird life has been described by Gates (1933). Twenty-seven Scarlet Tanagers were found dead or injured on or near the University campus on the morning following the storm. Since these 27 birds probably represent only a fraction of those actually killed, it is likely that a considerable flight of the species was migrating over Baton Rouge on this night. The date, April 20 (1933), stood for 10 years as the earliest spring "arrival date" for the Scarlet Tanager at Baton Rouge (until April 16, 1943, when a single individual was seen), and the species was noted on only four occasions in the interim. Hence, here is a species that has been noted an aggregate of only five times in 10 years at Baton Rouge; yet it is definitely a trans-Gulf migrant, and there is evidence that on April 20, 1933, a considerable number were passing over Baton Rouge.

Average Arrival Dates

Because the appearance of transient trans-Gulf migrants at any particular locality in the lower Mississippi valley is dependent largely on specific weather phenomena, arrival dates are highly variable. Ornithologists in other sections of the United States may find it useful to compute average arrival dates for each migrant species, but it is apparent from the foregoing statements that in the Gulf coast region average arrival dates are of little or no significance. The "average" date so computed is not the usual arrival date of the species in question (that is, the date on which they begin passing over the area) but is in general the average date on which polar-front weather has precipitated birds in that particular area.

Earliest Arrival Dates

The recording of the initial appearance of a species in a given area in any particular year is admittedly a highly fortuitous matter. But in regions where there are a number of observers in the field almost daily over many consecutive years, the "earliest date of arrival" of a species assumes considerable significance. Although the rate of advance up the Mississippi valley may be variable from year to year, depending on a number of factors such as the variable rate of the "advance of spring" up the valley (Cooke, 1888:37–41), the dates of arrival of trans-Gulf migrants that breed along the Gulf coast and elsewhere in the extreme lower Mississippi valley are remarkably uniform from year to year, and the earliest dates of their arrival there are consistently in advance of the arrival of the same species several hundred miles up the Mississippi valley—which is exactly what one would expect.

Dates of arrival on the Gulf coast of *transient* trans-Gulf migrants are, on the other hand, highly variable, and many species are recorded consistently much earlier in Tennessee, for example, than on the coast itself. If these transients regularly descended on reaching land, one would expect the "first arrival" dates along the coast to be earlier than those recorded farther inland.

In Table 3, 24 species of birds that do not breed in the lower Mississippi valley but are known to be trans-Gulf migrants in the spring are listed with the earliest dates on which they have been recorded in several regions. The earliest dates of arrival at Memphis, over 300 miles north of the Gulf coast, are in many instances earlier than those recorded at Pensacola, on the coast of Mississippi, or at Baton Rouge. Fifteen (63 per cent) of the species listed in Table 3 have been recorded earlier at Memphis than they have at Baton Rouge. Ten have been detected at Memphis earlier than on the coast of Mississippi, and the same number have been seen earlier at Memphis than at Pensacola. Similarly, Nashville records are in some instances earlier than those recorded at certain Gulf coast stations. Six (25 per cent) of the species listed have been recorded earlier either at Memphis or Nashville than at Pensacola, on the coast of Mississippi, or at any locality on the coast of Louisiana. These figures are significantly high when one considers the long period of years over which Gulf coast records have been kept and the greater number of ornithologists who have studied there compared with the number who have made observations at the two Tennessee stations. This consistently earlier recording of transients in Tennessee can be explained only if incoming migrants as a rule (i.e., during fine weather) pass over the Gulf coast in the spring and proceed far inland before descending.

TABLE 3

Earliest Arrival Dates for Certain Transient Migrants in Various Southern Regions *

Species	Coastal Louisiana (misc.) 1885–1944	Coastal Mississippi 1935–43	Pensacola, Florida 1916–43	Baton Rouge, Louisiana 1933–44	Memphis, Tennessee 1926–43	Nashville, Tennessee 1915–43	Athens, Georgia 1921–35
Black-billed Cuckoo (*Coccyzus erythropthalmus*)	April 11	May 5	May 2	April 21	April 28	May 3	April 27
Yellow-bellied Flycatcher (*Empidonax flaviventris*)	May 12	May 12	no spring record	no spring record	May 11	no spring record	no spring record
Olive-backed Thrush (*Hylocichla ustulata*)	April 19	April 19	April 5	April 20	April 11	April 16	April 10
Gray-cheeked Thrush (*Hylocichla minima*)	April 20	April 12	no spring record	April 22	April 23	April 8	May 20
Veery (*Hylocichla fuscescens*)	April 20	April 20	April 15	April 20	April 20	April 24	April 19
Philadelphia Vireo (*Vireo philadelphicus*)	April 26	May 7	April 18	no spring record	May 2	April 28	no spring record
Golden-winged Warbler (*Vermivora chrysoptera*)	April 6	April 10	April 5	April 17	April 13	April 26	April 26
Blue-winged Warbler (*Vermivora pinus*)	March 22	March 27	April 4	April 12	April 3	April 7	April 16
Tennessee Warbler (*Vermivora peregrina*)	March 28	April 7	April 12	April 6	April 9	April 21	May 1
Nashville Warbler (*Vermivora ruficapilla*)	April 11	no spring record	no spring record	no spring record	April 16	April 22	no spring record
Magnolia Warbler (*Dendroica magnolia*)	April 20	April 19	April 27	April 17	April 21	April 18	April 15
Cape May Warbler (*Dendroica tigrina*)	April 27	May 1	no spring record	no spring record	April 27	April 16	April 14
Black-throated Blue Warbler (*Dendroica caerulescens*)	March 22	April 30	no spring record	no spring record	May 5	April 21	April 7

TABLE 3 (*Continued*)

Species	Coastal Louisiana (misc.) 1885–1944	Coastal Mississippi 1935–43	Pensacola, Florida 1916–43	Baton Rouge, Louisiana 1933–44	Memphis, Tennessee 1926–43	Nashville, Tennessee 1915–43	Athens, Georgia 1921–35
Black-throated Green Warbler (*Dendroica virens*)	April 8	March 24	March 20	May 1	March 19	March 20	March 24
Blackburnian Warbler (*Dendroica fusca*)	March 27	March 27	April 5	April 26	April 5	April 7	March 29
Chestnut-sided Warbler (*Dendroica pensylvanica*)	March 21 (winter ?)	April 14	April 12	April 16	April 16	April 22	April 20
Bay-breasted Warbler (*Dendroica castanea*)	April 17	April 19	April 24	April 17	April 22	April 19	April 26
Black-poll Warbler (*Dendroica striata*)	April 15	April 26	April 23	April 25	April 21	April 18	April 19
Oven-bird (*Seiurus aurocapillus*)	March 28	March 31	April 4	April 21	April 11	April 1	April 3
Northern Water-thrush (*Seiurus noveboracensis*)	April 6	April 19	April 5	April 16	April 19	?	April 15
Canada Warbler (*Wilsonia canadensis*)	no spring record	May 10	no spring record	May 1	April 24	April 28	April 27
Bobolink (*Dolichonyx oryzivorus*)	April 1	April 30	April 20	April 19	April 28	April 19	April 14
Scarlet Tanager (*Piranga olivacea*)	April 3	April 3	April 5	April 15	April 16	April 6	April 11
Rose-breasted Grosbeak (*Hedymeles ludovicianus*)	April 16	April 15	April 21	April 21	April 18	April 18	April 22

* Data in this table have been drawn from the following sources: *Louisiana localities*—From Oberholser (1938), from records and specimens in the Louisiana State University Museum of Zoology, and from records and specimens assembled by Thomas D. Burleigh and Thomas R. Howell at New Orleans; the term "Coastal Louisiana" refers to the combined records from New Orleans, Grand Isle, and Cameron. *Coastal Mississippi*—Burleigh (1944). *Pensacola, Florida*—From records and specimens assembled by Francis M. Weston. *Athens, Georgia*—Burleigh (1938). *Memphis, Tennessee*—Records assembled by Ben B. Coffey and his associates and from specimens collected by Eugene Wallace, Austin W. Burdick, and Robert Tucker and deposited in the L.S.U.M.Z. *Nashville, Tennessee*—From records and specimens assembled by Albert F. Ganier and his associates.

Extent of the Coastal Hiatus

There is considerable evidence that the "coastal hiatus" in Mississippi valley migration extends northward across the entire Gulf coast region well beyond the 31st parallel of latitude. Just how far inland the hiatus extends requires much additional investigation, but the most southern locality in the Mississippi valley with a "normal" spring migration seems to be Memphis, Tennessee (Map 1). There are minor fluctuations discernible in the flow of migrants in this region, but for the most part, the place throngs day after day with migrants. Many of the species listed in Table 2 as rare or absent in spring at Baton Rouge are very common in migration at Memphis. Hence the northern edge of the hiatus must lie to the south of Tennessee.

Further investigation will probably show that the relative abundance of migrants increases in direct proportion to the distance from the coast. During the period 1929 to 1932, I observed birds at Monroe and Ruston in northern Louisiana; between 1932 and 1943, I received many valuable notes from the late Mrs. George H. Lowery, Sr., who lived at Monroe and made a study of the bird life in that vicinity. Although there is need for much additional field work in northern Louisiana, it can be said that spring migration at Monroe is far more pronounced than at Baton Rouge, but probably appreciably less than at Memphis. Nearly all of the trans-Gulf migrants are seen regularly in spring at Monroe, yet their numbers do not seem to approach those recorded slightly farther north, at Memphis. Burleigh's careful and intensive survey of the bird life at Athens, Georgia (1938), likewise shows that fewer migrants are seen at that locality than slightly farther north in the lower Allegheny Mountains (Pearson, Brimley, and Brimley, 1942).

Speculation on the destination of the Scarlet Tanagers prior to encountering the hail storm at Baton Rouge (see above) gives some indication of the extent of the coastal hiatus. Assuming that the tanagers had continued flying at a minimum speed of 25 m.p.h., they could have covered a distance of approximately 250 miles and reached southern Arkansas or northern Mississippi by daybreak.

There is, of course, no way of knowing whether the tanagers had only recently departed, during the preceding late afternoon, from some coastal region, en route northward via Baton Rouge, or whether, on the contrary, they were still in continuous flight from some tropical locality. The time of their passing Baton Rouge, about two hours after sunset, suggests the former inference, since it would require just about that length of time for the birds to reach Baton Rouge from almost any Gulf coast point.

But regardless of whether this particular flight of tanagers had its beginning in tropical America or on the Gulf coast of Louisiana, the significant feature of the coastal hiatus is again illustrated: Migrants which arrive on the northern Gulf coast during favorable weather continue inland a considerable distance and hence miss the greater part of the Gulf coast region. Migrants which arrive on the northern Gulf coast during unfavorable weather are precipitated in the coastal areas, but as the weather clears, they resume their flight, the initial part of which again carries them over vast stretches of the Gulf coast states.

Trans-Gulf Migrants That Breed in the Lower Mississippi Valley

Discussion up to this point has been concerned wholly with transient trans-Gulf migrants, i.e., species that do not breed along the Gulf coast or in the extreme lower Mississippi valley. Whereas transient migrants are decidedly rare [5] and arrive irregularly throughout interior Louisiana, Mississippi, and other southern states, migrants which stop to breed arrive on their breeding grounds with remarkable regularity.

The Prairie Warbler (*Dendroica discolor*) is a case in point. During the past 10 years, the species has been recorded only once within the immediate environs of Baton Rouge, where it does not breed. However, it does breed abundantly 20 miles northeast of Baton Rouge near Baywood in the cut-over pine-hardwood region, and it appears regularly there on or around April 1. In view of the abundance of the species just beyond Baton Rouge we might surmise that it would be at least fairly common in migration at the latter place. Such is not the case. The single Baton Rouge record is an individual seen on April 21 (1940), nearly three weeks later than the species regularly appears at Baywood. Similarly, the Worm-eating Warbler (*Helmitheros vermivorus*) breeds fairly commonly in the wooded beech-magnolia ravines of West Feliciana Parish, but has not yet been recorded in the spring 30 miles south at Baton Rouge.

At Baton Rouge such common nesting species as the Parula, Yellow-throated, Swainson's, Prothonotary, Kentucky, and Hooded Warblers, the Chat, the Warbling Vireo, Red-eyed, and Yellow-throated Vireos, Orchard and Baltimore Orioles, Acadian Flycatcher, Wood Pewee, Eastern Kingbird, Nighthawk, Chuck-will's-widow, Yellow-billed Cuckoo, Summer Tanager, Purple Martin, Painted and Indigo Buntings, and others, arrive on dates that are comparable with arrival dates at other Gulf coast stations where the species also breed.

Analysis of the status of certain species at Baton Rouge, Pensacola, Gulfport, and New Orleans shows clearly the difference between the arrival of birds in areas where they are known to breed and in areas where they are strictly transient. For example, Swainson's Warbler (*Limnothlypis swainsonii*) breeds commonly at Baton Rouge and at New Orleans, but not at Gulfport nor at Pensacola. The species arrives regularly at Baton Rouge on or shortly after April 2 and has been noted as early as March 30 at New Orleans. At Pensacola, where Swainson's

[5] This, of course, leaves out of consideration herons, swallows, and other birds that are, in part, coastwise migrants.

Warbler does not breed, it has not yet been recorded during spring migration. Yet the species is known to breed a short distance north of Pensacola (Weston, *in litt.*), and just east of Pensacola at Whitfield (Howell, 1932), where Worthington and Todd (1926:223) took 20 specimens between April 4 and May 1, 1903.

Further, Swainson's Warbler breeds at Brooklyn, Mississippi (Burleigh, *in litt.*), and at New Orleans, places which are respectively 50 miles north and 50 miles west of Gulfport. Nevertheless, in the eight years of his intensive field work at Gulfport, Burleigh has observed the species but once in the spring. This was an individual seen on April 19, 1943. The following quotation is taken from Burleigh's field notes for that date: "Weather clear with strong, cold, northwest wind [typical polar-front weather]. Island alive with birds for the first time this year" (Table 9). Burleigh, on the same day, procured his earliest Gulfport record for the Bay-breasted Warbler (*Dendroica castanea*) and the Northern Water-thrush, the former being six days earlier than his earliest previous record for the spring. The principal conclusions to be drawn from these data are: Swainson's Warbler is common after April 1 at localities on the Gulf coast where it nests; in areas where it does not nest, it is rare or absent in the spring; and when it does occur in such areas, its appearance there is correlated with a general precipitation of transients as a result of unfavorable weather conditions.

The situation with respect to the Dickcissel (*Spiza americana*) is similar to that of Swainson's Warbler, for the species does not breed at either Pensacola or Gulfport, but does breed locally at Baton Rouge and at New Orleans. At the two latter places it arrives regularly by April 15 and is often abundant by April 20. There are, however, no spring records for Gulfport, and Weston has seen the species but once at Pensacola in 28 years.

The Coastal Hiatus and Maps of Migration Routes

The absence of records for a given species from all coastal stations during prolonged periods of study must by no means be taken as proof that the species in question is not a trans-Gulf migrant. Given the right kind of weather and a competent observer at exactly the right spot, species which have previously gone undetected at coastal stations may finally be recorded in great numbers.

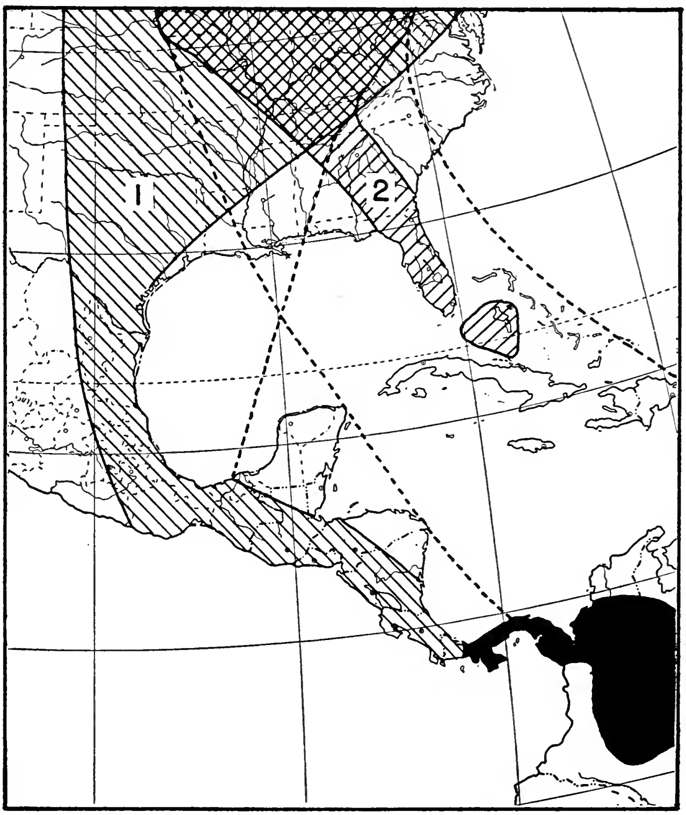
For example, up to 1942 there were no spring records for the Nashville Warbler from southern Louisiana, Mississippi, Alabama, or western Florida. But between April 9 and 11, 1942, at Cameron, Louisiana, the Nashville Warbler was found in considerable numbers among the swarms of migrants that were precipitated on the coastal ridges by polar-front weather on April 9 and 10. The following excerpts are taken from my field notes: "April 9: Strong north winds attended by very cloudy and unsettled weather . . . April 10: Skies cleared about noon, but wind continued out of the north throughout the remainder of the day and part of that night . . . Collected two nighthawks from a small flock feeding low over the edge of marsh at dusk, and both, much to our amazement, proved to be the Texas Nighthawk (*Chordeiles acutipennis*). This is the first Louisiana record and a considerable eastward extension of range . . . April 11: Plenty of migrants of all kinds on the narrow, wooded cheniers . . . Secured third Texas Nighthawk . . . Concentrations of birds noted today are precisely what we expected in view of the weather. Migrants coming across the Gulf in the face of the north wind dropped down upon the first bit of land instead of passing on inland . . . Warblers found in virtually every bush. Probably as many as several thousand warblers alone seen in course of day. These consisted of 26 species, the most surprising being the Nashville Warbler, which was present in considerable numbers" (Table 7). In all probability the Nashville Warbler will eventually be found in comparable numbers at other Gulf coast stations when a weather barrier occurs at the given locality at the precise time that a flight of Nashville Warblers reaches that point.

Similarly, the Philadelphia Vireo had not been recorded in spring at any coastal station before April 18 and 19, 1919, when Weston saw one at Pensacola. It has since been recorded on the coast only from Gulfport (one collected by Burleigh on May 7, 1941) and from Cameron (three collected by Sutton and Lowery on April 26 and 30, 1942). Thus the absence of the Philadelphia Vireo from most Gulf coast regions is by no means an indication that the species is not a regular trans-Gulf migrant. Since during favorable weather all transient trans-Gulf migrants fly far inland before descending, the Philadelphia Vireo can be expected at any coastal station only when forced down by adverse weather conditions.

The Warbling Vireo (*Vireo gilvus*) is a further case in point. The species breeds at certain localities within the coastal hiatus but not on the coast itself. In those localities where it does not breed, it has the status of other transient trans-Gulf migrants, i.e., it is absent entirely, rare, or highly intermittent in occurrence. The Warbling Vireo does not breed at Pensacola, Gulfport, or Cameron, and it has been recorded at none of these localities in the spring. At localities within the coastal hiatus where the species breeds, it has the status of all species of locally breeding trans-Gulf migrants, i.e., it is regular in appearance. At Baton Rouge, for example, where the Warbling Vireo breeds, it arrives regularly on or about March 26.

Wilson's Warbler (*Wilsonia pusilla*) has not been noted in spring from any locality in the South that lies east of Texas and less than 150 miles from the coast. However, the species reaches localities in northern Georgia and North Carolina on dates almost simultaneous with its arrival in the middle Mississippi valley. The great number of individuals that migrate northward parallel to the Allegheny Mountains must, therefore, as Cooke concluded 40 years ago (1904:127–128), jump over the southern part of the Mississippi valley and the Gulf of Mexico from their winter home in southeastern Mexico.

The Connecticut Warbler (*Oporornis agilis*) is generally supposed to migrate northward through the Florida Peninsula, and the Mourning Warbler (*Oporornis philadelphia*) is supposed to migrate northward by way of eastern Mexico and the Texas coast (Map 2). They are said to converge in the middle Mississippi valley (Cooke, 1904 and 1915; Lincoln, 1935 and 1939; Wetmore, 1926; Chapman, 1932; and others). Practically every writer on bird migration cites the Connecticut Warbler as an example of a species that reaches the United States exclusively by way of the Florida Peninsula. In fact, no alternative route appears to have been proposed. Let us examine the true status of the species in



Map 2. The commonly accepted spring migration routes (shaded areas) of (1) the Mourning Warbler (after Chapman), and (2) the Connecticut Warbler (after Lincoln and others). The winter range (in part) of the Mourning Warbler is shown in black. The migration routes postulated in this paper are indicated by the dotted lines.

Florida. Howell (1932) describes it as "a rare migrant in spring and fall." Citing presumably all authentic records for the state, he gives records for only five localities where the bird has been seen in spring, two of which are lighthouses. In the West Indies, the species has been recorded only from the Bahama Islands (Bond, 1936 and 1940). On the other hand, the Mourning Warbler which most, if not all, writers describe as reaching the United States by way of eastern Mexico and the coast of southern Texas, has been recorded three times from Florida (Howell, 1932); two of these records were in the spring. Frazar (1881: 251) saw "large numbers" of Mourning Warblers in migration 30 miles south of the mouth of the Mississippi River on April 22, 1881.[6]

There is additional ground for assuming that the Connecticut and Mourning Warblers are at least in part trans-Gulf migrants. Both have been noted in the spring in northern Louisiana, and both are fairly regular in their occurrence at Memphis, Tennessee, localities which are rather far to the west unless a more direct trans-Gulf flight is admitted. Furthermore, Sutton (1938) reports the taking of a male specimen of the Connecticut Warbler in western Oklahoma on May 18, 1937. This record is after all not so surprising when we recall that the species breeds as far west as Alberta. The earliest spring records for the Connecticut Warbler in northern Louisiana, at Memphis, and at Nashville (April 27, 27, and 21, respectively) are earlier than Burleigh's earliest record (May 7) for the species at Athens, Georgia (Burleigh, 1938). On the basis of the alleged "Florida flyway," Athens should get the vanguard of the migrants.

An additional point of considerable importance is the fact that the Connecticut and Mourning Warblers are late migrants. The earliest Florida record for the Connecticut Warbler is May 4, and the bulk of the records for that state are past the middle of May. In this latitude, distinct polar-front weather is less prevalent during May than during April, and hence species which migrate in late May are much less likely to be precipitated on the coast by local weather phenomena than are species which migrate during April. The absence of eastern Gulf coast records for the Connecticut Warbler is therefore not nearly so surprising as the lack of spring records for the Gray-cheeked Thrush and the Swainson's, Golden-winged, and Nashville Warblers at Pensacola, or the absence of spring records for the Warbling Vireo, Dickcissel, and Nashville Warbler at Gulfport. Various other birds that are far better known and in some cases much more easily detected than either the Mourning or the Connecticut Warblers have been recorded at none of the Gulf coast stations for many years, and yet no circuitous routes of migration have been proposed for them. It is thus apparent that undue emphasis has been placed on the absence of records for the Mourning and Connecticut Warblers in the lower Mississippi valley and along the Gulf

6 See Note 2, p. 95.

coast. This hiatus in the spring "occurrence" of these species represents, in all probability, nothing more than the area over which trans-Gulf migrants habitually pass before descending.

Weather and Migration Waves

Through the courtesy of Mexican weather authorities, I obtained limited but valuable information pertaining to the state of the weather on the Yucatan Peninsula and in the region bordering the Bay of Campeche on days (1939–1943) when certain weather phenomena are known to have occurred in the northern Gulf coast region (U. S. Weather Bureau, 1933–1943). A few of these cases are analyzed in Tables 4 to 9.

Many migrant North American birds are known to pass northward overland through Central America into southeastern Mexico, whence they depart for the United States via the trans-Gulf flyway. We can assume with fair certainty that, should clear weather prevail in the Yucatan-Campeche region, north-bound migrants would not accumulate there; that is, upon reaching the Bay of Campeche or the northern part of the Yucatan Peninsula, migrants would proceed directly across the Gulf.[7] So long as favorable conditions prevailed in both the Yucatan and Gulf coast regions, the steady flow of trans-Gulf migrants would continue far inland and descend over a comparatively wide area in the middle Mississippi valley. The hundreds of thousands of birds that stream across the Gulf flyway, even though dispersing widely upon alighting, insure any interior station, if far enough inland, a more or less smooth stream of north-bound migrants. But north Gulf coast regions would be almost, if not wholly, without transient migrants.

[7] An inferential basis for this assumption is supplied by our knowledge of what south-bound migrants do on the northern Gulf coast in fall prior to undertaking their return flight across the Gulf. Although the fall migration is known to be less hurried than the spring, migrants do not tend, as a general rule, to accumulate along the coast unless there are strong winds from the south. The subject of fall migration in this region will be discussed in detail in a later paper.

TABLE 4
The Weather and Migration, March 1–4, 1939

1939 March	Yucatan Peninsula	Gulfport, Mississippi	
	Weather	Weather	Migrants
1–3	Clear; SE wind	Cloudy; slight rains; S wind	None
4	[no data]	Polar-front weather: rains; NW wind	Large number of early migrants

[Interpretation: Between March 1 and 3 migrants leave Yucatan region under favorable weather conditions. Since they encounter favorable weather on reaching the northern Gulf coast, they continue northward over the coast, and no migrants are recorded there. On March 4 incoming migrants encounter head winds associated with advancing polar fronts and are precipitated on the first available land.]

TABLE 5

THE WEATHER AND MIGRATION, APRIL 23–MAY 4, 1940

1940 April	Yucatan Peninsula	Gulfport, Mississippi		Baton Rouge, Louisiana	
	Weather	Weather	Migrants	Weather	Migrants
23–24	Slight SE wind	Partly cloudy; S wind	Small number	Partly cloudy; SW wind	None
25	Same	Heavy overcast; rain; S wind	Small number	Partly cloudy; slight rain; variable NE wind	None
26	Same	Polar-front weather: cloudy; heavy rains; N wind	Record number	Clear; E wind	None

[Interpretation: Migrants, leaving Yucatan region under favorable conditions, at first encounter favorable weather north of the Gulf and continue inland, passing over the northern Gulf coast region as well as the middle region (represented by Baton Rouge). On April 26, however, migrants are precipitated by polar-front weather at Gulfport (and presumably elsewhere along the part of the coast covered by the polar front).]

1940 April	Yucatan Peninsula Weather	Gulfport Weather	Gulfport Migrants	Baton Rouge Weather	Baton Rouge Migrants
27	Light showers on E coast; SE wind	Clear; S wind	Almost none	Cloudy; SE and E wind	[no data]
28	Slight SE wind	Partly cloudy; S wind	None	Cloudy; SE wind	Almost none
29	Same	Partly cloudy; showers; S wind	None	Polar-front weather: heavy overcast; variable winds; 2.44 in. rain; electrical storm	Moderate number
30	Same	Polar-front weather: heavy overcast; heavy rain; strong S wind shifting to N	Moderate number	Continued polar-front weather	Large number

[Interpretation: Migrants precipitated on the coast on April 26 leave on April 27 and 28, when the weather clears, and pass over the middle region, where the weather continues fair. Since favorable conditions still prevail in the Yucatan region, the northward flow of migrants continues, and these pass over the coast as well as over the middle region until April 29, when polar-front weather precipitates migrants at Baton Rouge (and presumably along the entire polar front). The polar front moves southeastward, and on April 30, migrants are again precipitated at Gulfport.]

1940	Yucatan Peninsula Weather	Gulfport Weather	Gulfport Migrants	Baton Rouge Weather	Baton Rouge Migrants
May 1	Slight N wind	Continued polar-front weather: heavy rains; NW wind	Record number (notably on coastal islands)	Cloudy in forenoon; N wind. Clear later; SW wind	Record number
2	SE wind	Clear; N wind	Almost none	Clear; W wind	Record number
3	Same	Clear; N wind	Almost none	Clear; NW wind	Moderate number
4	Same	Clear	Almost none	Clear; SW wind	Almost none

[Interpretation: North wind over the Yucatan Peninsula on May 1 retards departure of migrants; hence, though a north wind prevails on the northern Gulf coast on May 2, there are few or no incoming migrants to be precipitated.]

TABLE 6

The Weather and Migration, March 25–29, 1942

1942 March	Yucatan Peninsula	Grand Isle, Louisiana	
	Weather	Weather	Migrants
25	Dry; SE wind	Cloudy; S wind	[no data]
26	Same	Same	[no data]
27	General showers; SE wind	Polar-front weather: heavy overcast; strong N wind	Large number

[Interpretation: Migrants leaving Yucatan region on March 25 encounter favorable weather on the northern Gulf coast, but those leaving on March 26 and 27 are precipitated in coastal areas by an advancing polar front.]

1942 March	Yucatan Peninsula Weather	Grand Isle Weather	Migrants
28	General showers; strong N wind	Skies clear; wind shifting from N	Record number
29	[no data]	Clear; S wind	Moderate number (apparently no new arrivals)

[Interpretation: Presumably almost no migrants leave the Yucatan region on March 28 in face of strong N wind and other polar-front phenomena, and hence no new arrivals are detected on the northern Gulf coast on March 29. Favorable weather in the Grand Isle region on March 29 permits resumption of northward flight by birds precipitated there on the two preceding days.]

TABLE 7

The Weather and Migration, April 7–11, 1942

1942 April	Yucatan Peninsula	Cameron, Louisiana	
	Weather	Weather	Migrants
7–8	SE wind	Cloudy; heavy rains; strong, variable S wind	[no data]
9	Scattered showers; SE wind	Polar-front weather: heavy rains; N wind	Record number
10	General rains; N wind	Continued polar-front weather	Record number increased by new arrivals
11	N wind	Skies clear; temperature rises; wind shifts to S	Record number

[Interpretation: The stream of migrants leaving the Yucatan region under favorable weather conditions is not interrupted until at least April 10. Encountering polar-front weather, the migrants are precipitated on the northern Gulf coast on April 9 and continue to accumulate there on April 10. The tremendous numbers recorded at Cameron on April 11 possibly included arrivals on that day, but it is probable that the change in weather in the Yucatan region stopped the stream of departing migrants on April 10.]

TABLE 8

The Weather and Migration, May 5–9, 1942

1942 May	Yucatan Peninsula	Gulfport, Mississippi	
	Weather	Weather	Migrants
5	Clear to slightly cloudy; SE wind	Clear; warm; S wind	None
6	Same	Cloudy; S wind	None
7	Same	Polar-front weather: rain; N wind	Large number
8	Rain on E coast and in N; N wind	Skies clear; S wind	Small number
9	[no data]	Clear; warm; S wind	Almost none

[Interpretation: Migrants leaving Yucatan under favorable conditions on May 5 and 6 encounter similar conditions on northern Gulf coast and consequently pass inland over the coast before descending. On May 7 incoming migrants are precipitated by a polar front that advances to the Gulf coast on that date. Effects of polar front extend to Yucatan region on May 8 and stop the northward flow of migrants; at the same time fine weather on the northern Gulf coast causes the migrants precipitated on May 7 to resume their flight northward; and the region is then almost without migrants.]

TABLE 9

The Weather and Migration, April 14–20, 1943

1943 April	Yucatan Peninsula	Gulfport, Mississippi	
	Weather	Weather	Migrants
14–15	Cloudy; scattered showers; N wind	Cloudy; S wind	None
16	Cloudy; SE wind	Cloudy; intermittent rain; strong SE wind	One
17	Same	Same	Small number
18	Same	Same, but more unsettled	Moderate number
19	General rains, heavy on E coast; strong NW wind	Polar-front weather: heavy rains; strong NW wind	Record number
20	[no data]	Clear; cold; wind shifting to S	Small number

[Interpretation: On April 14 and 15 weather conditions prevent departure of migrants from the Yucatan region. At least some migrants leave on April 16 and 17 with the improved weather, and a few are precipitated on the Gulf coast on April 17. (Since the weather is semi-favorable along the coast, some migrants may proceed inland.) As the weather becomes more unfavorable, increasing numbers pile up on the coast until April 20, when there are no new arrivals because unfavorable weather in the Yucatan region has again prevented departure of migrants, and favorable weather on the northern Gulf coast permits the accumulated migrants there to resume their northward flight, thus emptying the region of its migrant bird life.]

Thus, with clear weather in both the Yucatan-Campeche and the Gulf coast regions, one may walk the length of Grand Isle, or search the woods about Baton Rouge or any other locality in the extreme lower Mississippi valley region, and not find a single transient migrant. This has been done time and again by all Gulf coast observers—not just for one day, but day after day so long as fine weather prevails.

Now let us assume that a polar front advances from the north and reaches the Gulf coast. The coastal islands and other coastal regions are then flooded with migrants. The migrants behind the polar front drift on northward. If the weather clears rapidly, the migrants retarded along the coast by the weather barrier leave almost simultaneously, and their first flight carries them far inland, over an extensive area of the coastal region. Ornithologists in the general area in which the major part of the flight finally descends record the appearance of a "wave."

On the other hand, let us suppose a period of inclement weather in the Yucatan-Campeche region. Just as south-bound migrants tend to accumulate on the northern Gulf coast in the fall in the face of bad weather, so, presumably the north-bound migrants accumulate in the Yucatan-Campeche area in the spring. This results in not only a large assemblage of individuals, but also a wide variety of species. Assuming that on the advent of clear weather a considerable part of the accumulated hordes start across the Gulf almost simultaneously, it is apparent that some section of the Mississippi valley region will shortly receive a large and diversified wave of migrants. Since, during the preceding days of bad weather, no migrants have crossed the Gulf, and since birds which crossed ahead of the bad weather have progressed far northward during the lull, the resumption of even the usual flow of migrants across the Gulf would produce a distinct wave; but this particular flight will contain not only the migrants of the usual steady stream, but also those which have accumulated during the bad weather in the Yucatan region. If, then, this flight encounters a new polar front as it crosses the Gulf, the precipitation on the northern Gulf coast will greatly exceed the precipitation resulting from the stopping of just the daily clear-weather flow of migrants.

This alternate passing over or dropping down of migrants that is recorded in the Gulf regions breaks up what would otherwise be a steady flowing stream of migrants, and waves of migrants result. There seems to be little doubt that this is an important factor contributing to the wave characteristic of northward migration which many writers have noted. The great fluctuations discernible in the southern states must extend in their effects considerable distances up the Mississippi valley and possibly throughout the eastern United States. However, the stupendous number of migrants moving up the valley would seem to have a tendency to produce a smoothing-out effect on the flow of migrants. As far north as Memphis, for instance, there is a more or less continuous stream of migrants, with only minor interruptions.

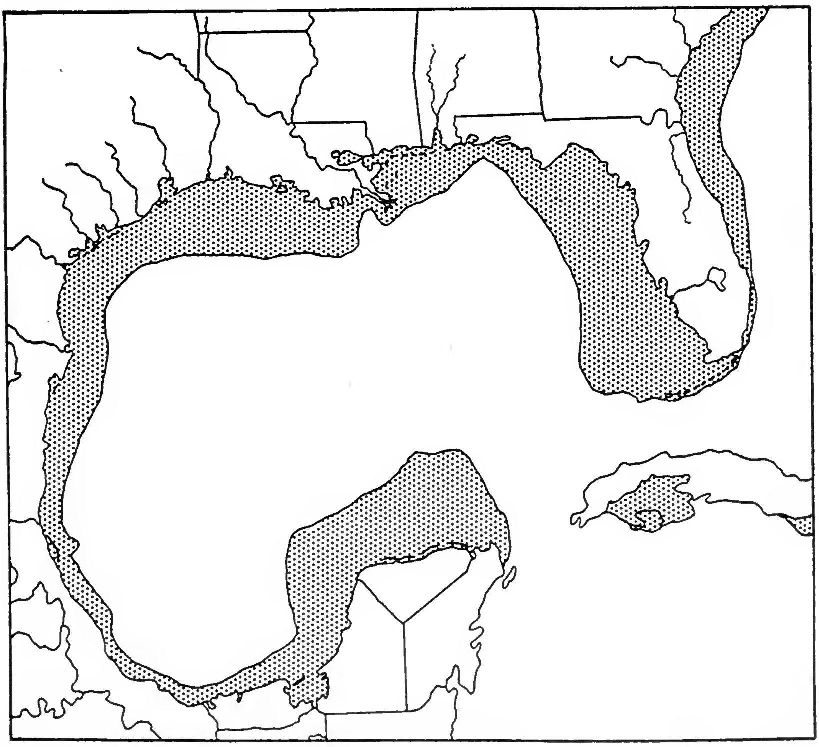
Of course, as birds progress up the valley, weather conditions might tend to retard migrants in this or that region, and new waves might result. However, waves in the upper Mississippi valley are apparently not comparable in intensity with waves on the Gulf coast. I have seen no account from northern regions which reports a complete absence of migrants once the spring procession has begun.

Geological Considerations

Ornithologists in general agree that the basic pattern of bird migration is closely correlated with Pleistocene or Ice Age history. Specific events in the Pleistocene history of the Gulf coast may or may not have a direct bearing on the present-day Gulf coast hiatus in migration, but they constitute a very interesting basis for cautious speculation.

The land bordering the Gulf of Mexico was by no means stable or fixed during late geologic time; it was, on the contrary, subject to frequent and radical alteration, a fact which must have had more than a minor influence on the pattern of trans-Gulf migration.

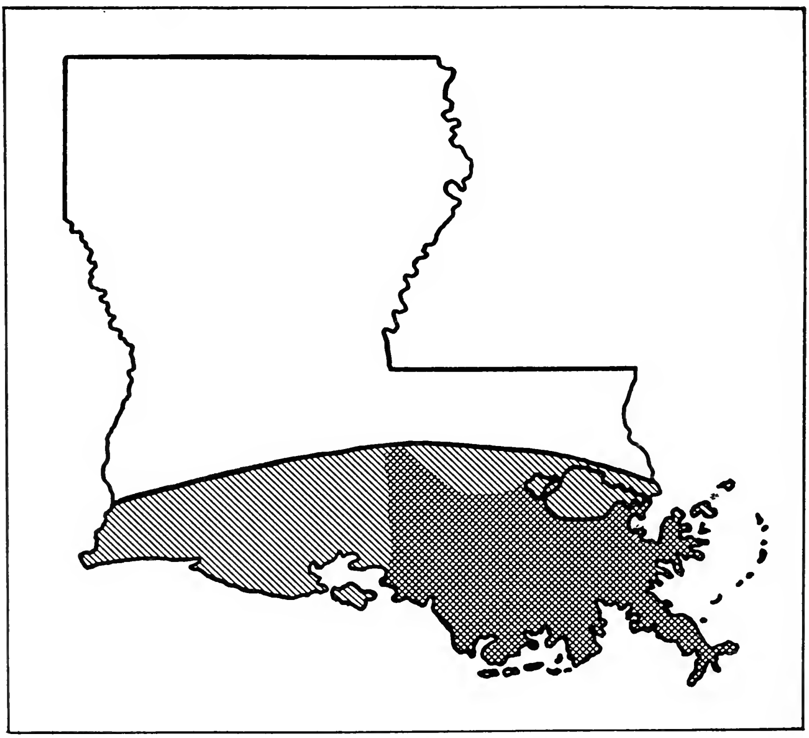
During the major glacial stages of the Pleistocene, the seas were lowered approximately 400 feet as a result of evaporation and subse-



Map 3. The Gulf coast. Dotted areas show the approximate extension of the coast during the maximal lowering of the seas in the major glacial stages of the Pleistocene. (Based on the 400-foot contour of bathometric charts.)

quent deposition of moisture as land-covering ice. This lowering of the seas effected great changes in the size and shape of the Gulf of Mexico and the adjacent land. Plotting the 400-foot contour of the Gulf, as is done in Map 3, presents a fairly accurate picture of the shore line of the Gulf during the maximum ice advance in each of the glacial stages. Florida, for instance, was in some places about twice as broad as it is today; southwestern Louisiana extended some 100 miles beyond its present limits; and the Yucatan Peninsula extended farther northward. That is, at the time that northern birds were being forced into the south, the Gulf was a much smaller body of water and hence much easier to cross.

During the interglacial stages, the melting ice of the retreating glaciers slowly refilled the seas, and it is possible that on occasions the level of the sea was somewhat higher than it is at the present day. Following the last, or Wisconsin, Glacial stage, the level of the Gulf rose rapidly for a period until the Gulf extended a considerable distance up



Map 4. Louisiana. Hatched area shows the approximate encroachment of the Gulf of Mexico during the interglacial stages of the Pleistocene. Cross-hatching represents the "Mississippi Embayment" which occurred about 7,000 years ago.

what is now the Mississippi delta region, reaching a point almost as far north as Baton Rouge (Map 4). Thus a considerable part of the "coastal hiatus" area was at times under water.

Summary

In the spring, during favorable weather, trans-Gulf migrants that do not breed in the Gulf coast region or in the lower Mississippi valley do not come down immediately on reaching land but fly far inland before descending.

During unfavorable weather, incoming migrants of all types are precipitated, sometimes in tremendous concentrations, on the first available land. They pile up on coastal islands and cheniers, at times even in coastal marshes and other unfavorable places.

Migrants which are forced by weather to stop on the shores of the Gulf coast resume their northward flight with the first favorable weather and pass over a vast area of the southern United States before again descending.

Since, depending on the state of the weather, incoming migrants either fly far inland or descend on the very edge of the Gulf coast, the intermediate area becomes an extensive "hiatus" in the path of the trans-Gulf flyway. Within this area, transient migrants are extremely rare, highly intermittent in their occurrence, or even wholly absent during many consecutive spring migrations.

The lack of spring records from the Gulf coast and the lower Mississippi valley for certain species is shown to be an insufficient basis for assuming that they are not trans-Gulf migrants.

Trans-Gulf migrants that breed in the Gulf coast region and in the lower Mississippi valley are regular in their arrival at their breeding grounds, although they may be rare or absent at places a few miles away.

Analysis of weather conditions in the Yucatan-Campeche region preceding specific dates on which migrants are known to have been precipitated on the coast of the United States because of weather barriers reveals that, in all cases examined, birds left the Yucatan-Campeche region under auspicious conditions. For those periods when unfavorable weather is known to have extended across the Gulf to the Yucatan-Campeche region, the available evidence shows that the northward flow of trans-Gulf migrants was stopped, only to be resumed, and in increased magnitude, when the weather permitted.

The data indicate that the "waves" characteristic of spring migration in the Mississippi valley are caused primarily by two factors, both dependent on weather conditions: the alternate passing over or dropping down of migrants that is recorded in the Gulf regions; and the recurrent interruptions of the stream of migrants leaving the Yucatan-Campeche region.

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ON THE HABITS AND NEST OF THE ANT-THRUSH *FORMICARIUS ANALIS*

BY ALEXANDER F. SKUTCH

IN THE lofty forests of the lowlands of Costa Rica and Panama, one of the most distinctive bird notes is the mellow, resonant whistle, usually twice repeated, of the ant-thrush (*Formicarius analis*). The bird-watcher may hear the triple whistle a score of times before he catches a glimpse of the dark-colored, long-legged bird of about the same size and much the same aspect as a small rail. Alert and wary, one of these birds will usually detect the approach of an intruder while still some distance away, and will quietly disappear through the undergrowth—using its legs rather than its wings for locomotion. With dainty, deliberate steps, it walks over the litter of the forest floor, the short, abruptly erect tail tilting forward with each step. The dark brown, black, olive, and gray of the plumage blend so well with the fallen dead leaves of the background that whenever the bird pauses for a moment its form can be distinguished only with difficulty in the dim light that has been filtered through more than a hundred vertical feet of heavy foliage. (The Panama Ant-thrush, *Formicarius analis panamensis,* and Hoffmann's Ant-thrush, *F. a. hoffmanni,* are rather similar in appearance, and I have detected no difference in their voice or behavior.)

This ant-thrush has a fairly varied vocabulary. The call it most often uses is the triple whistle with the first note of the series longest and loudest, the whole sounding a trifle wistful or melancholy to human ears. But at times the bird voices a longer sequence of these whistles—rarely as many as ten. It will hesitantly approach the man who cleverly imitates this call—in fact, the first ant-thrush I ever saw was called out of the undergrowth of the forest on Barro Colorado Island by Dr. Frank M. Chapman. When alarmed, this ant-thrush utters a sharp, clear, somewhat explosive *tleet,* sometimes repeated in a continuous sequence. The note is quite as characteristic of the bird as its whistle; it cannot easily be confused with the call of any other bird of the forests where this ant-thrush dwells.

Formicarius analis is as strongly attached to the ground as any rail. I have never seen birds of this species perch on a bough; and they are quite as reluctant to fly as the forest quails (*Odontophorus*) among which they live. It is unfortunate that the most terrestrial of all antbirds should be the type genus of the family, for the majority of the Formicariidae are arboreal and are only rarely seen on the ground; they live in the lower half of the forest, or else in thickets and bushy growth. Even the species that forage with the army ants hop down briefly to snatch an insect from the forest floor, then promptly rise again to some low perch where they watch and wait for another victim. Yet the strong-legged ground-foraging antpittas of the genus *Grallaria* hop rather than walk and thus clearly link the numerous arboreal members of the family with the terrestrial *Formicarius*.

On January 23, 1931, on Barro Colorado Island, Canal Zone, I was walking along the Armour Trail through heavy forest when I observed a Panama Ant-thrush foraging not far ahead of me. I stopped short, and the bird, apparently undisturbed, continued to hunt for food in the middle of the pathway, then moved off to one side where the ground vegetation was so sparse that I could easily observe all its movements. Still assiduously hunting, it worked around in a circle that led it back to within three yards of where I quietly stood; it picked up a few morsels there, then deliberately walked away and was lost to view amid the undergrowth. While foraging, it picked from the ground and swallowed small objects that I could not identify; and often with its rather short, black bill it flicked aside fallen leaves in search of its food [1]—a habit also of the antpittas (*Grallaria*) and the Bicolored Antcatchers (*Gymnopithys bicolor*)—but it never scratched with its feet.

I have more extensive notes on Hoffmann's Ant-thrush, which inhabits the Pacific side of southern Costa Rica, ranging from sea level up into the mountains to at least 3,000 feet. On April 30, 1942, I spent many hours in a blind on the forested ridge that rises steeply behind my home in the Térraba Valley in southern Costa Rica. I was watching the nest of a pair of Ruddy Quail Doves (*Oreopeleia montana*), built amid the rather dense undergrowth. About the middle of the morning, I heard the mellow triple whistle, then the sharp *tleet tleet*, of an ant-thrush. Soon through the little rectangular window at my right, I glimpsed the shy bird—the first of the kind I had seen in the six months I had spent in these forests. It had caught a small snake, brownish above and bright coral-red below, a little less than a foot in length, and was pecking it and knocking it about on the ground with its bill. It continued this for a good while, until presently another ant-thrush—probably the mate of the first—hurriedly approached as though to take the snake. To my great disappointment, the intervening undergrowth prevented a full view of what ensued; but I could see that the snake, still squirming, was pecked and shaken a good while longer, until at last both ant-thrushes and victim were lost to view amid the undergrowth. Since other antbirds give food to their mates—I have seen the Spotted Antbird (*Hylophylax naevioides*), the Antwren (*Microrhopias quixensis*), and others do this—I should not be surprised if the snake passed from one bill to the other before it was devoured.

On May 21, 1942, as I searched for nests through the undergrowth of another part of the forest in which I had seen the birds with the snake, a Hoffmann's Ant-thrush flew in front of me, startling me with

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[1] Van Tyne (1935:28) found the food of *Formicarius analis pallidus* in Petén to consist of "snails and a few beetles."

its clear, sharp, metallic *tleet,* several times repeated, and in a trice vanished amid the bushes, saplings, and low palms of the underwood. I did not see the bird at the moment it took wing; but its line of flight had led from a low, moss-covered trunk, scarcely more than a hollow shell. On one side of the trunk the bark had broken away and hung loosely from above, leaving a wide gap that ended at about the level of the top of my head. I pushed into this gap the little mirror I always carry in my pocket for such contingencies, and it showed a cavity extending far down into the stump. I could see no sign of nest or eggs, but I clung to my impression that the bird had flown from the trunk.

Returning two hours later, I approached the stump slowly, keeping my eyes upon it, but making no effort to move silently. When I was still five or six yards distant, the head and foreparts of an ant-thrush were suddenly thrust out through a small gap in the hollow shell, beside the larger and more obvious one already mentioned. Clasping with its feet the opposite edges of the long, narrow aperture, the bird regarded me deliberately with large brown eyes, and rested there motionless, giving me an excellent opportunity to examine it through the field-glasses. Its crown was a dark, nondescript shade of brown; but its nape was bright rufous, and this color extended far down on the sides of the neck, forming a collar interrupted in front by the black throat. The brown eyes were surrounded by bare bluish skin. I moved a step forward, and the bird darted out and down, voicing its sharp *tleet tleet* call of alarm. I was elated by my discovery, the most exciting of the year.

The slightly leaning, hollow trunk was about 12 feet high and 7 inches thick. It was covered with green moss; a few aroids and small ferns were growing on it here and there. A stout woody vine which twined round it led up to the lower boughs of a neighboring tree. The central hollow was entered from above by the larger gap, facing south, which I had first noticed, whose lowest point was six feet two inches above the ground. Beside this and facing east was the smaller gap, which extended two inches lower.

I piled some logs at the base of the trunk and stood upon them for a more careful examination of the central hollow. The light beneath the trees was somewhat stronger now that the sun was higher; and in the mirror I could discern, or thought I could discern, two eggs lying very far below. To see them plainly, artificial illumination would be necessary. The same afternoon I brought an electric torch with a long cord and a bulb attached, which I hung in the hollow. Now I could clearly see the nest and eggs.

The two eggs rested approximately two feet below the entrance, or about four feet above the ground. They lay, as at the bottom of a well, upon a mat of dark brown material that filled the lower part of the deep, narrow cavity. They appeared to be white, very finely and faintly stippled over the whole surface with brown, but it was impossible to make certain of these details from the reflected images of the distant, artificially illuminated eggs. The bottom of the cavity was so dark even at midday that they could be seen only very dimly in the mirror when the light was extinguished.

When I had completed my examination of the nest, I set up my brown wigwam before it in order to begin the study of the habits of the ant-thrushes the following morning (May 22). This is the record I made:

5:15 A.M. While the light is still dim in the forest, I enter the blind before the nest. As I go in I hear the sharp *tleet* alarm-call of an ant-thrush. Evidently it took fright and flew from the nest.

5:33. An ant-thrush silently flies up and enters the trunk through the small gap facing the east. It enters in one continuous motion, without the careful inspection of cavity and surroundings practiced by woodpeckers, trogons, and most other hole-nesting birds.

7:22. The mate, arriving silently from the north through the undergrowth, suddenly flies up and enters the trunk by the smaller gap. It is silent save for the whirring of its wings. Almost at once an ant-thrush (doubtless the one which has been incubating) appears in the small gap and stands facing outward in the opening, where a sunbeam, filtering through the forest canopy, falls full upon it. The bird calls, delivering an emphasized first whistle and about 10 following whistles; then it flies off to the south.

8:15. An ant-thrush suddenly enters exactly as at 7:22. Two minutes later a bird appears in the cavity behind the entrance and rests there, looking out. After a while, it descends below the doorway. Twice again an ant-thrush appears in the doorway, then descends—pausing for a time before the last descent. Finally an ant-thrush appears and stands in the large gap facing south.

8:28. It flies silently away.

11:27. This bird silently approaches, flies up and enters. An ant-thrush (the mate?) almost at once appears in the doorway, stands there a few moments looking around, then flies silently away. I now leave the blind and approach the nest; the other ant-thrush darts out and away, calling sharply: *tleet tleet tleet.*

Since the sexes of the ant-thrush are indistinguishable in appearance, it was not possible to determine exactly the part taken in incubation by male and female. But I think it a fair conclusion that at 7:22 and again at 11:27 nest-relief took place—that the bird that entered was not the one that immediately afterward emerged. It is not easy to decide whether the ant-thrush that flew away at 8:28 was the same one that arrived at 8:15, or the mate. Since the bird that occupied the nest when the other came at 8:15 had been incubating for less than an hour, it is possible that it refused to make way for its mate, which then lingered in the top of the hollow awaiting the other's departure but finally grew tired and flew away. It is not unlikely, however, that the one that had been incubating did relinquish the eggs to the other but delayed its own departure, not yet feeling hungry.

The ant-thrushes' periods of sitting ranged from an hour and 49 minutes to 3 hours, or a little less. If there was no change-over at 8:15, then one bird sat continuously for 4 hours and 5 minutes; but we cannot be certain of this. Antbirds as a rule take long sessions on the eggs, male and female replacing each other infrequently. Even the smaller species often sit for two or three hours without interruption; and once I watched an Antpitta (*Grallaria perspicillata*) incubate for five hours without a break. At least in those species in which the sexes can be distinguished, the male usually takes somewhat longer sessions on the eggs by day than the female; but the female sits through the night. The ant-thrush coming to take its turn on the eggs always arrived silently, without signaling to its sitting mate. The outgoing partner usually flew off in silence, but once one of the birds called long and loudly from the doorway before flying out. When frightened from the nest by my approach, however, they almost invariably voiced sharp notes of alarm as they flew away. Their flight upon leaving the nest was strong, swift, and direct, gradually descending, reaching the ground a good distance from the hollow trunk.

I never attempted to remove the eggs for closer examination and measurement, for this would have been impossible without enlarging the gap in the side of the hollow trunk and placing the nest in jeopardy. From long experience in the tropical rain forest, I knew that this nest, cunningly concealed though it was, stood only a slight chance of escaping predators until the young were fledged; and I refrained from making any alteration that would decrease the probability of its success. But I came each day with light and mirror to see whether the eggs had hatched.

On May 27 the mirror revealed that the two eggs had hatched since the preceding day. The empty shells had already been removed. These were most surprising nestlings to find in an antbird's nest. All the other newly hatched antbirds I have seen—11 species in 7 genera—were as completely naked as newly hatched vireos, but these baby ant-thrushes were covered, on the upper parts at least, with long, dense down that seemed far more compact than that on most passerine nestlings, and by artificial light was dark gray. I inserted my arm into the cavity up to the shoulder, but the nestlings lay beyond my finger-tips.

Without enlarging the entrance, I would not be able to reach them; so I contented myself with examining them in the mirror. Viewed from above, they appeared as completely and as warmly clad with down as newly hatched rails; but when from time to time they squirmed about, they revealed glimpses of pink, naked skin on the neck and underparts. Most of the time they lay motionless, huddled into a single, dark gray, downy mass. But at intervals one would move, and the other make a swift answering movement to bring it once more into close contact with its nest mate.

I had hoped to watch the care and development of the young ant-thrushes; but their concealment, which to me seemed so excellent, was yet not sufficient to shield them from discovery by one of the many enemies of nesting birds that lurk in the tropical forest. Or perhaps on my visits I had left scents which led the sharp-nosed coatimundi or some other mammal to investigate the hollow stump. At all events, upon visiting the nest on May 30 I found the trunk torn open and the nestlings gone.

I tore out the side of the hollow shell to expose the ant-thrushes' nest. The bottom of the cavity was filled to a depth of about 14 inches with a loose mass of dead leaves of many kinds, chiefly dicotyledonous, but including some strips of palm fronds. The largest leaf measured 5 inches long by 3¼ inches broad. At the top, the leaves were mixed with slender dead petioles and flower stalks. Upon this filling rested the nest proper, a thick mat consisting largely of petioles and flower stalks, mixed with a number of long, slender, yellowish flowers, too far decayed for identification, and a few ventral scutes of a big snake.

Antbirds' nests are typically open, hemispherical structures, often suspended between the arms of a forked horizontal twig, vireo-wise. In none of the numerous open antbirds' nests that I have examined has there been any snakeskin. So too with wrens: house wrens (*Troglodytes* spp.) and Bewick's Wrens (*Thryomanes bewickii*), which breed in cavities, frequently place a bit of cast snakeskin in their nests; but the many wrens that build roofed nests in trees or bushes rarely if ever use this material. The Crested Flycatcher and other species of *Myiarchus* often take pieces of cast reptile skin into the cavities where they lay their eggs; but among the flycatchers that build nests in the open, the Arkansas Kingbird (*Tyrannus verticalis*) is exceptional in employing exuviae. The castle-builders (*Synallaxis* spp.) collect for their nests a great deal of the cast skins of both snakes and lizards; but although these birds do not nest in cavities, they construct relatively huge edifices of sticks in which they build the nest proper—much as a wren builds in a box provided for it. Thus reptile skins are quite commonly used by passerine birds that lay their eggs in cavities, very rarely by those that nest in the open. The theory has been advanced that birds place exuviae in their nests as scarecrows to ward off the attacks of predatory creatures, but I find it difficult to believe that a few ventral scutes of a snake lying at the bottom of a dark cavity could be of service in frightening away any animal, however small. Yet the snake scales were not an integral part of the nest, and in view of their common use by hole-nesting species I believe that reptile skins, as such, must have some significance for the birds which is obscure to us.

I have published an account (Skutch, 1934) of the nesting of the Slaty Antshrike (*Thamnophilus punctatus*); subsequent studies, still in manuscript, of a number of other species and genera show that the open nest and naked young of this bird are fairly typical of the antbird family. Van Tyne (1944) found the hole-nesting habit described in only two genera of antbirds, *Gymnopithys* and *Formicarius.* Cherrie (1916) described a nest of *Formicarius colma* found on the Orinoco in March, 1899, which was in a natural cavity in a tree trunk and contained two pure white eggs. He also reported that *Formicarius analis saturatus* nests in holes in trees (Cherrie, 1908:366). Cleaves (1944) figures the nest, also a tree cavity, of *F. a. panamensis.*[2]

Thus *Formicarius analis* differs from the majority of other antbirds in its manner of reproduction as well as in its terrestrial habits. It nests in a cavity instead of in the open; and the young upon hatching are covered with down instead of being quite naked. It agrees with the more typical antbirds in laying two eggs (a number that appears to be as constant in this as in the hummingbird and manakin families) and in the participation of both sexes in incubation.

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[2] Carriker (1910) ascribed to *F.* [*analis*] *umbrosus* a frail open nest, containing a single egg that was dark greenish-olive, heavily blotched with different shades of burnt umber; but it would be most surprising if there really exists among closely related species such wide variation in nest and eggs.

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Finca 'Los Cusingos,' San Isidro del General, Costa Rica

GENERAL NOTES

The display of the Maned Goose.—In a recent paper, "The Family Anatidae" (*Wils. Bull.* 57, 1945:3–55), Ernst Mayr and I suggested (p. 31) that the Maned Goose (*Chenonetta jubata*—called "wood duck" in Australia) is closely related to the Carolina Wood Duck, *Aix sponsa,* and even more closely to the Mandarin, *Aix galericulata.* In habits and behavior, it resembles them nearly; and in pattern, the downy young is strikingly similar to that of *Aix galericulata.* In display, the relationship is also apparent, and I have recently been able to make further observations on this point. The New York Zoological Society possesses a single Maned Goose, an adult male. Since early March (1945—it is now May), he has been constantly displaying—both more elaborately and more persistently than is usually the case with a mated bird. His display on the water resembles very nearly that of a Mandarin drake, as described in "The Family Anatidae," page 30. He puffs out the feathers of his head and breast and holds his head back, pressing it down tightly among the interscapular feathers, completely hiding the neck; at intervals he slowly lowers his head toward the water, then throws it back quickly.

Either I had never seen the *Aix* type of display so well marked in *Chenonetta* (See p. 31 of "The Family Anatidae"), or the notes on the observation were lost when my files were destroyed by fire in 1939, and I therefore think it advisable to record this additional confirmation of the close relationship between *Chenonetta* and *Aix.*—Jean Delacour, *New York Zoological Society, Zoological Park, New York 60, N.Y.*

Crow killed by a Red-tailed Hawk.—On May 18, 1945, at 8:30 A.M., I noted an adult Red-tailed Hawk (*Buteo jamaicensis*) with a Crow (*Corvus brachyrhynchos*) in its talons. The hawk was perched in a tree near the Swan Creek Wildlife Experiment Station, Allegan County, Michigan; as I approached, the hawk relinquished its prey and flew off. I examined the crow and found it dead but still warm. There were numerous talon marks in the skin and flesh at the base of the skull and in the upper neck. Hawk predation on crows is apparently quite uncommon.—Philip Baumgras, *Swan Creek Wildlife Experiment Station, Allegan, Michigan.*

Some West Virginia breeding-season records.—The following records have accumulated during occasional field work in West Virginia since 1930. For information on the West Virginia status of several of the species treated here, I am indebted to Maurice Brooks.

Swainson's Warbler, *Limnothlypis swainsonii.* On July 2, 1944, George H. Breiding and I visited three Swainson's Warbler territories which John Handlan had found on the southwest edge of the city of Charleston, Kanawha County, West Virginia. Although including a small stream and an occasional rhododendron and mountain laurel, these territories, with second-growth deciduous trees, a few pines, and rather open clumps of mixed shrubs, saplings, and vines, are hardly to be compared with the dense streamside rhododendron thickets which make up the breeding territories of Swainson's Warbler in the Kentucky and West Virginia mountains. One of the three males was silent; the second sang regularly, but we could find neither female nor nest; the third sang occasionally but, during the 70 minutes of our observation, did not leave his favorite haunts to join a female which was caring for two juvenile birds (about five days out of the nest) a hundred yards up a steep slope. Two or three observers have reported fledglings in West Virginia, but no occupied nest has yet been found there.

Sycamore Warbler, *Dendroica dominica albilora.* I have spent considerable time searching for this species during the breeding season in the western counties of West Virginia, where it is decidedly rare. On May 28, 1939, I found a nest (with one egg and three newly hatched young) at a height of 30 feet in a small clump of sycamores along Mud River, about four miles east of Huntington, Cabell County. According to Maurice Brooks this is the first nest record of the Sycamore Warbler for West Virginia, although the state is included in the breeding range of the species in the 1931 A.O.U. Check-List. In 1937 and 1938 I found pairs in Wayne and Putnam counties. Others have recorded the species in Kanawha, Cabell, and Mason counties, extending its known range in West Virginia to five western counties. The eastern race (*Dendroica d. dominica*) has not yet been recorded for the state.

Sutton's Warbler, *Dendroica potomac.* On June 21, 1944, George H. Breiding and I discovered an adult male of this form along a stream 18 miles west of Martinsburg, Morgan County, in the eastern panhandle of West Virginia. This adds a new county to the distribution and a new type of habitat, since the territory occupied contained considerable hemlock along with a few scattered southern pines. We followed the bird for more than an hour at close range under good conditions for observation. The plumage details as figured by Sutton (*Cardinal,* 5, 1940:plate opp. p. 49) were clearly visible. It sang almost continuously, sometimes the "double" Parula song as described by Haller (*Cardinal,* 5, 1940:49), at others, the normal Parula song with a "freak" ending—stopping suddenly with a soft insect-like note which suggested that the bird had been "submerged" or had suffered muscular collapse. No mate was observed; in fact, we gathered the impression that we were watching an unmated bird. Its territory was about 800 by 300 feet, lying on either side of a stream and including steep banks and numerous "singing trees." Other warblers in song near by included a Blackburnian, a Magnolia, a Worm-eating Warbler, and several Redstarts and Parulas. This is the fourth known record of this warbler. In addition to the two specimens taken by Haller in Berkeley and Jefferson counties, a third bird was observed by Bayard H. Christy and Maurice Brooks (*Cardinal,* 5, 1942:187-189).

Dickcissel, *Spiza americana.* The A.O.U. Check-List records the Dickcissel as "extremely rare and irregular east of the Alleghenies." On June 22, 1944, George H. Breiding and I collected a singing male (with enlarged testes) two miles southwest of Kearneysville, Jefferson County, in the eastern panhandle. We did not look for a nest, but the Dickcissel was obviously nesting in a small field of mixed alfalfa and timothy. The specimen was given to the museum of West Virginia University. This record is the first for West Virginia east of the mountains. Summer records elsewhere in West Virginia are as follows: (1) two birds in Upshur County in 1914 (A. B. Brooks); (2) two pairs in May and June, 1916, near Bethany, Brooke County (Sutton, *Cardinal,* 3, 1933:121); (3) one bird near Cranesville, Preston County, June 3, 1936 (Ruth and Maurice Brooks); (4) a colony in Mason County during the summer of 1938 (Karl Haller).

Henslow's Sparrow, *Passerherbulus henslowi.* On July 7, 1935, I obtained the first record of this species for West Virginia, a breeding male (western race) taken in Mason County (*Wilson Bulletin,* 50, 1938:291). The eastern race has since been found to be quite common in eastern West Virginia. Both races have increased phenomenally during the last 10 years, and they now occur regularly in many localities. Since 1938 I have found them in some numbers in a dozen scattered counties and discovered two nests in Preston County. Two singing males seen June 13, 1944, at Tomlinson Run State Park, Hancock County, are among the first records for the northern panhandle. To date, the population build-up in West Virginia parallels that in Ohio, though occurring 20 years later. In Ohio this bird made the transition from rarity to extreme abundance in less than 20 years.

Eastern Lark Sparrow, *Chondestes grammacus grammacus*. On June 22, 1944, I discovered an adult, followed by two recently fledged young, on a dry limestone-studded slope west of the Potomac River and six miles north of Shepherdstown, Jefferson County. Breeding records of this species east of the mountains are rather rare.—LAWRENCE E. HICKS, *Ohio State University, Columbus, Ohio.*

Bird remains from an Indian village site in Ohio.—In 1917 Mills ("Certain Mounds and Village Sites in Ohio," Vol. 3, Pt. 1, p. 46) reported six species of birds from the Feurt Village Site which is located about five miles north of Portsmouth in Clay Township, Scioto County, Ohio, just east of the Scioto River. From 1937 to 1942, excavations for archaeological specimens were carried on at this site by Dr. Stanley Copeland, H. R. McPherson, and Philip Kientz, of Columbus, Ohio, who generously allowed me to study the animal remains that they recovered there. The material is presumed to date from the fifteenth or the sixteenth century.

From among the remains 646 bird bones were identified; 439 are from the Turkey, but altogether, at least 30 species of birds are represented. Eight of these have been reported by Alexander Wetmore (1943, *Wils. Bull.,* 55:55 and 127) to whom I am indebted for assistance in identifying most of the bones. The complete list of birds now known from the site is as follows:

Common Loon
Gavia immer
Pied-billed Grebe
Podilymbus podiceps
Great Blue Heron
Ardea herodias
Trumpeter Swan
Cygnus buccinator
Canada Goose
Branta canadensis
Blue or Snow Goose
Chen sp.
Mallard
Anas platyrhynchos
Black Duck
Anas rubripes
Blue-winged Teal
Anas discors
Wood Duck
Aix sponsa
Ring-necked Duck
Nyroca collaris
Lesser Scaup Duck
Nyroca affinis
Red-tailed Hawk
Buteo jamaicensis
Red-shouldered Hawk
Buteo lineatus
Bald Eagle
Haliaeetus leucocephalus
Marsh Hawk
Circus cyaneus hudsonius
Ruffed Grouse
Bonasa umbellus
Prairie Chicken
Tympanuchus cupido
Bob-white
Colinus virginianus
Turkey
Meleagris gallopavo
Little Brown Crane
Grus canadensis canadensis
Sandhill Crane
Grus canadensis tabida
Woodcock
Philohela minor
Passenger Pigeon
Ectopistes migratorius
Great Horned Owl
Bubo virginianus
Barred Owl
Strix varia
Flicker
Colaptes auratus
Pileated Woodpecker
Ceophloeus pileatus
Ivory-billed Woodpecker
Campephilus principalis
Raven
Corvus corax
Crow
Corvus brachyrhynchos.

—ROBERT GOSLIN, *Department of Physiology, Ohio State University, Columbus, Ohio.*

The formation of pellets by the Barred Owl.—An adult female Barred Owl (*Strix varia*) from Tulsa, Oklahoma, was used in the following investigation of pellet formation, which was made in 1939 in the University of Michigan Laboratory of Vertebrate Biology at the suggestion of the Director, Lee R. Dice.

Deer mice (*Peromyscus*) were supplied to the owl as its only food, always in numbers exceeding its maximum nightly consumption. The pellets regurgitated by the owl were collected each day, stored, and examined later to determine the number of mice in each pellet. The number of pairs of mandibles each pellet contained was used as an index to the number of mice that went into its formation, since the mandibles are especially resistant to digestion and are easily identified. It was assumed that the parts of a mouse were not dissociated in digestion; that is, when both mandibles were present in any pellet, it was assumed that the remains of the whole mouse were there. Careful examination of all the bones in a number of pellets showed that this assumption was justified in general, though it could not be proved in every case, and it is possible that there was a certain amount of dissociation.

The owl ate 149 mice (all adult, or of near adult-size) between January 7 and March 25, an average of 1.9 mice per night. Of these, 148 mice, or 99.3 per cent, were counted in the pellets, which varied in size as follows: 68 pellets were small, and each contained the remains of a single mouse (46 per cent of the total mice consumed); 28 medium-sized pellets contained the remains of two mice each (38 per cent of the total mice); 8 pellets of large size carried the remains of three mice each (16 per cent of the mice). Pellets were always regurgitated within eight hours after a meal. Pellet size was apparently not determined by the number of mice taken at a feeding: the owl was occasionally observed in pellet regurgitation, and several times two or three small pellets, each containing the remains of a single mouse, were expelled at brief intervals.

When first regurgitated, a pellet is a solid, moist mass of closely packed hair and skeletal remains, held firmly together by a mucilaginous secretion. The pellets harden as they dry and are, for a time, quite resistant to dissection. They come apart easily if soaked in water; kept in dry storage, they disintegrate within a year.

In order to determine whether hair is essential as a binder for pellets, the owl was fed deer mice of a hairless strain for four consecutive nights. Pellets regurgitated after these feedings varied in size and content just as "normal" pellets did. Although less firm than the hair-containing pellets, they were cemented by the same thick mucilaginous substance which became firm on drying, and they retained their distinctive shape throughout regurgitation, the drop from perch to floor, and later handling by the investigator—demonstrating that neither the formation of pellets nor the retention of their characteristic form requires the presence of hair. —E. Carl Sensenig, *Department of Anatomy, Tulane University, New Orleans.*

Cape May Warblers capturing flying insects.—From May 8 to 14, 1944, I observed five male and three female Cape May Warblers (*Dendroica tigrina*) about my orchard in Findlay, Hancock County, Ohio. The warblers fed for the most part in the topmost branches of the trees, but occasionally one of them, always a male, would descend to a wire cable that was stretched at a height of three feet between two posts of the grape arbor. The bird would remain there for 15 or 20 minutes at a time, half walking, half fluttering, back and forth on the wire while weaving from side to side, craning its neck, and snapping its beak. Sitting 15 feet away from the wire and using my binoculars, I determined the purpose of this peculiar behavior: the bird was catching the tiny insects that moved to and fro in pale wavering clouds in the shade of the trees. An insect was captured, on the average, every five seconds. The misses were few, averaging one in every 15 attempts. One bird, for example, caught 156 insects in 12 minutes. The insects were fruit flies (*Drosophila melanogaster*) and a species of midge.—Richard Stuart Phillips, *Findlay, Ohio.*

EDITORIAL

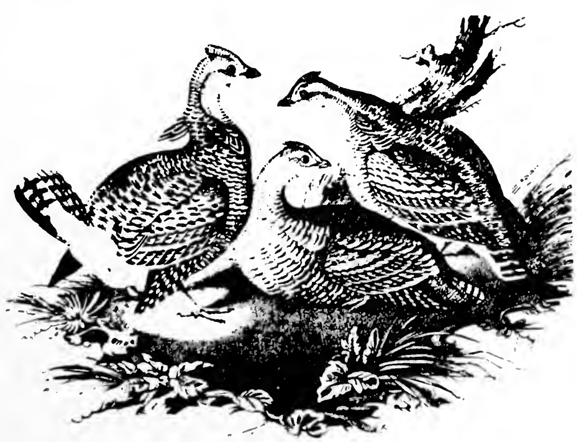
Peter Rindisbacher's portrait of the Dowitcher which, as a result of one of A. W. Schorger's valuable historical studies, appears as the frontispiece of this number of the *Bulletin,* is of especial interest because it is one of the earliest portraits of the species. It is, in fact, the earliest picture we have seen of the fall plumage, which is so very different from the ruddy-breasted spring dress. It was, of course, the fall plumage that Thomas Pennant described in 1785, from Mrs. Blackburn's collection of New York birds, as the "Brown Snipe"; he described the spring plumage elsewhere in the book as the "Red-breasted Snipe." Pennant did not give the bird a Latin name, but Gmelin, in his 1788 edition of Linnaeus, cited Pennant's description of the "Brown Snipe" and gave the bird the name *griseus* that we now use.

In 1813 Wilson remarked the Dowitcher's similarity to the common (Wilson's) snipe in "general form, size, and colors"—an observation fully confirmed by Percy Lowe in 1931 after a detailed study of the anatomy.

Mr. Schorger sent us some very interesting photostat negatives made from the "Wilson's Pinnated Grouse" and "Grouse" portraits mentioned in his paper. Unfortunately it was not possible to include these as illustrations of the article, but we hope that, in spite of unavoidable loss of detail, the copy shown below of the Prairie Chicken portrait will convey some impression of Rindisbacher's published work. This portrait is of particular interest because it was engraved for the *American Turf Register and Sporting Magazine* by Alexander Lawson, the great Philadelphia engraver, who is now best known for his part in the publication of Wilson's "Ornithology."

It might well repay an ornithological student to investigate the pages of the *American Turf Register* (published from 1829 to 1844). B.L.H. [Bertha L. Heilbron] states in *Minnesota History* (vol. 14, 1933:423) that the *Register* "from time to time reprinted extracts from the published works of . . . . Audubon and other writers on the West." Complete files of this once popular magazine are now, of course, extremely rare.

We are very grateful to Mr. Schorger for the opportunity to publish a contribution to the history of ornithology that offers so many facets of interest.



From "Wilson's Pinnated Grouse" by P. Rindisbacher

Since war time regulations again prevent our holding a regular Annual Meeting, President Kendeigh has asked the Council and the Chairmen of standing committees to meet August 20 at Jackson Mill, West Virginia, to carry on the necessary business of the Club. He asks that members write to the Secretary about any business which they would like to have brought up at the meeting.

Generous support of the Club through difficult years has enabled us to continue the subscriptions of members prevented by war conditions from paying their dues. We were very happy to receive a letter recently from an English member who had finally obtained a permit and was sending dues for 1942 through 1945. "It was pleasant when coming home on leave," he says, "to find Wilson Bulletins awaiting me. . . . Kind regards and all good wishes to the W.O.C."

The Wilson Ornithological Club Library is enjoying a steady increase in size and in use. In spite of the undoubted decrease in ornithological research caused by the war, more requests have come to the Library in the past few months than ever before. Added experience in administering the Library has demonstrated very clearly the value of the reprint collection. From that collection the librarian is often able to supply the needs of a borrower by sending several small reprints from periodicals, thus saving the bird student considerable postage expense and keeping the bound volumes available for other workers. We therefore urge members to send in to the Library as complete a set of their reprints as possible—including reprints from even the most generally available publications.

There is another easily overlooked need of the Library, namely, the need for recently published books on ornithology and related subjects. The Club has no funds for the purchase of new books, and yet many of the calls that come to the librarian are for the latest publications. Perhaps the need could largely be met by our members sending in recent books which they have read and do not need for reference in their libraries. We are sure that some members, when they know of this problem, will want to send to the Library copies of recent books which they especially admire and would like to have other members read.

We should be glad of the members' assistance in compiling the Bibliography section of the *Bulletin*. When you have read an article dealing with birds or related subjects—particularly when it appears in a non-ornithological journal—which you think should be called to the attention of the other members of the Club, please send the title, with complete reference (preferably in the form used in the Bibliography), to the Editor. A brief statement of the contents of the article would be doubly helpful. It is perhaps not necessary to remind our readers that such articles (or reprints of them) would be a valuable addition to the Wilson Ornithological Club Library.

Ornithological News

Mr. John H. Baker, President of the National Audubon Society, has been good enough to give us some details of a cooperative project for investigating the status of the Whooping Crane. The Society and the Fish and Wildlife Service have agreed to jointly sponsor field investigation and research on the numbers, breeding localities, and life history of this crane in order to determine what steps may reasonably be taken toward further protection and restoration of the species. The Society has undertaken to finance the first year's expenses of the project, and a final report will be published as one of the series of Audubon Research Reports.

Mr. C. L. Broley of Winnipeg, Manitoba, has organized sources of information on this year's nesting Whooping Cranes in western Canada and assured the cooperation of the Mounted Police, the airlines, Hudson's Bay Company, Radio Station CBC in Winnipeg, and Ducks Unlimited, as well as that of several publications and Provincial Departments. Mr. Fred G. Bard, Curator of the Provincial Museum of the Department of Reconstruction and Rehabilitation at Regina, Saskatchewan, has been engaged as field investigator for the nesting season of 1945. The U. S. Army Air Force will cooperate by providing planes and crews to aid in making field surveys. Our First Vice-President, Dr. Olin Sewall Pettingill, Jr., has been engaged as Audubon Research Fellow on the project, beginning September 15, 1945; he has been granted leave of absence by Carleton College for the duration of the investigation.

Further details on the project will be published in the May-June number of the *Audubon Magazine*.

Houghton Mifflin have reissued Roger Tory Peterson's "A Field Guide to the Birds," which has been out of print for some time.

It has been announced that James L. Peters, Curator of Birds at the Museum of Comparative Zoology, has been elected Vice-President of the International Commission on Zoological Nomenclature, to succeed the late Dr. C. W. Stiles of the Smithsonian Institution.

Aldo Leopold has an interesting note on administration *versus* research in the *Wartime Newsletter* (Feb. 1, 1945, page 3) of the Wildlife Society. He reports that the Wisconsin Conservation Department plans to "protect . . . the technical initiative" of those men now needed in administrative positions whose work has previously been chiefly in research, by guaranteeing them a "certain proportion of their time for the continuance of research" and giving them the "necessary assistance to make this guarantee feasible of execution."

NEW LIFE MEMBER

Maurice Graham Brooks, member of the Wilson Ornithological Club since 1926 and Secretary since 1941, received the A.B. and M.S. degrees from the West Virginia University and is now Associate Professor of Wildlife Management there. He is a Member of the American Ornithologists' Union and represents our organization on its Council. As editor of the *Redstart* and Chairman of the West Virginia Biological Survey, he is taking an important part in the investigation of his special field of interest—the ecology of the birds and plants of the Appalachian Mountains.

WILDLIFE CONSERVATION

Crop Protection without Wildlife Destruction

Margaret M. Nice has recently called our attention to the development of a device to frighten wild ducks from grain fields. Recurrent serious damage to corn and grain in the Platte River Valley in Colorado and Nebraska, to wheat and barley in the Dakotas, and rice in California and Texas, has necessitated control measures such as, for example, the lengthened duck-hunting season and liberalized bag-limit of 1944.

The new device, developed by the Fish and Wildlife Service's Research Laboratory at Denver, employs an electric beacon so regulated that it rotates a beam of light over the area to be protected. A standard automobile spotlight, with clear glass lens and 50-candlepower bulb, is used as the source of light. Rotation power is furnished by a 6-volt phonograph motor operated from a storage battery or by another type of motor operating on 115-volt alternating current.

Three leaflets issued by the Fish and Wildlife Service (BS-13, August 1935; BS-149, November 1939; Wildlife Leaflet 256, June 1944) describe the mechanism in detail and discuss the results of its use. As a means of minimizing crop damage by wildlife, this seems far more satisfactory than the customary "shoot," the use of poison, or the establishment of bounties.—C.A.D.

Protection for Hawks and Owls in Minnesota

In 1903, the Minnesota Legislature adopted the A.O.U "model law" for the protection of non-game birds (including most of the hawks and owls) ; in 1925, this act was rescinded, and legal protection was withdrawn from all hawks and owls. Efforts were then made from time to time to persuade the Legislature to restore protection but were thwarted by a few groups actively supporting an all-embracing "vermin control." This year, however, the Minnesota Ornithologists' Union organized a Bird Protection Committee, with W. J. Breckenridge as chairman, which, supported by the Minnesota Conservation Federation, asked the Legislature to provide protection for most species of hawks and owls. As a result, the new Minnesota game and fish code protects all hawks and owls except the Goshawk, Cooper's Hawk, the Sharp-shinned Hawk, and the Great Horned Owl. —Gustav Swanson.

Revival of the Bounty Question

The present high population of red and gray foxes (*Vulpes fulva* and *Urocyon cinereoargenteus*) in the north-central and eastern states has resulted in renewed demands from farmers and sportsmen that fox bounties be established or—where they are already in effect—increased.

Apparently in an effort to ward off unwise pressure for a fox bounty, the state conservation departments of New York and Michigan have recently prepared for distribution popular bulletins dealing with the fox problem. The Conservation Department of Ohio, which has a fox-bounty law already before its legislature, is contemplating a similar publication. The New York bulletin, "The Fox in New York," by Clayton B. Seagears is a well-illustrated and carefully documented report on the life history, abundance, economic importance, and management of both red and gray foxes in that state. The demand for this publication quickly exhausted the first edition, and a second edition is now planned to meet more than 3,000 unfilled requests. The Michigan publication, "The Red Fox, Friend or Foe," by Donald W. Douglass and G. W. Bradt, is also well written and contains a candid discussion of the bounty system.

The current issue of the Wisconsin Conservation Bulletin (Vol. 10, No. 4) carries a discussion of the fox problem in an article, "Deer, Wolves, Foxes and Pheasants," by Aldo Leopold.—C.A.D.

Wildlife Conservation Committee
Charles A. Dambach, *Chairman*

ORNITHOLOGICAL LITERATURE

MODERN BIRD STUDY. By Ludlow Griscom. Harvard University Press, Cambridge, Mass., 1945: 5⅛ × 7½ in., x + 190 pp., 15 photos, 10 maps and diagrams. $2.50.

"Modern Bird Study" is a fine little book, and I have read it with the greatest interest from cover to cover. It is not simply about birds; it is not simply another "What bird is that?" book; it is about avian populations and all that the words imply: the adaptability of bird populations, their migrations, the routes that they take during their travels, and their distribution. The first five chapters—Development of Field Ornithology. Capacity and Intelligence of Birds. Adaptability of Birds. Migration: Causes and Origin. Migration: Factors and Routes—"will appeal to any layman with a general interest in birds," as Griscom says in his preface; "The chapters on distribution and classification are more technical. . . . The main object of the book . . . is to show that the study of birds is not only a branch of scientific research . . . but that it also contains many topics of interest to the layman, and that the growing army of bird watchers have and can really assist the ornithologist in solving problem after problem by controlled, careful, and thorough observation."

It is a delightfully made little book, too. It fits into the pocket, and I can think of nothing better to lighten a tiresome train journey. There are 15 unusual photographs by Cruickshank, A. A. Allen, Edith Sloan Griscom, and others, as well as 10 very helpful maps and diagrams. Useful references are given at the end of each chapter, and there is an adequate index. At first sight the text may seem short, but it is as packed with meat as the proverbial nut.

Of course, it is the part concerning distribution that interests me most, and the analysis here is really first rate. I was extremely interested to find that Griscom is much more sympathetic to J. A. Allen's postulates concerning North American geographical distribution than to C. H. Merriam's. In the chapter on classification, there is an excellent analysis of the question of superspecies and incipient species, as well as a clear, brief, easily understood discussion of sympatric and allopatric species; monotypic and polytypic species; and intergradation.

This is a hard book to review because I am tempted to give long quotations from it—which simply reiterates what I said before: it is a meaty little book. (At first sight I may seem biased because Ludlow Griscom is here at the Museum of Comparative Zoology, but I think probably it would be truer to say that I am hypercritical because the book is distinctly "up my alley.")—T. Barbour.

CHECK-LIST OF BIRDS OF THE WEST INDIES. 2nd ed. By James Bond. Academy of Natural Sciences of Philadelphia, 1945: 6 × 9 in., xiii + 182 pp., map. $2.00.

At first glance the second edition of Bond's Check-List seems not to differ greatly from the original edition (1940) that was reviewed in this journal, vol. 53, p. 40, but a careful comparison of the two reveals numerous changes. In the first place, the preface has been enlarged and the lists of extinct and vanishing species revised; to the extinct birds is added *Columba inornata wetmorei* which has not been found since 1926; on the other hand, the number of birds that Bond believes may become extinct within the next hundred years has been reduced from thirteen to six. The list of rare or local forms has been omitted entirely.

A few species, reports of whose occurrence in the West Indies are now considered doubtful, have been dropped from the Check-List, and a few recent records (e.g. *Dendrocygna bicolor* from Cuba) added. A new feature is the inclusion of the earliest dates of arrival and the latest dates of departure of the North American migrants. In the original edition, free use was made of footnotes to explain the author's views on relationships and derivations; in the second, this practice is amplified. It is interesting to note in the present edition that Bond has carried out certain changes which he tentatively proposed in the earlier edition; for instance, he unites *Nesophlox* with the Central American *Calliphlox,* places *"Calypte" helenae* in *Mellisuga,* reduces the status of *Colaptes chrysocaulosus* to a race of *C. auratus,* and unites *Holoquiscalus* with *Quiscalus.* There can certainly be no serious objection to any of these proposals. On the nomenclatural side we find *Parula* replacing *Compsothlypis* (and the family called Parulidae) and *Spermophila* replacing *Sporophila,* since under the international code they are not preoccupied by *Parulus* and *Spermophilus* respectively.

This check-list is the culmination of many years of devotion to the ornithology of the West Indies, both in the field and in the museum; it will stand as authoritative for a long time to come.—J. L. Peters.

ATLAS OF AVIAN ANATOMY: OSTEOLOGY, ARTHROLOGY, MYOLOGY. By Frank Wilbut Chamberlain. Michigan Agricultural Experiment Station Memoir Bulletin 5, 1943 [1944]: 47 pp. of text, 95 pls. $2:50.

Because the title of this book might prove misleading to some ornithologists, it seems advisable to mention briefly some of its inadequacies. It was prepared primarily for use in veterinary medicine and deals only with domestic types, such as chickens, geese, swans, and their close relatives. It is not, then, a general atlas, and it is in no true sense comparative. Its descriptions and terminology are not correlated with the recent anatomical work by Howell (*Auk,* 54, 1937:364–375; 55, 1938:71–81), nor with the muscular anatomy by Hudson (*Amer. Midl. Nat.,* 18, 1937:1–108), with its superior illustrations. Indeed, these and many other significant papers, for example, those of Gadow and Fürbringer, are not listed in the one-page bibliography. The plates showing bones could have been distinctly useful if more than a smattering of the topographical features had been labelled. These drawings do indicate the kind of bird involved, but unfortunately the illustrations of joints and muscles do not. These defects may not be of consequence when the work is used in vocational training, but the general zoologist can view only with regret the failure of the veterinary anatomist to correlate his work with that in broader fields.—Alden H. Miller.

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"Age Groups and Longevity in the American Robin"—a Correction

Footnote 7, page 71 of the March (1945) *Wilson Bulletin* should read: "Nice (personal communication) estimated an average of 4.4 young per pair per season for *Turdus migratorius achrusterus* in Oklahoma."—Donald S. Farner.

REPORT OF THE SECRETARY FOR 1944

The Wilson Ornithological Club continued to prosper in 1944, despite interruptions resulting from the war. We closed our year (as of December 1) with 1,084 members on our rolls, a net increase of 56 over the membership in 1943. During 1944, we lost from all causes 95 members and received 151 new ones, including a number of former members who had dropped out during the last few years.

Our membership by classes is now distributed as follows: 3 Founders, 24 Life Members (an increase for the year of 5), 58 Sustaining Members (an increase of 13), 385 Active Members (an increase of 51), and 614 Associate Members (a decrease of 13).

The Membership Committee, with Frederick M. Baumgartner as Chairman, and also the officers and members of the Club, have been diligent in searching out new members. Special mention should be made of George O. Hendrickson whose recommendations secured 42 new members in 1944! Richard L. Weaver secured 8 new members; J. J. Hickey and George M. Sutton, 7 each; W. J. Breckenridge and Harold D. Mitchell, 5 each; Clark S. Beardslee and I. B. Boggs, 4 each; Frank J. Hinds, Linus C. Hoffmeister, Howard L. Mendall, Edwin T. Moul, and Frank A. Pitelka, 3 each; A. F. Ganier, Lawrence I. Grinnell, H. W. Hann, S. C. Harriot, and Gordon Wilson, two each; Bernard William Baker, Mrs. F. L. Battell, Howard Elmer Bishop, L. Irby Davis, John T. Emlen, Jr., William G. Fargo, S. B. Heckler, Harold M. Hefley, Dorothy Hobson, George T. Hughes, David W. Johnston, E. J. Koestner, Harry A. McGraw, Howard H. Michaud, Levi L. Mohler, Gale Monson, Roger Tory Peterson, Charles L. Remington, Thomas J. Scott, Wayne Short, Gerald B. Spawn, Doris Huestis Speirs, J. Murray Speirs, Gustav Swanson, Ruth D. Turner, Frank G. Watson, and Harold B. Wood, one each. The nomination blanks included with the annual dues notices have added an encouraging number of prospective members to our list.

The mail ballot for officers of the Club during 1945 resulted in the election of the slate suggested by the Nominating Committee, namely:

President: S. Charles Kendeigh
First Vice-President: Olin Sewall Pettingill, Jr.
Second Vice-President: Harrison F. Lewis
Secretary: Maurice Brooks
Treasurer: Milton B. Trautman
Councillors: Burt L. Monroe, Eugene P. Odum, Lawrence H. Walkinshaw

Josselyn Van Tyne was re-elected Editor at the meeting of the Council in August.

The Secretary wishes to express the thanks of the Club to the many persons whose efforts have forwarded the work of the organization during these difficult times.

Respectfully submitted,
December 1, 1945 MAURICE BROOKS, *Secretary*

WILSON ORNITHOLOGICAL CLUB LIBRARY

The following gifts have been recently received. From:
G. Reeves Butchart—1 book
Leon Kelso—1 pamphlet
William H. Phelps—4 reprints
Katie Roads—2 books, 2 pamphlets
Wendell Taber—1 book
Josselyn Van Tyne—43 reprints
James B. Young—1 reprint

To the Members of the Wilson Ornithological Club:

The prosecution of the war and the establishment of a sound peace are the vital concern of us all, and it is proper that a great part of the individual attention and effort of each of us should at present be devoted to them.

Nevertheless, other interests—the normal, cultural interests of times of peace—have still a rightful claim to our attention, since it is in fact for just such things that we are fighting. Not only may we rightfully support these interests, even in the midst of war, and even though they do not directly aid the war effort, but we may look ahead and plan for their further development after the war.

One such peacetime interest important to the members of the Wilson Club is the advancement of ornithology and related sciences, particularly by furthering the work of the Club in its special field. There is no need to impress upon you the value of the work of the Club. You have shown your belief in it by becoming members, by actively supporting the Club year after year, and frequently by raising your membership status. You know that the Club is doing fine work—now evidenced primarily by the publication of the *Bulletin* and its growing list of subscribers but also by other activities less well known but equally worthy of encouragement. The continued advancement of the Club's work and the extension of its field of usefulness can be achieved only through the continued and increasing support of its members and friends.

Your support may be given in various ways: through changing from one class of membership to a higher one, especially to that of Life Membership, and through gifts or bequests. By arranging with your attorney for a bequest, those of you who are greatly interested in promoting the work of the Club, though not now in a position to render substantial aid, may provide such aid for the future. But a Life Membership will undoubtedly appeal to a number of you. It requires payment of one hundred dollars, which may be made, if you prefer, in four equal annual installments. Gifts and bequests (unless the donor specifies otherwise), as well as Life Membership payments, are placed in the endowment fund, whose principal always remains untouched and is invested to produce a safe income—at present, of course, in War Bonds as the Club's collective contribution to the war effort.

The Committee extends to each of you the thanks of the Club as a whole for your cooperation in the past and solicits your continued support in the future.

Respectfully yours,
The Endowment Committee
George B. Thorp, *Chairman*

1400 Lake Shore Drive
Chicago 10, Illinois
June 1, 1945

REPORT OF THE COMMITTEE ON AFFILIATED SOCIETIES

At the August 1944 meeting of the Wilson Ornithological Club Council, a change in the membership of the Affiliated Societies Committee was approved. In future it will consist of a chairman appointed by the President of the Wilson Club, a member-at-large for the Wilson Club, and one representative from each of the affiliated societies. Formation of the new committee is now complete, and membership is as follows: *Chairman,* Gordon M. Meade; *Member-at-large,* George Lowery; *Representatives,* Eugene P. Odum (Georgia Ornithological Society), O. A. Stevens (Inland Bird Banding Association), Harvey B. Lovell, (Kentucky Ornithological Society), Amelia R. Laskey (Tennessee Ornithological Society), J. J. Murray (Virginia Society of Ornithology), N. R. Barger (Wisconsin Ornithological Society).

The affiliated groups will work through this committee to promote closer affiliation and exchange of ideas.

May 3, 1945 Gordon M. Meade, M.D., *Chairman*

TO OUR CONTRIBUTORS

Our members are asked to submit articles for publication in the *Bulletin*. Manuscripts will be accepted with the understanding that they have not been published or accepted for publication elsewhere.

Manuscript. Manuscripts should be typed on paper of good quality and of letter size (8½ x 11). Write on one side only and use double spacing. The title should be brief and carefully constructed so as to indicate the subject clearly. Ordinarily the scientific names of the birds treated should be given and should appear early in the article. Most articles should have a brief summary at the end.

Bibliography. Literature referred to in the text should be cited by author's name, year of publication, and exact pages of the particular reference. Such citations should ordinarily be listed in full at the end of the paper.

Illustrations. Photographic prints, to reproduce well as half-tones, should have good contrast and detail. Please send prints unmounted, and attach to each print a brief but adequate legend. Do not write heavily on the backs of photographs.

Proof. Authors are requested to return proof promptly. Expensive alterations in copy after the type has been set must be charged to the author.

Reprints. The Club is unable to furnish free reprints to authors. Arrangements will be made, however, for reprints to be made at cost.

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PRAIRIE WARBLER
(*Dendroica discolor*)

**Adult, at nest with young. Lovells, Michigan, June 19, 1944.
Photographed by Bernard Baker.**

# THE WILSON BULLETIN

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Vol. 57 SEPTEMBER, 1945 No. 3

NESTING BEHAVIOR OF WOOD WARBLERS

BY S. CHARLES KENDEIGH

THE following paper is based on a study of the nesting behavior of warblers made during the summers of 1942 to 1944 inclusive on the Edmund Niles Huyck Preserve, Rensselaerville, New York. This 500-acre preserve is about 30 miles southwest of Albany, on the Helderberg Plateau on the north side of the Catskill Mountains. The observations extended each year from the first week of June until the last week of July. Seventeen species of warblers were recorded during the three summers, probably all of them breeding, but worthwhile notes were obtained on only the 12, more common, species treated in this paper. The study of several species proved difficult because the movements of the birds in the dense foliage could often be followed only by sound, and the finding of their nests was usually accidental. No attempt at monographic treatment is made here, but the fragments of life history on the various species have been brought together at the end of the paper into a composite pattern of nesting behavior.

This area is in the ecotone or transition between the deciduous forest biome and the coniferous evergreen forest biome. Hemlock, beech, sugar maple, and yellow and white birches are the dominant species. White pine is present but of minor importance. Breeding-bird censuses were taken each year in shrubby fields, in a hemlock-beech forest, and in a forest composed chiefly of deciduous trees. The most time was spent with the birds in a 21-acre hemlock-beech community. This predominantly evergreen forest is not virgin, but some of the large hemlocks are 200 years old and 75 feet in height. The forest floor is covered with a mat of dry brown hemlock needles overlaid in most places with leaves of beech and yellow birch. There is not a great amount of undergrowth nor many herbs, but here and there the young second growth forms a dense stand. Figure 1 shows the degree of mixture of hemlock and beech, as well as the relative size of the trees.

On each survey of this community, the location of every bird observed was marked on a map of the area. After a few such surveys the approximation of marks permitted drawing of territorial boundaries as shown in Figures 1 and 2. This, together with peculiarities of song, made it possible to recognize individuals, although with less certainty than if the birds could have been color-banded. The boundaries of the territories as drawn and the measurements given for them are only approximate, and they may generally be too small. They were most accurately determined in 1942, when the greatest amount of time was spent in this area. It is entirely possible that more time spent in observing the birds in 1943 and 1944 would have shown that some of the territories were larger than they appear on the map. These territories were simultaneously occupied, although not continuously so, during the breeding season. For the Oven-bird and Magnolia Warbler, which have two breeding periods, the territories as mapped include the total area occupied for both broods, since there seemed to be very little change in the boundaries. A very few males, chiefly Oven-birds, were present only during the latter part of the season. Birds whose territorial boundaries were not determined are indicated on the maps by numbers in parentheses placed at the approximate center of the area of their activities.

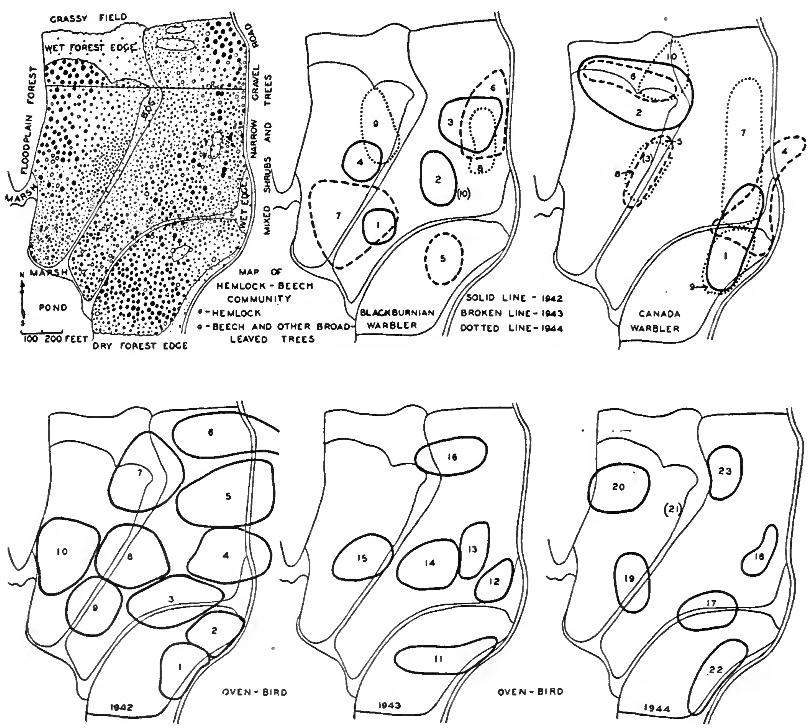

Figure 1. Map of hemlock-beech community and territories of warblers studied. Numbers in parentheses represent territories the exact boundaries of which were not determined.

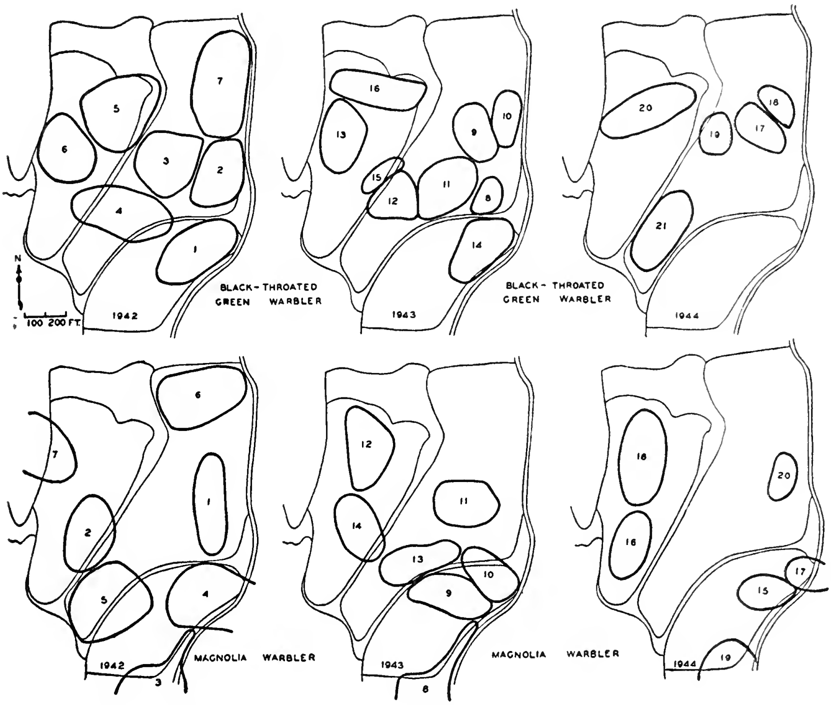

Figure 2. Territories of warblers in a hemlock-beech community.

Black and White Warbler

Male Black and White Warblers (*Mniotilta varia*) sing incessantly until mated. They seek exposed singing posts at or near the tops of isolated trees in shrubby fields, and perch crosswise on a branch. One song was syllabized *zii zii zii ziii-eee ziii-eee ziii-eee,* the first three notes being single, the last three double. A variation was a series of about eight short *zii* notes followed by a trill. About the middle of June, when nesting is well along, these warblers become almost entirely quiet and are easily overlooked. At a nest with 5 young about 4 days old, the young were fed twice by the male, 3 times by the female during 2 hours afternoon observation. This seems a very slow rate of feeding, yet the young successfully left the nest on June 29, when 8 or 9 days old.

On June 15, a pair of Black and White Warblers were much concerned over a young Oven-bird not long out of the nest and apparently separated from its parents. The young bird was calling loudly for food. The Black and White Warblers were apparently caring for it, although they were not actually observed to feed it until 3 days later.

Nashville Warbler

Male Nashville Warblers (*Vermivora ruficapilla*) sang from posts on the forest-edge at heights from 15 to 30 feet. The song consisted of a series of notes of the same pitch followed by a descending trill, probably a variation of the second song described by Saunders (1935: 182). The singing posts are often inconspicuous and the birds difficult to find. Males were observed on two occasions silently chasing other birds for some little distance in what appeared to be territorial competition. When excited, the females flutter their wings. Although adults were seen with food for the young in their bills, no nest was found. Fledglings were observed by the third week in June.

Magnolia Warbler

Figure 2 shows the territories of 20 male Magnolia Warblers (*Dendroica magnolia*) during the first breeding period. Fifteen of these average 1.8 acres in size. Territory 20, which was in a dense shrubby area and measured only about 0.6 acre, was the smallest. Territory 4 was quite large, probably 3 to 4 acres if one includes the area in the pine-spruce planting across the road where the nest was later built.

Territory is established and defended by song, plumage display, and chasing. Singing posts are most frequently on the outer edge of a hemlock and from 10 to 45 feet above the ground. When vigorous, the song may be repeated 10 times a minute. The song commonly given for territory and mate has been frequently described by others, e.g. *wee-o, wee-o, wee-chy* (Stanwood, 1910:384); there are, however, many variations. Another song for the same purpose, *ta hé ta heéch a*, may be the same as the second common song described by Brewster (Griscom, 1938:575). A song given during the progress of nesting or when the bird is patrolling a well-established territory consists of a series of notes (usually four), all of the same pitch: *mae mae mae mae*, or *cheel cheel cheel cheel*. The male Magnolia sings persistently day after day but often in a desultory manner. However, when a new male comes in to establish a territory or a male attempts to expand his territory, singing may be very vigorous and stimulate the males of this species over the entire woods to join in and assert their claims. Such responses show how closely knit and balanced a society these birds form when there are several territories in a comparatively small area.

When another bird of the same species intrudes in spite of the warning song, the male in possession of the territory flits nervously but silently around from branch to branch with tail spread, showing its white markings. Occasionally the resident male will fly out at the other male with tail and wings spread in display and then circle back without giving real chase. On several occasions when more vigorous resistance was required, the male suddenly stopped singing (sometimes uttering a few chirps) and gave full chase to the intruder without any attempt at plumage display. Once a male chased two male Black-throated Green Warblers that were squabbling near-by.

During the mating period, when a female enters the territory, the male stops singing and begins a display which is more complete than that used in territorial defense. With spread tail and wings the male follows the female through the trees from branch to branch, or sometimes flies directly at her. Nice (1926:193) has described a *kree-ee kree-ee* note given by the male when "courting" his mate late in the nesting period.

When nervously excited, the female also displays, at least to the extent of flitting her tail and exposing its markings. There was no evidence that the female recognized the limits of the territory that the male established. When leaving the nest during the incubation period she sometimes went well outside the male's domain. But she did resent intrusion in the immediate vicinity of her nest. Twice during the incubation period a female drove off male Magnolia Warblers that had been attracted by her scolding of me.

The behavior of the adults was watched at only one nest, and this for only 2.5 hours two days before, and for 2 hours shortly after, the eggs hatched (both times in mid-morning). During the first observation, the female incubated steadily for 2 hours with hardly a restless movement, left for 20 minutes and then returned for another attentive period. The male did not come near. During the second observation, the female brooded the newly hatched young for 20 minutes after being away 13 minutes, left for 4 minutes, brooded again for 24 minutes, was gone for 5 minutes, then back to brood for 12 minutes, when her stay was interrupted by the male's appearance. During the next half-hour the young were fed twice by the male, 3 times by the female, and the female brooded for 2 periods of respectively 13 and 10 minutes. Observations of Stanwood (1910:386), Mousley (1924:280), and Nice (1926:196) indicate that the incubation period lasts about 12 days and that the young leave the nest 8 or 9 days after hatching.

The Magnolia Warbler begins nesting rather early, and fledglings were found in 1942 on June 15; in 1943, on June 24. Second broods are regularly attempted, and the males sing energetically during the latter part of June while re-establishing their territories and acquiring mates. Singing continues until the end of July.

Black-throated Blue Warbler

One male Black-throated Blue Warbler (*Dendroica caerulescens*) was in the northeastern corner of the hemlock-beech study-area at the beginning of June, 1942; on June 18 a second male intruded on the area of the first male without being molested but later became established with a female just to the south. In this species the males seem more tolerant of each other than in most species of warblers. Once, for example, a male was observed singing and feeding 15 to 20 feet up in a beech when another male, likewise singing, was 30 feet up in the same or in an adjacent tree; the two birds appeared to pay no attention to each other. It was common to find two males thus singing near each other, and birds often shifted around in an apparently aimless manner. Males were frequently observed far from their usual posts (often as much as 500 or 600 feet); they sang as they gradually worked their way back. Probably with this species, as with some other warblers, the concept of "home range" should be retained, since it is doubtful whether the entire area, often several acres, over which the birds wandered was regularly used and defended. Some competitive singing between males and chasing of one male by another was observed, but the actual portion of the home range that was defended as territory was not satisfactorily measured.

There are two common and easily recognized songs in this species, and each song has variations. Both songs may occasionally be given by the same bird, but usually one or the other song predominates with any one male. One song is given slowly and has a harsh quality; *wheer wheer wheeee* (Chapman, 1907:137). Usually there are three *wheer*'s, but one male gave only one. The other song is faster, and the notes are sharper: *zee zee zee zee zeeeee*. Both songs end with an upward slur that involves all of the last note and sometimes with the second song includes several of the preliminary *zee* notes.

On June 10, 1943, a male and female were observed feeding together, the female energetically, the male half-heartedly. The male appeared excited but sang little. Once he flew to the limb beside the female, partially spread his wings in display, then left. Very soon he sang softly once, then flew to the female, uttered several chattering notes, displayed his wings, chased her two or three feet into denser foliage, and apparently copulated with her. He continued his display, without singing, and finally chased the female some distance away. Four days later, another male, considerably outside his usual area, was observed chasing a female. He was very excited; he did not sing but uttered the same peculiar chattering notes. Again copulation apparently followed. These chattering notes are the same as the alarm notes described by Harding (1931:517) as a series of *thck's*. On July 10, a pair was observed feeding young near this location.

In 1943, the behavior of birds at a nest was watched from the time the nest was begun, on June 29, until the young left on July 25. The nest was in an upright fork of a purple-flowered raspberry in a deciduous forest and was only one foot above the ground. During 36 minutes of observation on the first day, the female did all the nest-building, making 21 visits; the male did not appear. The female once chased away a male Chestnut-sided Warbler that came too near the nest. Because of the lateness in the season this may have been a second attempt at nesting. Elsewhere in the woods on this same morning, another pair of adults was observed carrying food.

On July 1, the nest was fully built but empty. During 71 minutes of observation, the female came once and sat in the nest for 7 minutes, squirming and kicking around part of the time. The male came twice when the female was absent and sang near-by, but did not approach the nest itself. Presumably the first egg was laid the next day since there were two in the nest at 8:16 A.M., (E.S.T.), July 3. During 94 minutes observation on that day, the male was absent, and the female came to the nest once, sitting quietly on the eggs for 20 minutes.

On July 5, there were 4 eggs in the nest, and incubation was well under way. During 5.3 hours of observations made at various times of day, and spaced at 3- and 4-day intervals throughout the incubation period, the attentive periods averaged 28 minutes in duration, varying between 22 and 40+ minutes, and the inattentive periods averaged 9 minutes, varying between 5 and 15 minutes. The male was not recorded a single time during this period either around the nest or singing near-by. This does not agree with observations by Harding (1931:513, 516), who observed the male taking part in nest-building and feeding the female while she incubated.

Two young had hatched by 12:50 P.M. on July 16; at 8:00 A.M. the next morning the third young had appeared, and at 4:45 P.M. the fourth was out of the shell (an incubation period of 12 days). One young had disappeared by July 23, but the other three had matured sufficiently to leave the nest early in the morning on July 26. Thus their nestling life was 9 and 10 days long.

During the period of hatching on July 16 when there were 2 young and 2 eggs in the nest, the attentive periods of the female were 11, 25, and 10.5 minutes in length and the inattentive periods, 3, 8, 2.5, and 6 minutes, indicating a shortening and a greater irregularity of both periods compared with attentive and inattentive periods during incubation. During 68 minutes, the female fed the 2 young 5 times. The male was not present.

Approximately 1.7 hours were spent in observation at the nest, beginning at 9:10 A.M. on July 20, when the young were 3 and 4 days old. The female was at the nest for periods of 19, 11, and 37 minutes, although much of this time she stood on the rim and worked with her bill inside the nest. The irregularity in the length of her attentive periods was due in large part to the male's coming to the nest with food and interrupting her stay. The male fed the young 6 times, and the female fed them 3 times. The male invariably sang as he approached the nest, and this appeared to be a notice for the female to prepare to leave. The song was given softly and was often incomplete.

On July 23, when the young were 6 and 7 days old, the female brooded 13+ and 10 minutes during the 105 minutes of observation beginning at 8:33 A.M. She fed the young 4 times and the male fed them 3 times. The male's behavior when approaching the nest alone was the same as before; twice the male and female came to the nest together. The young now had their eyes open, and the tips of their pin feathers were beginning to break open. They left the nest 3 days later. During the 3.4 hours observation on July 20 and 23, the young were fed on the average once every 13 minutes. This is in marked contrast to the average interval of 2.4 minutes recorded by Mousley (1924:274).

Black-throated Green Warbler

Twenty-one territories of the Black-throated Green Warbler (*Dendroica virens*) averaged 1.6 acres in extent and varied from 0.6 to 2.5 acres in size (Figure 2). Territory 1 represents an unusual case since the territory was occupied consistently only until June 10. After that it appeared that the male had a mate with a nest across the road in a dense pine-spruce planting. On July 3 a male with the same type of song and accompanied by young out of the nest was in the original territory. Territory 15, a very small one, was also only temporarily occupied.

Territories are especially important with this species, and intrusions by other males are met with vigor. The male immediately gives chase and drives the other bird to the boundaries of his area. If the intruder remains in the vicinity, intermittent chasing may continue for several hours. There may be chipping notes given, but there is no singing nor usually any special plumage display. Once a male was observed to dart after another male and then to hover for an instant. Competitive singing sometimes occurs between males on adjacent territories when no trespass is involved. On June 28, 1943, two, or possibly three male birds were in a part of the hemlock-beech forest three or four hundred feet away from the nearest active territories. There was some chipping but no singing, although the birds seemed aware of each other's presence. This is apparently an instance of wandering by males outside of established territories, which is common in warblers although this wandering tendency is less marked in this than in some other species.

There are two main variations in the song melody of the Black-throated Green Warbler, as has been frequently noted by others. This fact, together with secondary variations in the song and the male's persistence within mapped territories, permitted recognition of pairs throughout most of the season or until they began to wander with their young. Sixteen of 27 males sang a song described by Pitelka (1940:14) as: *zrrr-zrrr-zu-zu-zwee*. Some males uttered this intermittently amidst a constant stream of low chips. The first, second, and last note are rasping in character. The second note, as given in this region, is higher than the first in pitch, not lower as Pitelka diagrammed it for birds in Michigan. This rendition is somewhat similar to the third example of the second type of song described by Saunders (1935:191). As one moves away from a male the last note is lost to audibility first, then the first and second notes, while at a still greater distance the more metallic third and fourth notes alone can be heard. There is less variation in this song than in a second song. Eleven males had a song described *zee zee zee zee zu zwee* by Pitelka. In this song the fifth note (*zu*) was on a lower pitch than the others and was occasionally doubled; some males uttered three or five instead of four preliminary notes. In both the *zrrr* and the *zee* types of song the last note is slurred upward. The song of any one individual was almost exclusively one or the other type (or a variation of one type). In 1942, there were only one or two doubtful instances of a male uttering both types of song; in 1943, at least 3 males sang both types of song rather frequently. Singing persisted even after the young left the nest or until mid-July.

Two pairs in 1942 had young out of the nest on June 23, another pair on July 3, and others soon after. In 1943, such families were not seen in the hemlock-beech forest. Perhaps they were there, though not seen by the observer, but since red squirrels were unusually abundant that year, and the population of Black-throated Green Warblers was considerably reduced in 1944, there is reason to think that much of the nesting was unsuccessful. This species apparently raised only one brood in a season.

During 2.5 hours of nest observation divided between 2 afternoons the young were fed 6 times by the male and 7 times by the female with the sex doing one feeding undetermined. This was at the rate of once every 11 minutes. Part of the female's time, however, was occupied with brooding.

Blackburnian Warbler

Since the Blackburnian Warbler (*Dendroica fusca*) frequents the highest stratum of the tree tops, observations of this species were particularly difficult. Nine territories were marked out, mostly from the location of songs heard, and their average size was relatively small, 1.3 acres (Figure 1).

Saunders (1942:253) describes the song of these birds in southwestern New York as a series of two-note phrases followed by a trill which is commonly lower in pitch than the rest of the song: *tsita-tsita-tsita-tsita zzzzzzzzz*. At Rensselaerville the trill is more commonly a slur rising in pitch, although one unmated male, perched on a projecting dead limb high above the forest canopy, sang an elaborate song with a trill descending in pitch and ending with a final *tsee*. After a male acquires a mate and settles down, the song often consists of the initial series of double notes only. By the end of June or the first week of July, singing ceases except for occasional notes.

A nest was found on June 18, 35 feet up in a hemlock in an inaccessible location 6 feet out on a horizontal limb. Its construction was nearing completion with the lining being inserted. In 82 minutes of observation the female visited the nest 7 times. The male occasionally sang near-by and once alighted near the nest, but the female spread her wings and chased him away as if she would not tolerate his presence in the immediate vicinity. On June 21, during 15 minutes of observation, neither adult visited the nest, but a non-singing bird, possibly the female, was seen to chase a male Black-throated Green Warbler out of the territory. On June 24, incubation apparently was under way. During 53 minutes of watching in mid-afternoon, the female incubated twice (for 10 and 18 minutes), and was inattentive for 15 and 10 minutes. The male sang periodically nearby. The next morning the female, while under observation, incubated for one period of 30 minutes and was inattentive for periods of 9 and 10 minutes. The male was not seen.

Chestnut-sided Warbler

In 1940, Eugene P. Odum, then resident naturalist on the Preserve, noted the arrival of the first males of the Chestnut-sided Warbler (*Dendroica pensylvanica*) on May 14 and the first females on May 22. In 1942, the first females must have arrived about the same date since the first young being cared for out of the nest were observed on June 22. However, many females were delayed in starting to nest; in six instances signs of first mating behavior with arrival of females in the males' territories were observed, on June 5, 8, 10, 12, 12, 12. The sexes are not always easy to distinguish in the field, although the male has a darker back and a brighter crown. Only the male sings, as is true also with the other wood warblers, and the female is usually shy and retiring, keeping well down in the low bushes and briers.

The unmated male on his territory, which is typically an open shrubby field containing patches of briers, bushes, and scattered trees, spends much of his time singing from tops of bushes or from the lower branches of trees. During the early season the song may be given 5 or 6 times a minute and may be heard at any time of day. The song is of two types. In the establishment of territories and advertising for mates it is characteristically clear and loud and may be heard at some distance. Jones (1900:35) has given the best rendition of it, *te te te te we chu,* with the fifth note accented and of higher pitch. Developing gradually from this song as the season progresses is one of a different character that Saunders (1942:254) renders, *wayo wayo wayo wayo weeo weeo wayo wayo*. Commonly the last two notes are not given, and *weeo* is more nearly *wheea*. This second song is more common after incubation is well established, is not given so vigorously or sharply, and seems to indicate a lower emotional level. It serves as a signal of territorial possession rather than of competition, although two males on adjacent territories were once observed giving this song alternately when only 30 feet apart.

Ordinarily there are several song posts habitually used by the male on his territory, and he sings successively from one, then another, until he completes the round of his possessions. Where the territories of two males lie close together, the males occasionally compete in song. On several occasions one male was seen to chase another out of his territory, once fully 200 feet. In this singing, chasing, and competition between males there is no special plumage display aside from that which occurs with the normal movements of parts of the body.

The female enters the territory quietly and inconspicuously by short flights from branch to branch through the bushes and trees. When the male sees her, he becomes silent and may dive at her or chase her from limb to limb. As his excitement grows, he makes a plumage display. This may occur as he alights near the female at the end of a dive from a high perch; it lasts only a few seconds. The tail feathers are spread, the wings extended, and crown feathers erected. The wings and tail quiver up and down. The female may display in return, though less vigorously. Doubtlessly this plumage display is mutually stimulating and leads to the emotional pitch necessary for coition. After one such dive by a male a series of chattering notes was heard, but copulation, if it occurred, could not be seen in the dense foliage. There is no singing during the display, although subsequently the male may fly excitedly around, give his first song described above, and chase other birds that normally he would not notice.

The male accompanies the female in the search for a nest-site, following her closely from tree to tree or bush to bush. There may be occasional singing, but they are mostly quiet, and they carry on some feeding. The male may slightly spread and droop his wings and partly raise his tail in a manner typical of pre-copulation behavior in other species. The female appears more intent than the male in the search for a nest-site. One nest was later found in a brier patch about 50 feet away from where a vigorous dive and plumage display by a male had been seen. However, the female looks for, and often establishes, nest-sites outside of the male's original territory. The male is somewhat attentive to the female during nest-building and egg-laying, but his enthusiasm is less sustained. He continues to sing during the incubation period, although he is quiet for long stretches of time. These quiet periods become more frequent as incubation continues.

Previous to the mating period, the male's territory, in three instances that were measured with some accuracy, covered 1.2, 1.3, 1.3 acres respectively, and two other known territories were about the same size. Another territory was estimated at 2.5 acres. During the incubation period, or during protracted pre-mating periods, the male greatly extends the area over which he roams, going well outside his previous territorial boundaries. This was observed repeatedly and regularly with several males. They wandered from 200 to 700 feet, and covered from 2 to 12 acres, or even more. On these long excursions the male sings his *wayo wayo* song more frequently than the *te te* song, although they may both be given. This singing, however, is much less vigorous and less frequent than on the territory itself; there may be long periods of silence; or the male may not sing at all. There is no evidence that these larger areas are defended, although the desultory singing may serve to ward off intruders. It is best at present to designate this area simply as the bird's "home range" and to limit the term "territory" to that portion of the home range where singing is vigorous and regular or where there is chasing or other types of defense. The home ranges always extended into free and unoccupied areas. In no case did the home ranges of two males overlap, although this may have been because the birds were few and fairly scattered.

On June 22, 1943, a nest was found just being built at the edge of a shrubby field, in the triangular fork of a bracken fern only 2.5 feet from the ground. The female was working on the nest foundation at the time, coming to the nest with materials at about one-minute intervals. The next afternoon the nest was well formed, and the female was busy finishing the interior. She made 9 trips in the first 52 minutes of observation but was then absent for the next 38 minutes. The male sang unexcitedly and made some attempt to follow the female. Once he looked into the nest when the female was away. Another time he followed the female to the nest and displayed to her on its rim, uttering a *tsiip*. Early on June 25, the nest was practically complete, and the female apparently brought no new material, although she would sit in the nest and work at the lining. She made six visits in an hour. One visit was interrupted when she gave chase to a male Golden-winged Warbler (*Vermivora chrysoptera*) that came within a foot of the nest and again a minute later when it came within 15 feet. The male could be heard singing his *wayo wayo* song in the distance but was not seen near the nest.

The first egg was found in the nest early the next morning. During an hour's observation a male sang in the distance. The female came to the vicinity of the nest 6 times but only once went to the nest itself; then she sat on the egg for 2 minutes. Once she chased away a yearling male Redstart that came within 20 feet of the nest. The third, and last, egg was in the nest on June 28, and incubation had begun. All eggs were hatched by July 9 (an incubation period of 11 days); two of the young were so much larger than the third that they had probably hatched the day before.

Four and a half hours of observation, divided fairly evenly on the afternoons of June 28, 29, July 1, and 7, gave an average of 13 minutes for 11 attentive periods, and 8 minutes for 10 inattentive periods (excluding one long inattentive period of 23 minutes on the first day of incubation). A male could frequently be heard singing in the distance but was not observed near the nest. It appeared that the male's territory was chiefly to the north, and this nest-site was on the very edge of it or may even have been outside of it as originally established. The female almost invariably went north (in the direction of the territory) when she left the nest.

At another nest, under observation in 1942 for 8.7 hours scattered in morning and afternoon throughout the incubation period, the attentive periods averaged 21 minutes in length and the inattentive periods a little over 6 minutes. The female during incubation at this nest seemed quite independent of the male. Although the male occasionally sang near the nest, only twice in 21 times that she was observed to leave the nest did she appear to do so because stimulated by the male's presence. These departures ended attentive periods of only 11 and 16 minutes. The longest period observed was 27 minutes. The inattentive periods varied between 4 and 9 minutes.

The eggs in the 1942 nest, perhaps because of accidental jarring by the observer, did not hatch. On the day the young were found hatched in the 1943 nest, the male was back helping to feed them. In 1.4 hours of watching during the afternoon he brought food for the young 3 times and the female brought food twice. The female brooded 2 times (26 and 34 minutes) with inattentive periods of 11 and 13 minutes. On the morning of July 12 when the young were between 3 and 4 days old, the female during an hour and 26 minutes of observation brooded for one long period of 35 minutes after the preceding brooding period had been cut short at 4 minutes by the arrival of the male. It is of interest that this female's attentive periods while brooding the young were considerably longer than while incubating the eggs. On this same date the female fed the young 4 times and the male fed them 7 times, once interrupting his feeding to drive off a yearling male Redstart. The young were gone on July 16, only 7 and 8 days after hatching, and it is uncertain whether they left naturally or were taken by a predator.

Another nest was found on June 17 with young one or two days old. When first discovered, the female flushed from the nest, fluttered along the ground as if wounded, uttered scolding notes, and the male approached within a couple of feet. During an hour's observation in the afternoon, the female came to the nest 6 times (not certainly with food each time) and brooded twice for periods of 12.5 and 21 minutes, the brooding periods being interrupted or terminated when the male arrived with food. The male sang frequently and fed the young 5 or 6 times. On my return to the nest on June 24, 7 days later, the young were gone. On two or three occasions the male has been seen caring for the young out of the nest, and it is likely this duty continues to be shared by both sexes until the young become independent.

Oven-bird

Although territories for the Oven-bird (*Seiurus aurocapillus*) in the hemlock-beech study area were mapped (Figure 1) and several nests were located, little attention was paid to its behavior. Chasing, however, was frequently observed, and the "flight song" was heard several times. One performance was especially spectacular. There was a swift musical jumble of notes, apparently given at the beginning of the flight, for immediately afterwards the bird came into view, doing a loop that extended from the level of the tree tops (30 feet high) down to the ground. The bird seemed to have its wings folded close to its body and to be making a swift dive.

Apparently two broods are raised. The size of 21 territories varied from 0.25 to nearly 3 acres and averaged 1.6 acres. Song was greatly reduced after mid-July.

Louisiana Water-thrush

A single nest of the Louisiana Water-thrush (*Seiurus motacilla*) was found on June 10, but unfortunately not until the four young were 5 or 6 days old. Three days later, the young were fed 7 times in 53 minutes of observation. Apparently most of the feeding was done by the female; a male was singing in the distance a large part of the time. The young were still in the nest on June 15 when they were at least 10 days old. The exact time of their leaving was not determined.

Yellow-throat

The Yellow-throat (*Geothlypis trichas*) begins nesting early, for the first young were out of the nest by June 15 in 1942. On June 19, there was considerable commotion among the Yellow-throats inhabiting the shrubby-field study-area. There seemed to be an influx of new males, and adults with their young were roaming around on each other's territories and upsetting the normal equilibrium. It was also obvious that the males were making an effort to reestablish territories and secure mates for a second brood. There was chasing of one bird by another in wide circles and considerable singing both of the normal song and of the flight song. The excitement continued at a slightly lower level during the rest of the month and into early July when the second nestings were under way. In 1943 and 1944, this period of excitement and readjustment for second broods was again evident during the third week of June.

Although male Yellow-throats commonly sing from close to the ground or from low bushes, they mount higher under the influence of competition, even to 40 feet or more. As if this were not sufficient, they also have a song given during either a vertical flight or a horizontal one that begins with their usual song and ends with an outburst of ecstasy after which the bird flutters down to the ground or to an exposed perch. One horizontal flight song at a height of fully 100 feet was observed at

7:00 P.M. These flight songs may be heard well past the middle of July.

Territories were not mapped for this species, but in 1942, 7 pairs were fairly uniformly spaced over an area of 5 or 6 acres, which would make their territories less than an acre in size. The incubation period at one nest was 12 days long.

Canada Warbler

Male Canada Warblers (*Wilsonia canadensis*) have a clear, abruptly tumbling song (Saunders, 1935:217) that they commonly utter at a rate of 6 times per minute when advertising for a mate. Soon after a mate is secured they usually become very quiet. Since the young of one nest left on June 19, and at another nest they were nearly ready to leave on June 23, nesting must begin soon after the middle of May.

In spite of persistent singing, one male in 1942 was unable to secure a mate until the third week in June. The size of his singing area was only about 0.6 acre, but after nesting began he wandered over 2 acres, although then he was usually quiet. Another male, with a nest, roamed over 3 acres or more, an expansion of an earlier singing area. This again appears to be an example of a larger area being used after nesting has begun. With this species, however, there is some evidence that the entire larger area is vigorously defended against intruding males by scolding notes and by silent chasing. In Figure 1, the entire larger areas are mapped.

Redstart

Two male Redstarts (*Setophaga ruticilla*) in yearling plumage were regularly observed in the same thicket or patch of trees and evidently had established territories and nests. Other singing males in yearling plumage appeared to move around considerably and were apparently without mates. The majority of the males were in full adult plumage, however, and showed no wandering tendencies. In 1944, none of the estimated 10 males on the Preserve was in yearling plumage.

Adult males in this species are strongly territorial in behavior, defending their possessions by song, color displays, and chase. There is a variety of songs, a common one being: *zwee zwee zwee ze ze zump* with the fourth and fifth (*ze*) notes at higher pitch than the first three, and the last note at a lower one. Another series of notes at the same pitch resembles a song of the Black and White Warbler. Redstarts sing from perches up to 40 feet from the ground.

Chasing occurs on slight provocation and is not accompanied by singing though it may be preceded by sharp scolding notes or by a period of competitive singing. One male was seen to chase another for fully 200 feet. Redstarts were also observed to fly after Oven-birds and juvenile Hairy Woodpeckers. These chases are straight and rapid, and there is no plumage display except that which is incidental to movements of wings and tail.

A special flight maneuver has been described by Hickey (1940:255) that serves primarily as a threatening plumage display. These darting flights were observed in the present study only once or twice and only between males. In Hickey's words they consist of "short, horizontal, semi-circular flights made with stiffened wings and out-spread tails. These performances were frequently observed between males, less commonly between females and never between a male and a female where a question solely of territory was involved. . . . Low, repeated *quit quit* notes could be heard when the displays were concluded and the birds returned to their perches. As far as could be observed, these same performances seemed to serve as some part of the male's courtship of females. . . . The size of territories was usually about one acre or less. . . . Their boundaries were observed in two cases to break down on June 17, when young were being fed in the nest."

In courtship activities, a male in full adult breeding plumage may fly after a female, alight beside her, and spread his tail, showing its brilliant coloration. His wings may not always be extended, and he does not sing. He may retain the pose for several seconds before they both fly away.

Two nests were found in 1943 and one in 1944. On the mornings of June 12 and 17, 1943, during 119 minutes of observation at a nest containing eggs, the female's 10 attentive periods averaged only 9 minutes in length; 11 inattentive periods averaged only 2 minutes. The male sang nearby, and on the latter date came to the nest and flitted around it.

At the 1944 nest, 153 minutes of observation in both morning and afternoon on the second, third, seventh, and eleventh days of the incubation period covered 5 attentive periods that averaged 18 minutes and 6 inattentive periods that averaged 7.5 minutes. There was one exceptionally long inattentive period of 19 minutes. In this nest the fourth egg was laid on June 6. Since 3 of the young hatched on June 17 and the last not until June 18, it is probable that rather steady incubation began with the third egg and that the incubation period is 12 days long. The young left on June 27, which gave them only 10 days for development in the nest. In 53 minutes of observation in late morning when the young were 3 and 4 days old the female brooded 3 times for periods averaging 15 minutes, with inattentive periods averaging 4 minutes. The female's brooding was interrupted by the male bringing food. This he passed to the female who then fed the young. When the female was absent, the male fed the young directly. The male brought food 12 times, the female only once; this gives an average of once every 4 minutes for feeding the young.

There were half-grown birds in the third nest when it was found. On June 22 and 26, 94 minutes were spent watching the nest, beginning about 9:30 A.M. each day. On the first date the female brooded 3 times for 5, 6.5, and 2 minutes, with the male coming to interrupt her each time as he brought food for the young. Her inattentive periods were 2, 1.5, and 15 minutes long. On the first day the male fed the young 5 times, the female fed them 4 times; on the second date, the male fed 6 times and chased away a female Yellow-throat and an unidentified bird; the female fed the young 4 times. When a disturbance was made near the nest, both adults came scolding and flashed their tail markings as they flitted through the branches.

Discussion and Summary

Although there is variation in details from species to species, nevertheless there is sufficient agreement to permit description of a general pattern of nesting behavior for wood warblers. The following remarks are based primarily on the original observations reported here.

Song is used for marking out and advertising a defended territory. When song is not sufficient to keep an intruder away, chasing results. There is no evidence that fighting or physical combat between males takes place, except possibly in the Oven-bird (Hann, 1937:151). Song is distinctive for each species, and variations in the song are often characteristic of different individuals. Geographic variations in song also occur, since descriptions given by different authors vary in important details. In addition to proclaiming territory, song is used to attract the female but not as a primary stimulus leading to coition. After mating is completed, singing is less enthusiastic and less frequent and there are sometimes modifications in the character of the song. During the incubation period, the singing of the male helps to maintain the territory and in some species or in some pairs has an influence in modifying the female's attentive behavior. Singing greatly decreases at the time the eggs hatch but may be renewed with vigor between a first and second brood.

Nearly all wood warblers are strikingly marked and often brightly colored, especially in the male. Nichols (1913) lists three principal functions for warbler coloration: concealment, recognition, and advertisement and display of the male. The coloration is displayed to advantage by spreading the tail, extending the wing, and erecting feathers on the crown or elsewhere on the body. A partial display may be given when the male is excited by an intruding bird, but it reaches a climax when the male is exciting a female toward coition. This display takes the place of a mating song, although notes of excitement may be uttered preceding coition. In the Redstart, and to a lesser extent in Magnolia and Black-throated Green Warblers, a darting semi-circular flight with full display of color has developed for intimidation of intruders in territorial defense. Coloration doubtlessly also serves for recognition of species and sex by the birds themselves.

In addition to the defended territory, some warblers (Chestnut-sided, Black-throated Blue, Black-throated Green, and yearling Red-

TABLE 1

Attentive Behavior in Eight Species of Wood Warblers

	Incubation			Brooding			Feeding young					
		Average periods			Average periods*					Times fed		
	Total observation	Attentive	Inattentive	Total observation	On nest	Off nest	Total observation	No. of young	Age of young	♂	♀	Rate per hour
	min.	min.	min.	min.	min.	min.	min.		days			
Black and White Warbler	—	—	—	—	—	—	120	5	4	2	3	2.5
Magnolia Warbler	144	120[a]	20[a]	114	16	6	114	?	0–1	2	3	2.6
Black-throated Blue Warbler	323	28	9	168	19	7	100	4	3–4	6	3	5.4
							105	3	6–7	3	4	4.0
Black-throated Green Warbler	—	—	—	—	—	—	153	?	?	6	7	5.5[b]
Blackburnian Warbler	110	19	11	—	—	—	—	—	—	—	—	—
Chestnut-sided Warbler	266	13	8	170	25	15	84	3	0–1	2	2	2.9
							86	3	3–4	7	4	7.7
	520	21	6	—	—	—	—	—	—	—	—	—
	—	—	—	57	17	6	57	4	1–2	6	6	12.6
Louisiana Water-thrush	—	—	—	—	—	—	53	4	8–9	?	?	7.9
Redstart	119	9	2	—	—	—	—	—	—	—	—	—
	153	18	8	53	15	4	53	4	3–4	12	1	14.7
	—	—	—	—	—	—	94	?	4–8	11	8	12.1

* During the first four days.

[a] Probably not representative for the species.

[b] Includes one additional feeding by an adult whose sex was not determined.

starts) have a wider area—a "home range"—over which they wander, sometimes singing, sometimes not. This wide home range may begin to develop during protracted pre-mating periods but more commonly does so after incubation is begun by the female.

The female takes no part in defense of the male's territory and may disregard its boundaries. However, she vigorously defends a smaller area around the nest, especially during the egg-laying and incubation periods, from both sexes of the same and of other species of wood warblers. This defense is less vigorous after hatching of the eggs. "Injury feigning" behavior may occur in the presence of predators.

The female usually builds the nest alone, although occasionally the male may help. The female is responsible for incubation of the eggs, but the male helps to feed the young. Four days commonly elapse between the start of nest-building and the laying of the first egg. Full incubation behavior is established when the last egg is laid, or occasionally earlier, and the incubation period is normally 12 days long. After hatching, the young remain in the nest 8 to 10 days.

Periods of attentiveness and inattentiveness are well marked, especially during incubation and brooding of the young. In different individuals and species, the average length of the attentive period during incubation varied from 9 to 28 minutes and of the inattentive period from 2 to 11 minutes (Table 1). Brooding and non-brooding intervals vary over approximately the same range. The adult male usually feeds the young at least as frequently as the female and often more frequently, since part of her time is given to brooding. The average rate of feeding varied from 2.5 to 14.7 times per hour.

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NOTES ON THE LIFE HISTORY OF THE MEXICAN VIOLET-EAR

BY HELMUTH O. WAGNER *

THE range of the genus *Colibri* extends from Brazil and Peru to Mexico. In this vast territory there live nine species according to Ridgway (1911:481), six species according to Cory (1918:219–221). The concept of the polytypic species has not yet been applied to the hummingbirds; if it were, several forms of Violet-ear currently called full species would probably be united in one polytypic species, for the differences between the forms are very small. The Mexican Violet-ear (*Colibri thalassinus*) represents the genus in southern Mexico, Guatemala, and El Salvador. Dickey and van Rossem (1938:258) have suggested that it may be conspecific with *Colibri cyanotus,* of Costa Rica, whose range extends south to Venezuela and Peru.[1] Some of the habits of *Colibri thalassinus* seem to indicate that it may have immigrated into Mexico only recently. The following notes on the species were made in the mountains surrounding the Valle de Mexico from 1941 to 1945.

Habitat

In Mexico the Violet-ear is primarily a bird of the high mountain forest. In the mountains surrounding the Valle de Mexico, the breeding habitat was formerly mixed oak, cypress, and pine woods which extended up the slopes to an altitude of 2,900 meters, but today this habitat is almost completely destroyed. It was replaced by cornfields after the woods had been considerably thinned out by burning for charcoal. The Mexican Violet-ear has adapted itself to the new environment. It is found today not only in what remains of the original habitat but also in the densely overgrown barrancas (gullies) which cut through the cultivated land, as well as in bushes and the occasional high trees at the edges of fields. The males that do not migrate live between breeding seasons in the fir (*Abies religiosa*) forest at 2,900 to 3,500 meters altitude.

In Chiapas I have found the Violet-ear between November and June (that is, between breeding seasons) in open places of the virgin rain forest (2,000 meters), in cypress-pine forest (1,450 to 1,800 meters), and in clearings of the primeval forest at 1,000 meters. The birds visited these different places at different times according to changing weather conditions. The vegetation at these various localities is very different, but the presence of flowers, especially the several kinds of mountain *Salvia,* seems to determine the Violet-ear's occurrence at all of them.

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* Translated by Margaret Mayr.

[1] In Volume 5 of the "Check-list of Birds of the World," which appeared while this paper was in press, Peters reduces the number of species in the genus *Colibri* to four and lists *cyanotus* as a subspecies of *Colibri thalassinus.*—Ed.

Habits Between Breeding Seasons

In the northern part of its range, north of the Isthmus of Tehuantepec, the Violet-ear is, with some reservations, a migratory bird. The adult females, the young, and some of the adult males migrate after the breeding season. The other males stay as vagrants in the neighborhood of the breeding range. (In a very dry winter, such as 1944–45, they disappear from the area in the second part of February and are not seen again all spring.) Their number varies from year to year. I estimate that from 50 to 90 per cent of the total migrate. In the fall, when the genetically rooted migratory impulse becomes operative, environmental factors determine whether and when migration shall occur; but there is considerable variation in the degree of readiness to migrate, different individuals reacting differently to the same set of external conditions. When in fall, living conditions are relatively favorable, in other words, if the pressure of external factors is not particularly strong, then the percentage of migrating males is smaller than in those years in which the weather at migration time is inclement and the food situation therefore less favorable.

Migration occurs between the beginning of October and early November, always coinciding with a change in the weather for the worse. The migrants return in the second half of July. (In 1942, when in all Mexico the rainy season started four weeks later than usual, their return was delayed two weeks.) It is not known where the migratory Violet-ears are the remaining eight months of the year, but one may assume that they are in Central America. In Chiapas, Guatemala, and El Salvador, more females than males are collected in the months during which the females are absent from their northern breeding range, and this might be explained by the wintering there of the migrating birds from the north.

In the Valle de Mexico proper, I observed Violet-ears only in the months of July and October. They stayed in the oak forests of the Petregals, very near to the Capital, and were probably transients from the northern breeding range. The males made themselves conspicuous with their loud call. I suspect that a bird arrives in one night and departs in the next, since I would observe individual birds only for one day in the immediate vicinity of a given group of trees.

Manuel M. Villado (1873) reported that *Colibri thalassinus* arrived in the Valle de Mexico region in July and left in November. The same was reported by Rafael Montes de Oca (1874). They evidently were not aware that some of the birds did not migrate, and it seems improbable that the Violet-ears could have been overlooked during eight months of the year since they draw attention to themselves even between breeding seasons by their loud voices. Seventy years ago, then, the Violet-ear of the Mexico City region was presumably completely migratory. The reason for the declining intensity of the migrating impulse in at least a part of the population cannot be stated with certainty. The fact that the climate has become warmer and much more arid during this period, probably because of intensive deforestation and the draining of the Texcoco Lake in the Valle de Mexico, may be relevant. Comparison of the data of the above-mentioned ornithologists with my own field observations shows that other species also have changed their migratory habits. With some, we find a considerable prolongation of the time of residence here; others remain throughout the year in varying numbers, as the Violet-ear does.

In winter and spring, the resident male Violet-ear is found where favorable feeding conditions prevail. The effects of the increasing dryness (November to May) are most noticeable at the lower altitudes. Hence we find the Violet-ear during these months above 2,900 meters, especially in the fir forest and in canyons where it is damp even in the rainless season and where the effect of the night frosts is greatly diminished. (In extremely dry winters, as mentioned above, they disappear from the area entirely during the spring months.)

As a rule, several males gather at spots where there are at least a few flowering plants. Such external requirements for life probably bring them together rather than a social impulse. They immediately betray their presence to the observer by their loud voices. During the eight months' absence of the females, the males call loudly and are capable of reproduction, as investigation of the testes proves. They are silent only during the molt in April and on days of inclement weather.

They prefer exposed perches permitting an open view and usually sit high up in a fir tree on a small dry twig while they make their call—the short, continuously repeated, notes are so monotonous that one can hardly call them a song.

The Reproductive Period

Season. As soon as the females arrive in the breeding range at the end of July, they choose a nesting site and begin immediately with the building of the nest. There is only one brood in a season. They attempt to replace lost broods only if the nest is destroyed during the first half of the breeding cycle. Any other course is made impossible by the shortness of their stay (three to four months) and the length of the period between the beginning of nest building and fledging of the young (about two months).

The question remains whether the Violet-ear has a second or even a third breeding season between November and July. Hummingbirds, in contrast with most other birds, are capable of reproduction throughout the year except during the molt. They begin to breed in my observation area as soon as external conditions are favorable. The male Violet-ears that remain in the north during the absence of the females show all the exterior signs of readiness to breed, and the testes produce spermatozoa. In another species, the White-eared Hummingbird (*Hylocharis leucotis*), which lives in the same region, even some of the females remain through the winter. These reproduce regularly. And young birds have been found in the presumed winter range of the migrants. I collected a bird in that area on April 12 that was still in juvenal plumage. In El Salvador, Dickey and van Rossem (1938:259) collected a young Violet-ear that had just left the nest on February 7, 1925. These young might, of course, belong to indigenous parents, but why should the immigrant birds, which live in the region for eight months of the year, not breed at the same season?

Behavior of the male. The males that spend the winter as vagrants in this neighborhood appear in the breeding range as soon as some of the migrating Violet-ears have come back. They perch by preference in the high cypress trees that rise above the low oak forest and call. I often saw three to five males in a limited area, usually only 8 to 15 meters apart, so that they could hear and see each other. I once observed two calling males perch in the same tree not more than a meter apart for over 10 minutes without paying any attention to each other. Not every bird, then, has his own separate territory. Mutual stimulation among males, that is, an enhancing of sexual excitement, does not seem to occur. The gathering of several males at certain localities is probably due to the especially favorable environmental conditions. Many males stay in the chosen territory during the whole breeding season. Only those that have mated seem to follow their mates into the nesting territory. This attachment to the chosen territory extends apparently not only through one season but also from year to year. One male which could be distinguished from other males by its peculiar call stayed by preference during the breeding seasons of four successive years in the same isolated tree.

As mentioned above, the plant associations of the original breeding habitat have been largely destroyed by the constantly increasing cultivation of the country. The male Violet-ear has adapted himself to the changed conditions in the selection of perching places. Even after cultivation there remain a few high trees, especially where the properties of two owners meet, and such habitats are regularly used by the hummingbirds. Figure 1 shows a typical habitat of this sort in my observation area. In the immediate vicinity of the Capital, adaptation to changed conditions has progressed so far that the males are not only satisfied with isolated trees but even perch occasionally on the tips of corn plants. The density of the male population during the breeding season differs according to local conditions. It was especially dense at the edge of a forest which bordered newly cultivated fields. One morning I saw 27 calling males along a 500- to 530-meter stretch of road, the width of the area where I observed the birds being not more than 100 meters.

The males call continually in the breeding territory to attract the attention of the females. Not only do their calls take three different forms, but the behavior of the bird changes visibly, showing three rising degrees of sexual excitement. This division is, of course, arbitrary, since it is based only on a few conspicuous signs. The three forms of expression may be described as follows:

1. A varied call given while perching on an exposed branch. On different occasions I noted: *huit ti titatia; huit tita; tetahui tetahui;* and *teta tetui tetahui.* The call is continuous, yet not very intense. A change of perch takes place only when the male visits blossoms in the vicinity to feed. I heard this type of call in the winter, rarely in other seasons except during inclement weather, but always then, when the feeding conditions were not very good.

Figure 1. Type of cultivated area used by the Mexican Violet-ear as breeding habitat since the destruction of the forests.

2. A call with increased intensity and strength of tone as compared with the preceding: *ahuit ahuit ta ta; huita huita; huit ti ta huit ti ta.* The male turns his head slowly from one side to the other while calling. He changes his perch frequently from one tree to another, on the average, every two minutes, forty seconds (between 1 minute 35 seconds and 4 minutes 10 seconds). During the flight, which is slightly undulating (Figure 2), he is silent, but otherwise he rests from calling only to satisfy briefly his need for food. One hears this type of call when living conditions are favorable, especially during the first week after the females have arrived.

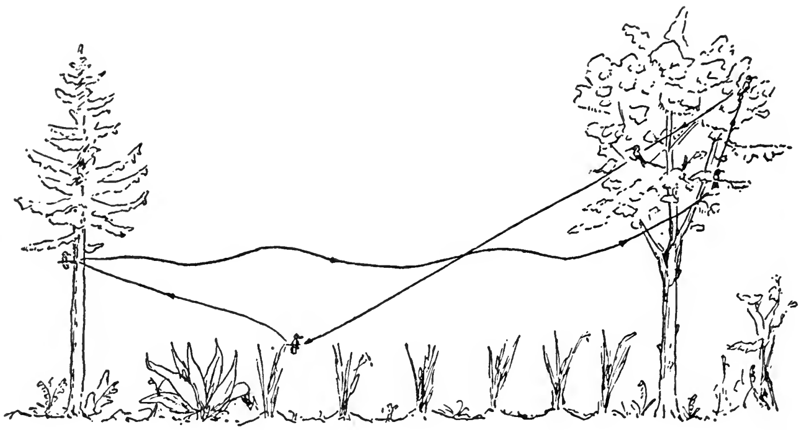

Figure 2. Perches used by a male Violet-ear while giving his call. Change of perch between calls regularly followed the sequence shown.

3. A continually repeated *huitta huitta,* expressing the peak of sexual excitement, and audible at distances of 80 to 100 meters. While perching, the bird turns his head continually from one side to the other as he sings. At the same time the head feathers—and in the highest ecstacy, the feathers of the back—are raised. The tail seesaws up and down restlessly. He changes his place continuously from one twig to another in the crown of a tree or from one tree to another. On stretches of more than 20 meters, the flight is undulating in both the vertical and horizontal planes. During the flight, he utters a call: *itta itta* or (more rarely) *huita huita.* This call is strong, though less loud than the call from a perch. When the male alights on a twig he keeps his wings spread and quivering for several seconds. Very rarely one sees the same quivering and spreading of the wings in a bird that has been sitting with folded wings for a few minutes.

On August 27, I recorded the alternating singing and feeding periods for the space of over an hour as shown in the accompanying table.

Singing period			Feeding period		
				1 min.	55 sec.
	10 min.	40 sec.		1	55
	5	15		3	10
	18	50		2	05
	3	00		1	05
	6	45		1	10
	8	10		1	55
	52 min.	40 sec.		13 min.	15 sec.
Av.	8 min.	46 sec.	Av.	1 min.	53 sec.

I found the third and highest degree of excitement only in the breeding territory and after the females had finished nest building and were looking for mates. It seems to occur only under the influence of the female. As sexual excitement increases, the males become more wary. If one approaches within 40 or 50 meters of them they leave their perch.

The males call during the whole day but become quieter in the afternoon, especially in the winter months. If the weather is cold and rainy, or even cloudy, the intensity and duration of the calling are considerably diminished.

In some places the breeding territories of the Violet-ear and the White-ear overlap. One then often sees males of the two species only 10 to 15 meters apart in cypress trees, calling loudly and paying no attention whatever to each other. There is, however, a change in this behavior when two birds come to the same flower to feed during an intermission of their calling. Then the smaller White-ear is immediately driven away.

Relations between the sexes. The Mexican Violet-ear belongs to the group of hummingbirds in which the mature females, after building the nest, search for the males. The males advertise their presence and gain the attention of the female by their loud voices and by display flights. (Most of the other hummingbirds in Mexico use only one of these two methods.) In the Violet-ear, it is primarily the far-reaching call that draws the attention of the females, but I am sure that the undulating flight during the change of perch has also a certain importance.

My knowledge of the courtship flight that precedes copulation is incomplete. It is based on a series of separate observations made over a period of years. I have combined these to make up what I suppose to be the sequence of the courtship ceremony. It would probably be impossible to observe the sequence as a unit since the various steps or phases take place at different localities. Since the sexes in the Violet-ear look alike, the identification of male and female in the following description of the courtship ceremony are based on my own assumptions.

1. When the nest is nearly completed, the female, now ready for fertilization, looks for places where males are calling. As soon as she comes in view she is followed by one or more males. When two or more males follow a female they begin a wild race, but as soon as one male reaches the side of the female, the other males drop out and return to their territory. Single males meeting a pair flying side by side pay no attention to them.

2. The pair fly side by side not more than 50 centimeters apart. In a fluctuating wavy flight they pass and repass a certain stretch (300-500 meters ?) which seems to be the nesting territory of the female. During the flight a soft *zcsesoorr* is audible. Apparently in the later flights

they sometimes clap their wings, since they make a sound like that made by pigeons. At one of the two end points of the stretch, the flight is interrupted for two or three minutes, while the female goes down in the same tree crown and flutters around with a low *tick tick tick*. The two mates are not together during this time, and I do not know what the male does. Suddenly he appears again flying directly past the female, who follows immediately. The stretch is flown in each direction at least five times.

3. The sexual excitement of the female has increased with each trip. Finally, at one of the end-points of the stretch, it reaches its climax. She descends from the top of the tree in a fluctuating, wavering flight, with loud wing-clapping; on nearing the ground she flies upward again and perches for a short time on a twig. She repeats this until the male again appears and leads the female in a final wild flight.

4. I did not observe copulation, which presumably follows this display. It does not seem to take place in the vicinity of the nest. I once had occasion to observe the second phase near a nest which presumably belonged to the participating female. About 20 minutes after I last saw the birds, the female returned to the nest. Two days later the nest contained its first egg.

As a rule in hummingbirds, the male pays no attention to the female after mating. Incubation and care of the young are solely the concern of the female. In the Mexican Violet-ear, although I commonly observed a single calling male in the vicinity of a nest, there was no evidence of his relationship to the owner of the nest. Robert T. Moore (1939:315—also Bent, 1940:471) reports, however: "In Ecuador I have observed the male and female [Lesser Violet-ear, *Colibri cyanotus*] take turns incubating at the same nest and collected both sexes to substantiate this observation."

Nesting territory. In the selection of nest sites, the females have adapted themselves to the changed conditions of their habitat as the males have in selecting singing perches. Only two of the eight nests I found from 1941 to 1943 were situated in the oak-cypress forest; the others were in densely overgrown barrancas, 20 to 30 meters wide, surrounded by cornfields. In the barrancas, whose slopes are too steep for cultivation, one often finds small oak shrubs among the dense bushes. The site originally preferred seems to have been a free oak branch (*Quercus crassipes* or *Q. nitens*) about 40 to 180 centimeters above the ground. I found five nests in such situations (Figure 3). Another nest was in the dense branches of a small oak (2½ to 3 meters high) which had grown up from an old root (the site shown in Figure 7). With the other two nests, however, the plant associations of the habitat, as well as the "nest tree," were entirely different. Each of these nests was built in the vertical fork of a stem of *Salvia polystachya* among the bushes of a barranca (Figure 4). The plants could barely support the nests and were saved from breaking only by the dense plant growth around them.

Figure 3. Nest of a Violet-eared Hummingbird on the twig of an oak (*Quercus nitens*).

Figure 4. Nest of a Violet-eared Hummingbird on a stalk of sage (*Salvia polystachya*).

Every female has a strictly defined territory in which no other female of the same species is tolerated. Surrounding the territory is a "neutral zone" in which neighboring females do not fight when they meet. Apparently the male stays in this zone also, and avoids if possible the nest territories, even the one belonging to his own mate. I was able in 1942 to determine quite accurately the size and boundaries of the nesting territories. In that year I found four nests of the Violet-ear that were occupied at the same time. They were nearly in a

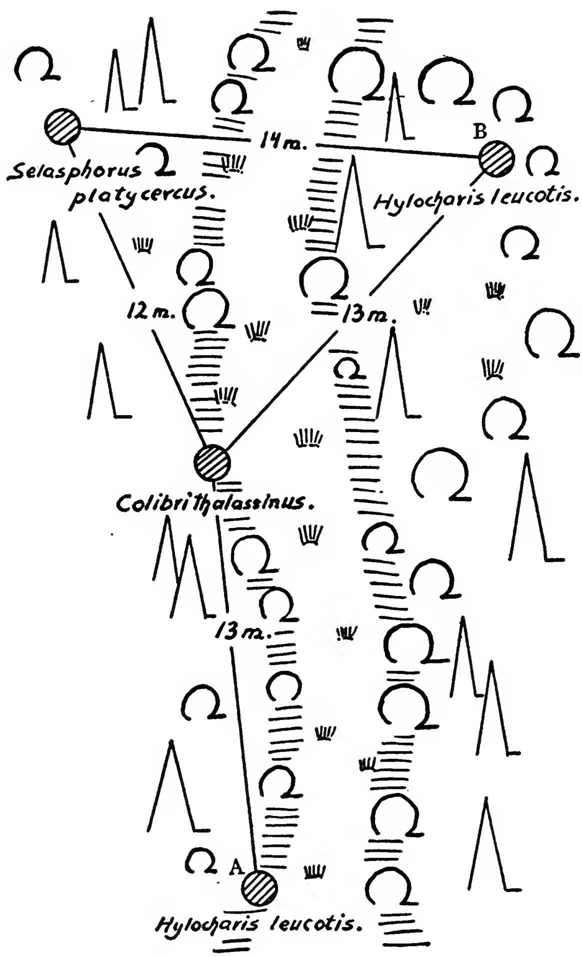

Figure 5. Location of nests concurrently occupied by three species of hummingbird (*Selasphorus platycercus, Hylocharis leucotis, Colibri thalassinus*). Distribution of vegetation shown schematically. Distances in meters. Nest B of *Hylocharis leucotis* was probably a substitute for Nest A, which had been destroyed.

straight line, three in an overgrown barranca, the fourth higher up, at the edge of a thin oak-cypress forest. The nests were 52, 60, and 95 meters apart. There were natural boundaries between the nesting territories since the dense flowering growth of *Salvia mexicana* was pushed back by higher bushes and trees even at the foot of the barrancas. Each of the nesting territories comprised an area of 600 to 1,000 square meters. The "neutral zones" around them were mostly border-strips where the vegetation of the barranca bordered on the cornfields. There are no flowering, food-bearing plants whatever in the cornfields, and they are therefore not visited by the Violet-ears. Birds that nest in the forest, where the flower growth is more sparse, apparently have much larger territories. Except for some *Salvia cardinalis* growing in the shady, damp places, *Pentstemon campanulatus* is the only one of the flowering plants in the forest that is visited by the hummingbirds.

The Violet-ears pay no attention to other species of hummingbirds that breed in the vicinity of the nest. In August, 1941, I found in a very restricted area a nest of *Colibri thalassinus,* one of the White-ear (*Hylocharis leucotis*), and one of the Broad-tailed Hummingbird (*Selasphorus platycercus*). All three nests were occupied at the same time, although the different species were at different stages of the reproductive cycle. The young of the Violet-ear hatched August 18; the young of the Broad-tailed Hummingbird left the nest about four days later, while the White-ear was still incubating the eggs. Figure 5 shows the locations of the nests and the distances between them. I never observed that the three female hummingbirds, whose territories partially overlapped, bothered each other. A nest of the White-ear was destroyed by the Violet-ear, but apparently not because it was the nest of another species, but merely to obtain material for her own nest.

The construction of the nest. The nest of *Colibri thalassinus* can be distinguished from all other Mexican hummingbird nests by the long grass hanging down from it (Figures 3 and 4). It is always built at the base of a fork on a slender twig. The structure of the nest is shown in the schematic vertical section, Figure 6. It is built mainly of moss, which the bird picks from the bark while hovering before the branches. Only after the main body of the nest is completed does the bird add the dried grass. The amount of grass used varies. Some nests are densely covered with grass; others show moss in places. The wide grass blades hang down freely to a length of 20 centimeters. The inner lining is usually of moss; sometimes a few feathers are also used but too few to be of importance. Great quantities of spider-web give the structure the necessary coherence. When the nest is finished it is connected with the neighboring twigs and leaves by a great many threads, but it is probable that these are blown there by the wind and not purposely arranged by the builder. By the time the young are hatched, almost all the threads are torn and hardly recognizable.

Once in a while plant down is used for the inner lining instead of moss. This down is the fine "hair" that covers the gall of the oak-gall wasp. It is surprising that the Violet-ear does not itself pick this material from the galls but steals it from neighboring nests of the White-ear. I observed the robbery and the destruction connected with it in three nests. Two of the Violet-ear nests that I found were lined with plant down obtained this way. Figure 6 shows the structure of such nests. The robbing of a nest of the White-ear usually takes place when it is least guarded—in the last days of the construction period or after the young are two weeks old. As soon as the owner of the nest appears, the Violet-ear departs without the least attempt to fight.

If the nest of the White-ear is not finished, she continues to build on it for two or three days until it collapses. She does not mend the damage. If young are in the nest, they stay there until the last pieces are picked away from under their bodies and they fall to the ground. For five days I observed very closely the destruction of a nest with young. One young, 18 days old, fell on the fourth day; the other, a stronger bird, fell one day later. Both died. To get to the dense inner lining of plant down the Violet-ear picks a hole about eight or nine millimeters in

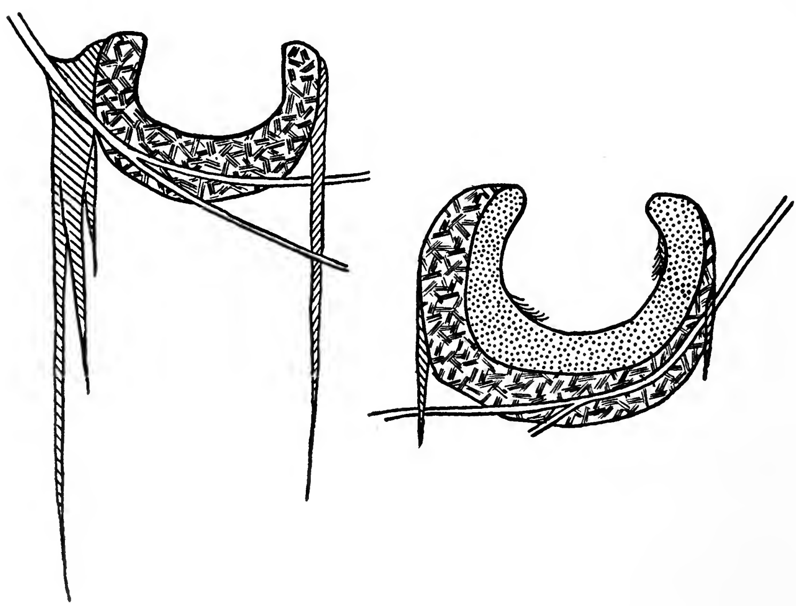

Figure 6. Cross sections of Violet-eared Hummingbirds' nests and supporting twigs, showing the basic structure of moss and hanging grass. Nest on left is lined with moss, nest on right with plant down stolen from a White-eared Hummingbird's nest. Spider web is used as a binder.

diameter in the side of the moss wall. In a short time the nest collapses. Later, the Violet-ear steals the moss also, until only a few remnants remain. While picking the material, the Violet-ear usually hovers before the nest. But if there is an opportunity to perch on a twig, she does so.

The nest of the Violet-ear is by far the most compact of all the hummingbird nests that I have had the opportunity to examine closely. Even by the time the young leave the nest, it has merely been stretched larger; the walls are not deformed or torn as is the case with many other species of hummingbird whose young in the last days rest on the platform-like ruins of a nest.

Incubation. I only once found a nest of the Violet-ear early enough to determine the exact period of incubation. The young hatched between the sixteenth and the seventeenth day. After laying the first egg, the bird sat on it for several short periods during the forenoon. This beginning of incubation before the clutch is complete seems to be the reason that the eggs hatch at different times.

After the clutch is complete, the bird leaves the nest only for short intervals to look for food. On the third day of incubation, she left every 24 to 30 minutes for periods of 9½ to 14½ minutes. As the day of hatching approached, her feeding time became shorter. On the twelfth day, that is, four days before hatching, the bird left the nest every 18 to 25 minutes for periods of only 3 to 4 minutes. On the last day she stayed away for scarcely 2 minutes at a time.

During the breeding season, the Violet-ear is, as a rule, extremely wary around the nest, but there are great differences among individuals. Usually the bird flew off when I had approached carefully to within 8 to 15 meters. She left stealthily and without a sound. When about 20 meters away she would start calling anxiously. The female always takes the same route to and from the nest, whenever possible one concealed by vegetation. One bird that regularly visited flowers within a meter's distance in full view of her nest, did not take the direct route in returning to the nest but went a round-about way, circling a bush to reach the point from which she regularly made her approach to the nest. Before going to the nest, a female usually perches on a certain twig and reconnoitres. Figure 7 shows the regular route of one female. She always approached through the dense vegetation at the base of the small oak in which the nest was situated, moving upward by several stages to the nest.

While there are eggs in the nest, the bird descends on them without first perching on the edge of the nest or on a neighboring branch. She hovers for several seconds about 10 to 15 centimeters (4 to 6 inches) above the nest, then descends by degrees and suddenly sits on the nest. This happens so fast that one cannot see all the movements in detail. She always sits on the nest facing in the same direction and this determines the direction of approach. After settling on the nest she moves about a little and then remains almost motionless. When something disturbs her, she moves her head restlessly from side to side, then usually flies off suddenly. The departure is in the opposite direction from the arrival. The bird rises from 4 to 6 inches in the air, hovers over the nest for a moment, and then darts forward.

An incubating bird closely watches birds of other species that come into the neighborhood of the nest but does not chase them away. A female flew off immediately, however, upon seeing a weasel pass underneath the nest site.

Rearing the young. The interval between the hatching of the two young may be as much as 24 hours. The first young to hatch is fed before the second has left the egg. The parent bird does not remove the pieces of eggshell; one can still see them at the bottom of the nest several days later.

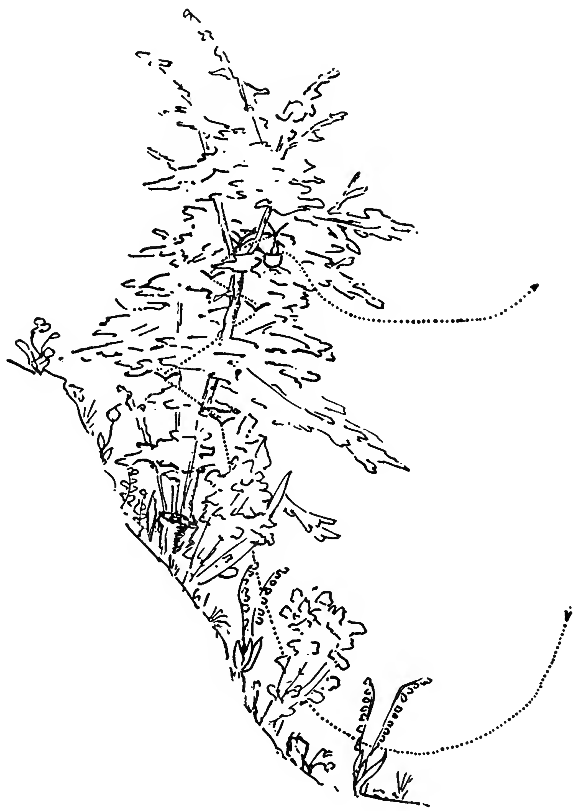

Figure 7. Regular flight routes used by a female Violet-ear when approaching and leaving her nest in a small oak 2½ to 3 meters high. Below, route of approach; above route of departure.

The feeding and brooding of the young follow a certain rhythm that changes with the age of the young. As the young develop, the time spent brooding becomes shorter and shorter (usually ceasing after the tenth day regardless of weather conditions), while the time spent looking for food becomes longer. This changing rhythm is illustrated in Table 1. The observations were made at the same nest in the early morning hours. When I arrived at the nest the temperature was between 8° and 10° C. and rose by noon to 12° or 14°. With the exception of a few afternoon showers, the weather during the period was very favorable for the development of the young.

TABLE 1

CARE OF YOUNG

Periods of Absence, Feeding, and Brooding in Minutes and Seconds

Second day			Fifth day			Eighth day			Eleventh day		
Absent	Feeding	Brooding	Absent	Feeding	Brooding	Absent	Feeding	Brooding	Absent	Feeding	Brooding
—	—	14′ 55″	2′ 30″	—	6′ 30″	18′ 37″	0′ 48″	9′ 14″	20′ 55″	0′ 57″	—
8′ 50″	0′ 27″	9′ 03″	7′ 41″	0′ 35″	5′ 25″	16′ 20″	0′ 41″	0′ 07″	22′ 08″	1′ 63″	0′ 35″
7′ 10″	—	11′ 30″	11′ 13″	0′ 50″	5′ 45″	21′ 12″	1′ 00″	0′ 18″	29′ 23″	0′ 45″	—
9′ 40″	0′ 35″	8′ 05″	12′ 18″	0′ 48″	7′ 24″	30′ 54″	0′ 56″	10′ 19″	25′ 06″	0′ 49″	—
5′ 15″	0′ 30″	7′ 12″	7′ 21″	—	9′ 17″	—	—	—	—	—	—
11′16″	0′ 29″	7′ 29″	13′ 18″	0′ 47″	—	—	—	—	—	—	—
Av.: 8′24″	Av.: 0′ 30″	Av.: 9′ 42″	Av.: 9′ 03″	Av.: 0′ 45″	Av.: 6′ 52″	Av.: 21′ 43″	Av.: 0′ 51″	Av.: 4′ 59″	Av.: 24′ 33″	Av.: 0′ 53″	

Fifteenth day			Eighteenth day			Twenty-second day		
Absent	Feeding	Brooding	Absent	Feeding	Brooding	Absent	Feeding	Brooding
39′28″	0′ 54″	—	—	0′ 54″	—	—	0′ 22″	—
29′11″	0′ 47″	—	40′ 28″	0′ 51″	—	6′ 30″	0′ 27″	—
33′47″	0′ 42″	—	36′ 51″	0′ 33″	—	6′ 25″	0′ 19″	—
32′10″	0′ 57″	—	41′ 17″	0′ 55″	—	6′ 06″	0′ 21″	—
—	—	—	—	—	—	6′ 09″	—	—
Av.: 33′39″	Av.: 0′ 50″		Av.: 39′ 32″	Av.: 0′ 48″		one young leaves the nest		
						—	0′ 19″	—
						17′ 51″	0′ 21″	—
						12′ 58″	0′ 24″	—

During the first days after the young hatch, the female does not always feed the young on her return to the nest. Then she has presumably looked for food just for herself. In such cases, the time of her absence is considerably shorter. Other species of hummingbird in the high mountains regularly show this behavior. The White-ear, for instance, during the first week after the young hatch always collects the food for herself and for the young at separate times. This may be connected with a difference in nutrition needs, but I think it more probable that it is an adaptation to the cold weather. The periods of absence are shortened by the separate feeding, and thus the young do not get so cold. In *Colibri thalassinus,* the development in this direction is only beginning. Its habits and degree of adaptation to local conditions indicate over and over again that the species has spread into the north only in recent times.

The day that the first young flew from the nest, the mother bird returned to the nest on the average every 6 minutes, 17 seconds. She would be able to find little food in this short time, and the feeding was accordingly very brief. It is possible that this habit is based on an inner restlessness which is transmitted from the young to the mother. After one of the young has left the nest the two birds are fed alternately, and the female visits the nest only half as often as before.

The table shows that on the eighth day, the female brooded twice for an unusually long period. On this morning the temperature was exceptionally low (8° C. at 9 o'clock, 11° at 11:00). Since at this stage of the young's development, the female stays away for a relatively long time searching for food, the young become rigid with cold when the temperature is unusually low, and they do not take the offered food. In such cases they are brooded longer. This was observed also with other species of hummingbird. The time the female broods is probably regulated by her hunger. When she eats the food intended for the young, the releasing factor that causes her to leave the nest is delayed. Thus is brought about a simple but very important regulation of brooding time according to increased need. The time spent in the actual feeding shows very little variation at different ages of the young. The amount of food given increases steadily, but in the beginning, the young take it in smaller portions, thus effecting a balance.

The Violet-ear feeds her young with the same food that she eats herself. During the first few days, small pieces of animal matter are usually fed, but it is amazing what large pieces can be taken even at that early stage. I did not find honey in crops of the young, but it may be assumed that they are fed it in small quantities to satisfy the need for liquids. The brood is fed regularly throughout the day until it is nearly dark. Feeding takes place from the edge of the nest, always from the same place. Once, however, when the young were rigid with cold and not eating well, I observed the female try to feed them after she sat on the nest. At each visit the female feeds the two young alternately three or four times. The food is collected in the crop and regurgitated in small portions. The touch of the adult's bill to the corner of the young's bill is enough to make the still blind young open its mouth. One gets the same reaction with the tip of a pencil. Touching any other part of the body does not cause them to open the bill. After the young can see, they open the bill as soon as the mother appears at the edge of the nest. The female puts her bill deep into the crop of the young to feed them, remaining in that position from two to four seconds. At first the feeding is done from above the head of the young. Later, when its bill grows larger, the young bird turns its head and is fed from the side. After nest leaving, the young are fed by their mother while sitting beside her on a branch. She still feeds from the side, so that her head lies between the mandibles of the young as she inserts her bill deep into its crop and regurgitates the food in several portions.

On the second, or at latest, on the third, day after leaving the nest, the young begin to hunt their own food, but they are still fed by the mother as well. It is very surprising to see a hummingbird that is hovering expertly in front of a flower, suddenly interrupt this activity to be fed by another bird. After five to seven days, the young are completely independent.

I have never heard any sounds from the young during the first week after hatching. Later, they peep occasionally. They invariably peeped when I took them from the nest to measure them, but I observed no connection between the sounds and the appearance of the adult at the nest.

The young are very sensitive to heat from the sun. At the time the nest site is chosen, it is in shade all day. But since the birds cannot take into consideration the continuous change in the sun's position, it sometimes happens that later in the season the nest is exposed to the sun. As soon as the sun rays reach the nest, the young begin to pant, even if the temperature is below 10° C. in the shade. With wide open bill, they stretch the head upward and swing it from side to side. If the female returns, she stays at the edge of the nest after feeding the young, restlessly moving back and forth so that the young are in the shade. Very rarely she sits over them, forming a roof against the sun. On such occasions I could see the heads of the young protruding on the shady side. So long as the brood pants, the mother does not fly away whatever their stage of development, but protects them from the sun. Their sensitivity to the sun decreases as they grow older. Even the adult Violet-ear can stand the bright sun only for a short time. The female pants occasionally while protecting the young from the sun. She opens the bill, dropping the lower mandible at an angle of 10 to 15 degrees, and becomes extremely restless.

When it rains, the female goes to the nest and protects the young. In the high mountains of Mexico, during the breeding season, it rains almost every afternoon. By that time the young have received plenty of food. The crop contains four to six times as much as the stomach can hold; hence they can live several hours without being fed and suffer no ill effects. However, if it rains continuously for several days as it did, for example, in 1941, most of the broods perish. The impulse to protect the young against the rain—a very good adaptation to the usual short heavy showers of the tropics—apparently prevented the parent birds from giving the young sufficient food under those unusual conditions.

From at least the fourth day, the young void over the edge of the nest, pushing the body upwards against the side of the nest to eject the feces. I did not observe any correlation between the times of feeding and voiding.

Development of the young. The length of time required for the young to develop sufficiently to leave the nest varies considerably—between 19 and 28 days. Environmental factors greatly influence growth; the most important is the quantity of food that the female procures for the young, and this depends on weather conditions. The various stages of development are apparently reached after given amounts of food are consumed. Differences in rapidity of growth are less pronounced between the broods of one breeding season than between broods of different years with widely differing weather conditions.

In general, the organs develop at a uniform rate. Only under extremely unfavorable conditions are some backward in development, and then the head seems to be less affected than the extremities or feathers. Figure 8 illustrates the difference in rate of growth under

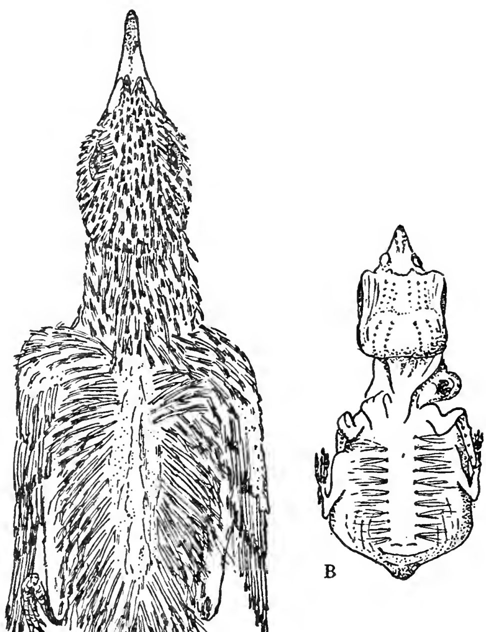

Figure 8. Two nestlings of about the same age (13 to 14 days). Young A (5.85 grams) was sole occupant of nest and developed under optimal weather and feeding conditions (season of 1943). Young B (1.10 grams) shows stunted condition at death after two weeks of malnourishment due to extremely severe weather (season of 1941).

different environmental conditions. Nestlings A and B are about the same age—if anything, the less-developed one is a little older than the other. I am comparing here the greatest extremes that I could find. The two birds were collected in the same area but in different years.

Nestling B had lived under the worst conditions imaginable. For two weeks after hatching it did not grow at all but merely subsisted. These two weeks were unusually rainy, and thus the mother was prevented from looking for food for long periods, and when she went for food she needed much more time than normally because of the unusually cold weather. The young bird shown here, as well as the other member of the brood, died after these two weeks of malnutrition. When I found them, they had just died, and the mother was still coming to the nest, trying to feed them. There were a few insects in the stomachs and crops. The nestlings weighed 1.10 and 1.05 grams. Their eyes were still closed.

Nestling A was the only occupant of its nest. I collected it when it was 13 to 14 days old. Every part of the body was much more highly developed than in Young B. It was covered with sheathed feathers in contrast with the other, which showed scarcely more than an indication of the feather tracts. The eyes had been open for 6 days. The weight was 5.85 grams, five times that of Young B.

Under normal conditions, if the brood consists of two young they leave the nest between the twenty-third and twenty-fifth day. A single nestling receives a double portion of food and grows considerably faster. Twice I watched the growth of neighboring broods, one with one young, the other with two. In one case, the single young left the nest four days earlier than the other two young, at 19 to 20 days. (The young left the nest on my approach. I had not handled it.) The longest time in the nest I have recorded was 27 to 28 days. In that case, a few rainy, cold days had inhibited the growth. Possibly under worse conditions, the time required for development might be even longer.

These facts help to explain the variation in the figures given in the literature for the nestling period of hummingbirds of a given species. One must assume that this period is also dependent on the length of day, varying with the time of year and the latitude.

The following notes, made on a brood of two at 3-day intervals, illustrate the normal progress of the young Violet-ear's development.

2nd day: 12 and 36 hours old. Upper parts, graphite black; lower parts, flesh color; at sides, gradual transition from one color to the other. Eyes closed. On the back, two rows of 10 to 12 down feathers (Figure 9), each 4 to 5 mm. long. (The number of down feathers is often not the same at the two sides.) Bill, light yellow; 3.5 mm. wide, 3.3 mm. long.

5th day: Color unchanged. The first signs of the contour feathers showing on the head as small papillae. Bill and body considerably larger, but unchanged in proportions.

8th day: Both young had grown so much that they filled the nest completely to the brim. Some sheaths were beginning to open on the head, showing the tips of brown feathers. Back covered with sheathed feathers, the primaries 2 to 3 mm., the secondaries just visible. No tail feathers visible. Bill longer, its tip darkening to black. One bird opened one of his eyes in a narrow slit when I pulled out a sheath.

11th day: The eyes had opened though they were kept closed most of the time. The whole upper parts were covered with sheathed feathers, those on the back beginning to open. At the sides of the body, a slight trace of feathers. Very short sheathed feathers on the tail. (The down feathers remain for several days at the tips of the opening sheaths.) The young no longer opened their bills when touched. The lining of the throat and mouth was orange-red with yellow border.

15th day: The growth of the body (except the chest) now almost complete. The sheaths were open over the whole of the upper parts. The feathers at the sides of the chest were beginning to appear. The primaries were 14–15 mm. long, the distal 4 mm. unsheathed. The sheathed tail feathers (5.2 mm. long) were just about to open. The feathers on the head had grown very little since the seventh day. The feathers of the back still had down at their tips. Bill, 6.7 mm. long. From the tip of the bill along the culmen, the color was progressively darkening to black. The tip was now completely black, the edges of the mandibles still yellow.

18th day: The young were completely feathered. Primaries, 22–25 mm., of which 12–15 mm. were unsheathed. Tail feathers, 10 mm., of which 3–4 mm. were unsheathed. The tips of the wings were even with the tip of the tail.

22nd day: All the feathers were entirely unsheathed. The brown edges of the contour feathers were already wearing off. The blue ear patches had begun to show. Length of culmen, 10.4 mm. (The bill of a full-grown Violet-ear in this area has an average length of 18.4 to 18.8 mm.) The bill was all black, only the corners showing a little yellow. While I was watching, one bird left the nest; the second one stayed for another day.

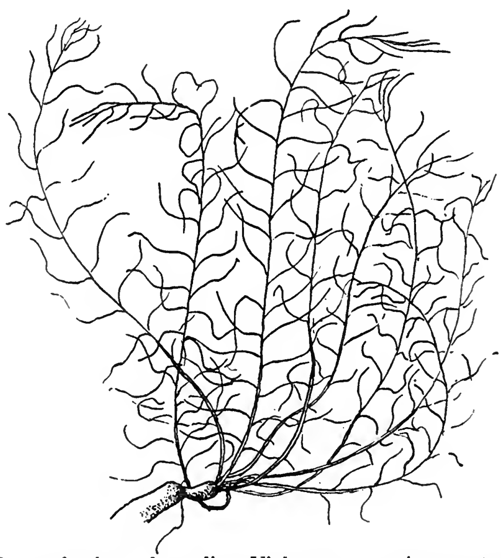

Figure 9. Down feather of nestling Violet-ear. 20 times natural size.

The period of development is, in general, divided into two phases. In the first phase—up to the fifteenth day—the body increases continuously in weight, but the growth of the feathers is very slow. In the second phase, hardly any gain in weight takes place, but the feathers and bill develop.

Unfortunately I was not able to record the gain in weight of the same individual. The following weights are from different birds:

Nest 2, 1941	(Nestling B, Figure 8)	14 days	1.10 grams
	(nest-mate of above)	14 days	1.05 grams
Nest 1, 1943	(Nestling A, Figure 8)	14 days	5.85 grams
Nest 2, 1943	(♂)	17 days	5.85 grams
Nest 2, 1943	(♀)	17 days	5.45 grams

For comparison, a few weights of full-grown birds:

♂ juv. November 2	5.30 grams
♂ ad. December 29	5.65 grams
♂ ad. January 8	5.65 grams
♂ ad. January 9	5.15 grams

The greatest weight I recorded was for two nestlings of 5.85 grams each, one 14, the other 17 days old. They were equally well developed externally. The greatest weight I recorded for adults was 5.65 grams (two males). A female of a brood is usually a little lighter in weight than a male of the same brood. Thus under normal conditions the nestlings reach the weight of the adults, or even go beyond it, after two-thirds of their nestling period. Their form, however, is very different from that of an adult, as shown in Figure 10.

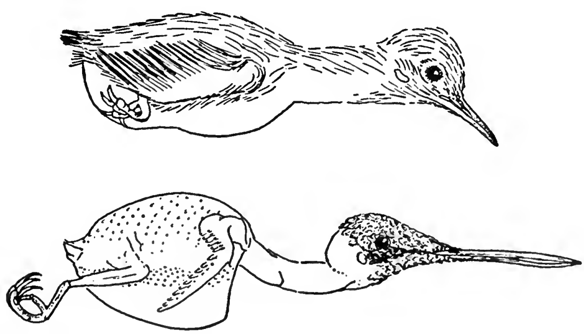

Figure 10. Nestling and adult Violet-ear. Nestling (age 17 days): 5.85 grams. Adult (collected January 9): 5:10 grams. The adult was plucked to show the body form.

Speed of Flight

The speed of the hummingbird's flight varies with circumstances. It was possible with a stopwatch to make numerous measurements of the male Violet-ear's speed as he made his regular flights from one isolated tree to another while calling to attract the female. He attained an average speed of more than 90 km. per hour. This speed, however, is considerably lower than his maximum, which I estimate may be twice as high. On the occasion of one Violet-ear chasing another, I noted a velocity of more than 150 km. per hour. Since this is only a single observation, the record is not absolutely dependable. When the bird passes close by at high speed, one hears a noise like the snap of a whip. The speed of its reactions and its versatility in flight are astonishing.

Summary

The Mexican Violet-ear (*Colibri thalassinus*) is primarily a bird of the mountain forest. Its breeding habitat in the mountains surrounding the Valle de Mexico is the oak-pine-cypress forest. Since the destruction of the forest and the cultivation of the land, the Violet-ear has adapted itself in some degree to the new environment.

In its northern range the Mexican Violet-ear is in part a migratory bird. The females, the young, and a varying percentage of the adult males go south in October and early November and return to their breeding range in July. The presumed winter range is in the mountains of Chiapas, Guatemala, and farther south. Environmental conditions greatly influence the percentage of males that migrate, as well as the time that migration takes place. According to reports from 1873 and 1874, all Violet-ears then migrated in winter. The non-migratory males usually stay as vagrants in the fir forest (2,900 to 3,500 meters) at places where there are flowering plants even in winter. In dry winters, however, all the males leave the area by the second half of February.

Immediately after their return in July, the females begin building the nest. There is but one brood. Substitute broods are attempted only if the eggs have been destroyed during the first half of the breeding cycle.

The males attract the attention of the females by their loud calls and display flights. There are several phases of song, expressing different stages of sexual excitement.

After completing the nest, the females look for the males, and courtship flight takes place.

The nest is usually situated low down in small oaks. As an adaptation to the new conditions, other low plants are also used. The nest is easily identified by the long grass hanging down from its sides. The most important building material is moss. Occasionally the Violet-ear steals nesting material from the nest of the White-eared Hummingbird.

The young hatch after an incubation period of 16 to 17 days (determined at only one nest). They leave the nest after 19 to 28 days (sometimes possibly more—under normal conditions they leave after 23 to 25 days). They are fed for 5 to 7 days after leaving the nest. In general, a period of 55 to 65 days is required for the nesting cycle—from the beginning of nest construction to the complete independence of the young.

The rate of growth of the young is largely dependent on the weather. Therefore the degree of development at any given age shows a marked variation.

The speed of flight is, under normal conditions, more than 90 kilometers per hour. This can be accelerated to more than 150 kilometers per hour (recorded in one instance).

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THE OCCURRENCE OF THE INCUBATION-PATCH IN SOME BRAZILIAN BIRDS *

BY DAVID E. DAVIS

FROM September 1942 to January 1943, a series of more than a thousand birds was collected at Teresopolis, State of Rio de Janeiro, Brazil, for the purpose of determining the breeding season. In addition to the usual data (date of collection, locality, etc.), the presence or absence of an incubation-patch and the age (as determined by the ossification of the skull and the size of the bursa of Fabricius) were noted. The sacrum of each individual was cut out and preserved in Bouin's fluid. The gonads were removed under a dissecting-scope and sectioned for an accurate determination of the breeding condition. The patch was considered present in the species if present in one or more individuals of either sex in active breeding condition; absent in the species if absent in two or more individuals in active breeding condition.

Brood- or incubation-patches are "specially modified areas of bare skin" which are "adaptations providing for the closest possible application of the eggs to the warm surface of the body, and, what is more, to an area rendered particularly suitable for the purpose by a heightened blood supply and other changes. . . ." (Tucker, 1943:22). Although not all species of birds have the patch, the majority do, and the patch is obviously an important factor in incubation (Ryves, 1943:10); in some species only one sex has the patch, and its presence (or absence) may be used in the determination of sex (Nice, 1937:4; Kendeigh, 1941:11).

The patch occurs only in the breeding season: species and sexes that showed patches in the breeding season showed none in the non-breeding season; and no individual with inactive or progressing gonads showed the patch. The occurrence of the patch in the series studied is shown by sex and species in Table 1. The patch was found in one or both sexes of 43 species (representing 16 families). In no species investigated was the patch absent in both male and female, but both sexes were not collected for all species.

The occurrence of the patch invariably agreed with the incubation habits when these were known. Ticehurst (1931:582–583) determined the occurrence of the patch in 35 species of shore birds and found almost perfect correlation with what was known of the incubating habits. So very few Brazilian birds have been intensively studied that it is not yet possible to completely correlate the occurrence of the patch with in-

* The work on which these observations are based was done under the auspices of the Serviço de Estudos e Pesquisas sôbre a Febre Amarela (Yellow Fever Research Service), which is maintained jointly by the Ministry of Education and Health, of Brazil, and the International Health Division of The Rockefeller Foundation. The collection of the birds here reported upon was part of an investigation of the ecology of the forests in relation to jungle yellow fever (Davis, 1945). The skins have been presented to the Museu National, Rio de Janeiro.

TABLE 1

THE OCCURRENCE OF THE INCUBATION PATCH IN MATURE BREEDING SPECIMENS OF SOME BRAZILIAN BIRDS

		Present		Absent	
		♂	♀	♂	♀
Tinamous (Tinamidae)	*Crypturellus obsoletus*				2
Parrots (Psittacidae)	*Pyrrhura frontalis*			2	
Cuckoos (Cuculidae)	*Piaya cayana*	1			
	Guira guira	2	1		
Hummingbirds (Trochilidae)	*Eupetomena macroura*	1			
Trogons (Trogonidae)	*Trogonurus rufus*	1	1		
Woodhewers (Dendrocolaptidae)	*Xiphocolaptes albicollis*	2	2		
	Lepidocolaptes fuscus			5	
Ovenbirds (Furnariidae)	*Certhiaxis cinnamomea*		1		
	Syndactyla rufosuperciliata	2	2		
	Automolus leucophthalmus			3	
	Cichlocolaptes leucophrys	1			
	Heliobletus contaminatus		1		
	Sclerurus scansor	2	1		
Antbirds (Formicariidae)	*Batara cinerea*		2		
	Drymophila ferruginea	1			
	Drymophila milura	1			
	Pyriglena leucoptera	1			
	Myrmeciza loricata	1			
Cotingas (Cotingidae)	*Attila rufus*		2		
	Pachyramphus polychopterus			2	
	Tityra cayana	1	1		
	Procnias nudicollis			2	
Flycatchers (Tyrannidae)	*Myiodynastes solitarius*	1	1		
	Myiozetetes similis		1		
	Empidonax euleri	1	1		
	Myiobius atricaudus		1		
	Onychorhynchus swainsoni		1		
	Hemitriccus diops			4	
	Elaenia mesoleuca		1		
	Phyllomyias griseocapilla	1			
Wrens (Troglodytidae)	*Troglodytes musculus*		1		
Mockingbirds (Mimidae)	*Mimus saturninus*		1		
Thrushes (Turdidae)	*Platycichla flavipes*		3	3	
Blackbirds (Icteridae)	*Molothrus bonariensis*				11
	Ostinops decumanus		1		
Tanagers (Thraupidae)	*Tanagra chalybea*		1		
	Thraupis ornata		2	2	
	Habia rubica		1		
	Trichothraupis melanops		1		
	Thlyposis sordida		1		
	Schistochlamys ruficapillus		1		
Sparrows, Finches (Fringillidae)	*Haplospiza unicolor*			4	

cubation behavior, but the few species for which data are available are mentioned below.

Absence of the patch in the two tinamou specimens (both female) agrees with the conclusion (drawn from field observations by earlier workers) that only the male incubates the eggs in this family. Presence of the patch in both sexes of the cuckoo *Guira guira* agrees with the observed fact that both sexes incubate. The presence of a patch in the one specimen (with fully active testes) of the Swallow-tailed Hummingbird (*Eupetomena macroura*) is surprising and requires confirmation; however, Robert T. Moore (1939:315—also in Bent, 1940:471) reports: "In Ecuador I have observed the male and female [of *Colibri cyanotus,* the Violet-eared Hummingbird] take turns incubating at the same nest and collected both sexes to substantiate this observation." The patch is presumably present in all females of the Dendrocolaptidae, Furnariidae, and Formicariidae, but breeding females were collected for only six species in these families. Two specimens, male and female, of the cotinga *Tityra cayana* showed the patch; both had been observed to incubate. The male of the related *Procnias nudicollis* has not been observed to incubate, and in the two males collected, the patch was absent. The presence of the patch in the females of the Tyrannidae is expected, but its presence in males of three species (*Myiodynastes solitarius, Empidonax euleri,* and *Phyllomyias griseocapilla*) is noteworthy. The absence of the patch in all 11 female specimens of the Shiny Cowbird (*Molothrus bonariensis*) is, of course, to be expected because of the parasitic habits of the species.

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BIRD DISTRIBUTION AND ECOLOGICAL CONCEPTS

A SYMPOSIUM DIRECTED BY V. E. SHELFORD [1]

PART I

THE CONCEPT OF THE BIOME AS APPLIED TO THE DISTRIBUTION OF NORTH AMERICAN BIRDS

BY EUGENE P. ODUM

IN discussing such broad topics as the relation of bird distribution to ecological concepts, one can easily become entangled in an effort to follow the various lines of thought suggested by the observable facts. In this, the introductory paper of the symposium, I shall therefore attempt to clarify and simplify rather than elaborate, presenting first a simple comparison of the life zone and biome theories, and second, a discussion of the theoretical and practical aspects of the biome concept as applied to the distribution of birds during the breeding season in North America. Since there are a number of recently published papers to which the reader may refer for definitions, details, and further explanations, I believe that I can best present my material in semi-outline form.

Classification by Community or Environment

Ecologists are often accused of creating a hierarchy of terms or systems of classification and then trying to fit all situations to them; hence it may be well to say a few words in justification of setting up systems for ecological classification even when knowledge is still in a formative state. From the time of John Ray and Linnaeus, the need for an orderly system of naming organisms has been universally recognized. But organisms do not occur in nature in such taxonomic groupings nor do they exist independently of one another; hence it is logical, as well as important, to study and classify them by their natural groupings (i.e., by actual communities). However, distributional classification is not an end in itself any more than taxonomy is. It is merely a useful tool in research; a method of organizing the manifold detail of field observations; a specific means of stimulating and directing research; an aid in orienting the student of distribution.

A new theory always stimulates investigation, but progress seems to be even more rapid when an opposing viewpoint is also presented. Witness the tremendous impetus given to biological study by the epigenesis *vs.* preformation and the evolution *vs.* non-evolution controversies. Work on classification by communities or environment has led to two important theories of distribution: Merriam's life zone system and the

[1] Presented before the Wilson Ornithological Club at Urbana, Illinois, November 21, 1941. Parts 2 to 5, by John W. Aldrich, J. J. Hickey, O. A. Stevens, and Roger Tory Peterson, and Part 6, a critical summary by V. E. Shelford, will appear in a later issue of the *Bulletin*.—Ed.

more recent biome system.[2] Discussions of these two theories have provided and undoubtedly will continue to provide a growing incentive for the study of the ecological aspects of distribution.

The Life Zone Theory

History. "Life zone," as a term, is too well known to ornithologists to require explanation. The life zone system was developed by C. Hart Merriam between 1890 and 1895 after he had observed the sharp "zonation" of life on San Francisco Mountain, Arizona. Impressed with the importance of temperature as a determinant, he formulated two temperature laws (Merriam, 1894:236) and mapped six zones as transcontinental bands along temperature isotherms (Merriam, 1898: map). Under Merriam's dynamic guidance, the life zone concepts had an important unifying influence on the pioneer field work of the U. S. Biological Survey and on the work of ornithologists generally.

Theoretical basis. Although temperature, which Merriam used as the basis (limiting factor) of his life zones, has proved time and again to be important, his temperature laws have not proved in practice an adequate basis for setting up major divisions of plant and animal life. Obviously, the actual distribution of organisms must serve as the basis of any logical, useful division and is, in fact, the basis used in the more recent discussions and mappings. (Merriam's two temperature laws have been criticized in detail by Livingston and Shreve, 1921; Kendeigh, 1932; Shelford, 1932; and Daubenmire, 1938.)

Application to actual distribution. Most of the recent applications of life zones have been concerned with restricted areas such as a mountain range or a single state (political unit), rather than with the fauna of an entire zone or with the entire distribution of any one species. Boundaries and bird "indicators"[3] have been set up for each locality, usually without much attempt to relate the locality to the continental zone as a whole, and when applied in this way to local distribution problems, life zone terminology has proved convenient to ornithologists. However, efforts to correlate such local studies have shown that the ranges of bird species agree well with Merriam's Arctic and Canadian zone divisions, but poorly or not at all with the Hudsonian, Transition, Upper Austral and Lower Austral zones. The Transition, Upper and Lower Austral zones, particularly, are not natural biotic units because they cut from east to west across regions of widely differing vegetation and avifauna. Dice (1923:43–44) points out that the life zone theory is "founded on the belief that there are zones of life extending transversely across the continent of North America, in the south as well as in the north;" that "belts of life do occur in the northern part of North America and on mountains, yet the recognition of transcontinental zones

[2] I have not made a detailed critical study of a third system of distributional classification (by "biotic provinces") recently proposed by Dice (1943).

[3] Specific organisms indicating the presence of certain conditions.

of life in the southern part of the United States seems contrary to the facts of distribution." This is the criticism most often made against life zones (see Ruthven, 1920; Shelford, 1932; Daubenmire, 1938; Pitelka, 1941).

Many indicators (or species characteristic of a given zone), such as those listed by Chapman (1932:32–34), fail to fit even remotely the zones they are supposed to represent. Thus such wide-ranging species of "seral" [4], or developmental, habitat as the Mourning Dove, Meadowlark, Bobwhite, or Kingbird, can hardly be considered characteristic simply of the Transition zone; nor are the Tufted Titmouse, Cardinal, Carolina Wren, and others, which Chapman (p. 33) lists for the Upper Austral, any more characteristic of that zone than of the Lower Austral.

The longitudinal division of the austral zones (i.e., the Transition, Upper Austral, and Lower Austral) into humid and arid portions helps to correct the above-mentioned failings of the life zone system but is not altogether satisfactory, since these divisions are highly arbitrary from the standpoint of environments. Obviously, the diverse conditions east-west across the continent require a number of major longitudinal divisions.

The original life zone concept more or less ignored the vegetation as a primary factor on the theory that although climate controls both fauna and vegetation, it affects one independently of the other. An increasing tendency has been evident, however, to base life zones on the vegetation; thus, "Canadian zone" in the minds of most ornithologists means "northern coniferous zone," and it is obvious that the "botanical" term describes the area far better than the "political" term. Biotic factors in general (both faunal and floral) have received more and more emphasis in the modified life zone concept of today (see Brooks, 1940:252–253, for example). Grinnell (1928; 1943:194) divided life zones into "associations," and associations into "ecological niches." Both terms emphasize community rather than temperature alone, and such shifts in emphasis direct attention to the fact that the terminology of the life zone system needs to be redefined or to be replaced by a more descriptive one.

Advantages of the concept. In bird study, the life zone theory has certain obvious advantages over other theories; most important among these are: (1) familiarity through long use by ornithologists and mammalogists; (2) simplicity and convenience (bird students find the concepts and terminology easy to grasp); (3) conformity with the evolutionary viewpoint in that it emphasizes the importance of temperature (climate) as a barrier to the northward and southward (and altitudinal) spread of species and genera.

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[4] A "sere" in biogeography is the complete cycle or "series of communities that follow one another on any given area of the earth's surface" (Carpenter, 1938:242), from initial barrenness to the final, "climax" formation (as, for example, coniferous forest).

The Biome Theory

History. The concept of an association of diverse, mutually dependent organisms in a natural ecological unit (biotic formation, or biome) has had a gradual development which began at least as far back as 1877 when Mobius used the term "biocenose" for such an association or community. The studies and writings of Clements (particularly his 1916 plant succession monograph and subsequent work) and the work of Shelford have given wide currency to the concept in North America. In other parts of the world, similar concepts have been found useful by other workers, for example, C. G. J. Peterson, in his work on marine communities; J. F. V. Phillips in his work in South Africa; Palmgren in Finland; and W. N. Beklemischev in Russia. A detailed history and discussion of the biome theory in general is given by Clements and Shelford (1939); Pitelka (1941) has studied the distribution of North American birds in relation to the major biomes.

Definition. Biomes may be defined as major biotic communities, that is, natural groups of organisms characterized by the occurrence of certain plants and animals which are *dominant* (in the ecological sense of "controlling" the group and habitat) and *influent* (that is, exerting an important influence on the group and habitat). Since plants are usually *dominant* in terrestrial habitats, biomes are largely determined by the vegetation, specifically by the "climatic climax" [5] vegetation, but also by the important (i.e., *influent*) animals. Hence a biome map is not simply a vegetation map. Vegetation provides the background, as it were, but the occurrence of certain animals actually determines the major divisions; for example, although the northern coniferous forest biome is made up of several distinct plant "associations," the area is given unity by certain plants and animals ("binding species") whose range extends through all of the associations (Shelford and Olson, 1935:375–378).

Comparison of Life Zones and Biomes

In the life zones and biomes of North America (compare Chapman, 1932: end paper map, with Pitelka, 1941: Figure 1) the most obvious differences are as follows: (1) For the transcontinental austral zones of the life zone system, the biome system substitutes a number of community centers (biomes) east to west across the continent. (2) In the life zone system there is but one "transition" zone, but biomes are separated by a number of areas of overlap, or transition, called *ecotones*,[6] whose width depends on the rapidity of change, which, in turn is often determined by the topography (for example, often a biome is on high ground, the adjoining one on low).

[5] "The community in which an area ultimately terminates" (Carpenter, 1938:58).

[6] One of the most interesting ecotones that I have visited is the aspen parkland region of western Canada, which is a "three-way" transition area. Not only do coniferous forest species and grassland species meet here, but the breeding ranges of a number of typical eastern deciduous forest species (for example, the Redstart and Rose-breasted Grosbeak) have westward extensions through this region (Lincoln, 1935:37).

But it is in their approach to distribution problems that the fundamental difference lies between the life zone theory, which emphasizes the effects of physical factors on species or other taxonomic groups, and the biome theory, which emphasizes the development and distribution of communities. In many areas (especially in mountainous regions), the boundaries of life zone and biome units coincide; and there life zone maps differ from biome maps only in the names of the areas, employing the geographical (political) terminology of that theory instead of the biotically descriptive names of the biome theory.

Bird Distribution and the Biome Concept

The biome theory does not minimize the effect of temperature as a limiting factor but it takes into account other features of climate and recognizes the direct importance of cover (shelter or habitat). The organisms themselves are used as indicators, on the assumption that they are collectively better "judges" of the conditions than any measuring device yet invented by man. In the final analysis, the arrangement of biomes and their sub-units gives about equal emphasis to climate and cover. They are not the only limiting factors, of course, but on a continent, they are assumed to be the most important for the majority of species. Let us examine these and other factors in order to see if this is a logical assumption, particularly in relation to birds.

Climate. The climate of any given area is of such undoubted importance in determining all the life forms that little need be said except to point out that such factors as rainfall, humidity, wind, and solar radiation, are important as well as temperature. The climax vegetation is probably the best indicator of the sum total of climate (Clements, 1920:63–64). A map of climaxes is a much better map of climates than is a map of any single climatic factor.

Cover (shelter or habitat). Not only is habitat all important in determining local distribution, but it is increasingly recognized as a major factor in limiting the overall range as well. Its importance is clearly shown by the spread of certain species into areas (formerly unoccupied by these species) after changes in vegetation (cover) have occurred there even without change in climate. One could list numerous recent examples of this, such as the spread of the Robin into the grasslands after the planting there of trees, the southward spread of the same species with "opening up" of forest and planting of lawns, the spread of Prairie Chickens into the coniferous forest area of Wisconsin after deforestation, or the eastward spread of the Prairie Horned Lark into extensive man-made grasslands in the eastern deciduous forest area. On the other hand, many other species fail to spread even when suitable habitat is available or made available; for example, the Wood Thrush, Eastern Wood Pewee, or Crested Flycatcher have not (as yet) spread into extensions of the original deciduous forest; in these cases climate (or some factor other than cover) may be the major limiting factor. Thus, the activities of man that produce changes in cover without change in climate may enable us to determine which of the two factors is the more limiting for particular species. Otherwise because of our present lack of knowledge of basic physiological and psychological responses of birds, it is by no means easy to come to a conclusion on this point. For example, J. J. Murray (1940:57), who has given us some excellent observations on the zonal distribution of Virginia mountain birds, observes that the Yellow Warbler occurs commonly in the valleys but not in clearings or orchards at high altitudes. Murray concludes from this observation that habitat is not limiting in this instance, whereas I would draw the opposite conclusion for the following reasons: Since the Yellow Warbler breeds far to the north (to the limit of willows on the tundra's edge) there would be no reason to suspect that climatic conditions on even the highest mountains in Virginia would be too rigorous for this hardy species. Topography and habitat, on the other hand, would be definitely against the species since suitable breeding habitat at high altitudes in Virginia is very limited in area and isolated by extensive stretches of unsuitable habitat. If the clearings at high altitudes became more extensive and sufficiently connected with lower areas I would be willing to predict that the Yellow Warbler would eventually invade them. The extent and position of apparently suitable habitat must be taken into consideration. In the other examples (tanagers, Veery) listed by Murray in the same paragraph, the evidence for climatic limitation is much clearer, but even in these, community factors cannot be ruled out completely.

Physiographic barriers. Though a primary consideration in limiting an island group, physiographic barriers in a large continuous land mass such as North America are obviously of less importance (as compared with habitat and climatic barriers) so far as distribution of birds is concerned. Physical barriers are, of course, indirect determinants of biomes since they greatly affect climate and vegetation.

Food. Although very important in determining the local distribution and abundance of birds, food rarely seems to determine the actual range of a species. The periodic fluctuations in populations of small mammals, for example, definitely affects the abundance and breeding of tundra hawks and owls, but since such mammal food is available in virtually all regions, its occurrence on the tundra is probably not a factor in restricting the range of tundra bird species. In other words, it is the exception rather than the rule to find correlation of the range of a bird species with the range of a specific kind of prey as, for example, the ranges of the Everglade Kite and Limpkin (J. B. May, 1935:18; Harper, 1936) seem to be correlated with the distribution of the snail *Pomacea* (*"Ampullaria"*).

Biotic interactions (*coactions*). The role which competition and predation play in limiting ranges is not yet well understood. It is of undoubted local importance just as food is, and may be a factor in limiting the spread of some species. We need to know more about the alleged limiting relations between such pairs of species as the Whip-poor-will and Chuck-will's-widow, the Bewick's Wren and House Wren (see, for example, E. V. Miller, 1941:84).

"Life form" of plant vs. *species of plant.* In general, few species of birds are restricted to a particular species of plant, but many birds seem to be limited to a particular type ("life form") of vegetation. For example, many species have a distinct preference for coniferous forest, but it may not make much difference whether it be spruce, fir, or hemlock. Thicket birds select bushy growths of a specific density rather than of a particular shrub species. Grassland birds may be equally at home in beard grass, mesquite grass, or bluegrass, if the stands are of the same general density or appearance. As Grinnell (1943:183) once remarked, "the presence of a certain kind of perch or particular sort of forage surface is practically essential to the presence of a given kind of bird whose structures and instincts are adapted to it." More adequate means of measuring the importance of this "structural" feature of the vegetation are greatly needed. Many species are very adaptable to changing *species* of vegetation (for example, when cultivated grasses replace native prairie grasses—Bennett and Hendrickson, 1939), but are unable to adapt to a new *life form* or even to small changes in habitat *structure.* Within a biome, it is the *life form* of the climax vegetation that tends to be uniform rather than the *species* of the dominant plants.

Conclusion. Considerable study may be necessary to determine the critical limiting factors for individual species. For "stenothermic" species (species with limited climatic tolerance), climate will prove to be limiting at least somewhere around the range boundary; for species with wide climatic tolerance (like the Robin), habitat or other factors may be limiting. In general, however, climate and habitat seem the most important. Therefore, a classification system (such as the biome theory) that considers both these major factors, as well as intra-community relations in general, is bound to produce a better correlation of its divisional units with the distribution of a larger number of species than a system based on one factor alone.

Evaluation of Biomes

Climax and seral communities. It is important to distinguish between *climax* and *seral* (developmental) communities since bird distribution is greatly influenced by the dynamic nature of succession.

"The last community of . . . a succession is the *climax* which is self-perpetuating and is characterized by a life-form of the dominants, such as grass, deciduous forest, etc. The dominants of developmental stages within a climax region may or may not be of the same life form, as, for example, seral stages in the deciduous forest climax may include herbs, grasses, shrubs, and both coniferous and deciduous trees" (Pitelka, 1941:115; see also Weaver and Clements, 1938: chap. 3).

Thus the habitat of early seral stages is often very different from that of the climax, with corresponding differences in avifauna. These differences *within* a biome should not be confused with differences *between* biomes.

When the climaxes of different biomes are compared, each is seen to have a very characteristic group of birds. Comparatively few species occur in the climax of more than one biome—which helps give the biome its identity as a natural community. Not all climax species, of course, have ranges that exactly correspond with the biome. When a species does not occupy all its biome, or when it spreads to other biomes, the ecologist's attention is focussed on the special factors limiting that particular species, just as a "difficult" genus stimulates the work of the taxonomist.

It is not uncommon for a species to occupy the climax of one biome and the seral (developmental) stages of one or more others. The Red-eyed Vireo, for example, occurs abundantly in three biomes, but occupies the climax only in the eastern deciduous forest biome, being restricted in the coniferous forest biome to developmental communities (e.g., aspen) and in the grassland biome, to "colonies" of sub-climax forest (e.g., streamside forests).

The most widely distributed species such as the Song Sparrow, Yellow Warbler, Mourning Dove, Red-wing, and various water birds, breed in the early developmental stages of vegetation. The early developmental stages (unlike the climaxes) of widely different regions often have a similar appearance and thus offer suitable habitat for species with wide climatic tolerance. A marsh, for example, provides much the same sort of habitat in various biomes. We would expect, therefore, that "seral" birds would show less correlation with biomes than "climax" birds do; but while this is generally true, many early seral birds are restricted to certain biomes or sub-regions, the climatic (or "non-habitat") features of the community apparently holding them there.

Primitive vs. *disturbed conditions.* It is important to distinguish between primitive, or natural, conditions (by which ecological units are delimited) and disturbed conditions directly or indirectly produced by man.

Man has perhaps changed the climate little, but he has greatly modified shelter, food supply, and other "habitat" factors. Man tends to produce a forest edge condition wherever he settles, whether in forest or grassland, that is, he thins the forest, creating openings, or, in grassland, plants trees. In general, he increases greatly the areas occupied by seral vegetation at the expense of the climax areas. The sharp natural differences between regions are thus reduced, and "forest edge" species with wide climatic tolerance are encouraged to spread. Thus, lists of *roadside* and *farmland* birds which we compiled on a 6,000-mile trip through western North America were monotonously the same regardless of the biome (or life zone) traversed, whereas birds of *natural* communities were excitingly different from biome to biome.

Man's indirect influence is, of course, felt far from his habitations. Lumbering (plus forest fire) and overgrazing have produced extensive fundamental changes both in vegetation and bird populations. In the central Alleghenies the effect of such changes on breeding warblers has been carefully analyzed by Brooks (1940); in Manitoba one sees aspen forests and Red-eyed Vireos over a wide area where (to judge from the prevalence of charred spruce stumps) spruce and warblers once were; in some places, destruction of the climax vegetation is so complete that the forest may, for lack of seed trees, never be restored; likewise, huge areas of western Texas, New Mexico, and Colorado that once were grassland are now sage brush or mesquite desert. Such alterations produced and maintained by man and domesticated animals are often called "disclimaxes" and should not be confused with the true or potential climax, which is determined by climate.

Man, of course, *directly* modifies the distribution of a few birds through the introduction of exotic forms, "control" by direct predation (hunting, destruction of "undesirable" species, etc.), and through wildlife management.

Biomes are based on the primitive or potential conditions. This is not only convenient, but provides the point of reference for evaluating man's influence on his environment. Thus, preservation of primitive areas is desirable not only from the esthetic point of view but from the practical one as well, and ecologists and ornithologists should make every effort to study such natural areas in order to determine how far man has already changed conditions and how far he may change them without disastrous results.

Lack of quantitative data. In studying the correlation between distribution of species and natural areas, the lack of quantitative data is a great handicap (Pitelka, 1941:116–117). The usual check-list notations and most maps so far published are not very helpful since they indicate only the extremes of a given bird's range and fail to show where the species is really a common and influent member of a community. It would help greatly if, in describing abundance and habitat, compilers of local lists would give at least as much attention to common species as they currently give to rare ones.

Distribution of subspecies. So far in the discussion, we have considered only the distribution of full species (including, in the case of multiform, or polytypic, species, all of the subspecies). Little can be said regarding the occurrence of subspecies in relation to biomes, not only because they have not been studied from this angle, but also because the criteria used to delimit subspecies are variable, and lines drawn between races must in many cases be more or less arbitrary. As monographic studies, such as that of A. H. Miller (1938) on the Junco, have abundantly shown, morphological characters of subspecies do not "change simultaneously geographically" in transition from one extreme form of a series to the other; color, body size, length of bill, and other characters may all vary geographically although independently of one another. Nevertheless, geographical variations in bird forms are undoubtedly correlated with environmental complexes, and taxonomists should give more consideration to natural community units when dividing a species into races. Aldrich and Friedmann (1943) have recently made an admirable attempt to correlate subspecies of the Ruffed Grouse with biotic communities. Paralleling and supporting this particular emphasis (as well as the general emphasis that the biome theory gives to biotic factors) is the change in the basic concept of species, which is becoming broadly biological rather than strictly morphological (see Mayr, 1943: chap. 5 and 6).

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GENERAL NOTES

Soaring geese at Tulelake, California.— At 1:10 P.M., February 27, 1944, while making observations on birds at the Tulelake National Wildlife Refuge, Tulelake, California, I heard the calling of a flock of Snow Geese (*Chen hyperborea*) as it passed rather high overhead. Noting that their flight was somewhat different from normal, I examined them through field glasses. The entire flock of 22 Snow Geese was clearly riding with outstretched set wings what was evidently a rising current of air. Their soaring was much like that of the Little Brown Crane (*Grus c. canadensis*) and Sandhill Crane (*G. c. tabida*) which I have watched in eastern New Mexico under similar weather conditions. I watched the flock of Snow Geese for more than 10 minutes as it drifted northward. During that time, I noted only an occasional wing beat. Shortly after the flock passed, a flock of 12 White-fronted Geese (*Anser albifrons*) passed, employing the same flight tactics. Their flight was also in a northerly direction. At the time of the observations the day was clear and warm, with only a slight breeze from the north. The soaring of these geese was evidently similar to that reported by Williams (*Condor,* 44, 1942:76) near Brigham City, Utah, in the fall of 1941. —CLARENCE A. SOOTER, *U. S. Fish and Wildlife Service, Alice, Texas.*

Reaction of American Mergansers to Herring Gull depredations.—On February 16, 1943, Burt L. Monroe, Thomas Smith, and I observed the following episode, which illustrates some aspects of bird psychology. A flock of 12 to 15 Herring Gulls (*Larus argentatus*) and 8 American Mergansers (*Mergus merganser americanus*) were fishing eight miles east of Louisville, Kentucky, at the mouth of Harrod's Creek. The small creek had frozen to within a hundred yards of its mouth, but the bay and river were open. We drove close to the shore and remained partially concealed in our automobile behind a large tree.

Soon a male merganser after a deep dive came up with a large fish in its bill. Instantly five or six of the gulls took wing and converged on the duck. The nearest gull easily snatched the fish, but being unable to swallow so large a mouthful soon lost it to another gull. The other gulls fought for possession until the fish was torn to bits. This happened several times, with the result that the mergansers were losing most of their catch. (With the broad expanse of the Ohio River, which was here more than 1,000 yards wide, to choose from, the mergansers remained to endure the persecution of the gulls probably because of the superior fishing at the mouth of the frozen creek.)

After a while, we noticed a gradual change in the fishing tactics of the mergansers. One came up with a fish. As usual, several gulls went for it, but before they could snatch it, the merganser dived with the fish still in its mouth. He came up 20 feet away in an open space and while swimming as rapidly as possible swallowed the food before the gulls could reach him. One gull, swooping too late for the fish, struck the merganser with all its weight, causing him to bob up and down, yet not frightening him enough to make him fly. Other mergansers also developed a watchfulness which enabled them to retain more and more of their fish. They seemed to pick spots in which to surface as remote as possible from the gulls, and they swallowed their catch quickly while avoiding the attacks of the gulls by swimming or diving.

After failing repeatedly to rob the mergansers of their fish, the gulls gradually lost interest and drifted farther out from shore, allowing the mergansers to fish unmolested. The ability of the American Mergansers to modify their behavior successfully in the face of the depredations of the gulls shows a surprising degree of adaptability.—HARVEY B. LOVELL, *Biology Department, University of Louisville, Louisville, Kentucky.*

Migration records from Yucatan.—The following selected observations, recorded along the north coast of Yucatan chiefly during the spring months of 1936, may prove of value in connection with the recent discussions of trans-Gulf migration. In each instance reported, both the behavior of the birds and the attendant circumstances suggested that the birds were en route across the Gulf.

Turkey Vulture. Between February 2, and March 25, 1936, only one to six Turkey Vultures (*Cathartes aura*) were recorded in the vicinity of Chichen Itza in the central part of the Yucatan Peninsula, some 50 miles inland from the north coast. On March 26, a flock of 13, and on March 27, individuals and small groups totaling 15, were moving northward over Chichen Itza. On March 31 and April 1, three to five separate individuals left the Yucatan shore between Progreso and Chicxulub (east of Progreso) and flew northward over the ocean until out of sight. About 8:00 A.M., April 2, a flock of seven came from the south and continued northward over the Gulf. In the clear atmosphere the large birds were visible for a great distance. On the same day, several individuals and small groups, totaling 18 birds, flew northward across the highway between Progreso and Chichen Itza.

Sparrow Hawk. On the morning of April 7, 1936, two Sparrow Hawks (*Falco sparverius*) were perched on the beach near Progreso within a few feet of the water. They repeatedly flew out over the Gulf but returned to the beach or to the vegetation immediately behind it. Finally, about 10:00 A.M., one of the hawks left the beach and flew northward over the ocean until lost from view.

Sandpipers. On March 31, 1936, many sandpipers were about the mud flats at Progreso. About 60 were identified as Least Sandpipers (*Erolia minutilla*), about 80 as Semi-palmated Sandpipers (*Ereuntes pusillus*). At dusk, several small compact flocks of "peeps" left the flats and flew northward over the water until out of sight.

Hummingbirds. On April 1, 1936, there were numerous hummingbirds on the beach between Progreso and Chicxulub. Some were perched among the sparse vegetation of the dunes, some on the beach itself—a number at the water's edge. About 60 were identified as Ruby-throated Hummingbirds (*Archilochus colubris*). At intervals throughout the day, individuals and small groups left the beach and flew northward over the ocean. Some returned after flying a little distance, but others continued northward until out of sight, and by evening few remained on the beach.

Barn Swallow. On April 7, 1936, a flock of some 40 Barn Swallows (*Hirundo erythrogaster*) was feeding and flying about the front beach and adjacent sand dunes between Progreso and Chicxulub. At intervals the birds flew out to sea until almost out of range of 8 x binoculars, then returned to resume feeding. Each time they flew outward, they stopped the customary revolving movements of feeding birds and assumed a disc-shaped formation. Finally, at about 10:30 A.M., they assumed this formation and flew northward over the ocean until out of sight. At 8:30 A.M. on August 11, 1937, two Barn Swallows, one adult and one immature, were perched on the stern of the ship *Munplacé,* which was then some 80 miles north of Progreso and moving northward. The two birds remained about the ship all morning, alternately perching on the rail and making excursions over the water. Although it has been supposed that swallows, in particular, migrate around the Gulf, these were apparently early fall migrants en route south across the Gulf. If this assumption is correct, the record has additional interest in relation to the well-known theory that swallows migrate only during daylight hours, since part of the migration of these swallows would necessarily have taken place during darkness. Worthington and Todd (*Wils. Bull.,* 38, 1926:220) also cite an instance of apparent night migration of the Barn Swallow.

Wood warblers. Throughout each day, and occasionally during early evening, in the spring of 1936, small birds, warbler size and with the *chips* of warblers, flew northward across the beach near Progreso and continued over the ocean. Between 9:00 and 11:00 P.M. on March 30, there was an unusual number. It was brilliant moonlight, and the wind was in the north-northwest.—JOSSELYN VAN TYNE, *Ann Arbor, Michigan,* and MILTON B. TRAUTMAN, *Stone Laboratory, Put-in-Bay, Ohio.*

Record of the Turkey from the Pleistocene of Indiana.—In 1936 Mr. Alton Bernhardt of North Liberty, found part of the cranium of a *Cervalces* at a locality on the headwaters of the Kankakee River, Indiana (C. L. Gazin. *Amer. Midl. Nat.* 19, 1938:740, figs. 1–2). This specimen he presented to the United States National Museum through the late Marcus Ward Lyon, Jr. In the summer of 1938 Mr. Bernhardt again visited this site to look for further bones, and on this occasion found the left humerus of a Turkey (*Meleagris gallopavo*) that he has also kindly given to the National Museum. The specimen, while of good size, comes from an immature individual in which the bone is not yet fully formed. The locality is along a drainage ditch near Potato Creek, a mile east and about three-quarters of a mile north of North Liberty, St. Joseph County. The turkey humerus was secured about 20 feet from the point where the *Cervalces* skull was collected. This is the first record for this species for the Pleistocene of Indiana.—ALEXANDER WETMORE, *Smithsonian Institution, Washington, D.C.*

Gulls and terns hawking flying insects.—A note by Milton and Mary Trautman on Ring-billed Gulls fly-catching (*Wils. Bull.,* 57, 1945:77) reminded me of my own observations along those lines in recent years, and the following extracts from my diary may be worth adding to the record. On September 2, 1943, while travelling from Fort Erie to Niagara Falls, Ontario, along the Niagara River boulevard, I saw great numbers of birds, obviously feeding on insects, hovering and darting high in the air over the road and inland across the fields almost as far as the eye could see. The insect eaters were nearly all terns and gulls, with Black Terns (*Chlidonias nigra*) in various plumage phases very much in the majority. However, Ring-billed Gulls (*Larus delawarensis*) were also well represented, and some near by were plainly seen to be snapping up the flying insects in an efficient if somewhat awkward manner. A few Bonaparte's Gulls (*Larus philadelphia*) were similarly engaged, and one or two Nighthawks (*Chordeiles minor*), with lighter and more airy flight, and apparently much greater skill, were joining in the feast. Common Terns (*Sterna hirundo*), in great numbers over the river, were busy diving for fish, but once in a while a Common Tern would join the insect hawkers when a group of them happened to come close to the river bank. A few miles further down the river, toward Chippawa, other insect hawking flocks of gulls and terns were encountered; one fairly large group was predominately Ring-billed Gulls, while a smaller group, still nearer Chippawa, was largely composed of Black Terns. About a year later, on September 13, 1944, at several points along the river boulevard, from Old Fort Erie to near the mouth of Black Creek, Ring-billed and Bonaparte's Gulls in considerable numbers were observed hawking insects. The insects were not certainly identified, but at Fort Erie they seemed to be chiefly caddis flies, and near Black Creek, either caddis flies or flying ants. At Fort Erie, almost 50 per cent of the hawking gulls were Bonaparte's, but lower down on the river, the insect-eating flocks appeared to be composed almost entirely of Ring-billed Gulls. On both of the occasions cited, flights of ants were general throughout the area. Those on which the gulls and terns were apparently feeding seemed to be largely referable to the genus *Lasius.*—R. W. SHEPPARD, *1805 Mouland Avenue, Niagara Falls, Ontario.*

EDITORIAL

Unfortunately, the meeting of the Wilson Ornithological Club Council which was scheduled for August 20 had to be canceled. Arrangements for a later meeting have not yet been completed.

The following Nominating Committee has been appointed by President Kendeigh to prepare a slate of Wilson Ornithological Club officers and Council members for 1946: Ernst Mayr, Chairman; W. J. Breckenridge; Ralph E. Yeatter. They will be glad to receive suggestions from members of the Club.

We wish to thank our loyal Life Member, Bernard W. Baker, for the generous gift which makes it possible to publish in color his handsome photograph of the Prairie Warbler that illustrates this issue.

OBITUARY

George Willett, ornithologist of the Los Angeles Museum and Vice-President of the American Ornithologists' Union, died August 2, 1945, at the age of sixty-six. His very extensive field experience in Alaska and California was the basis for many valuable reports, including detailed studies of the avifauna of southwestern California.

Ornithological News

The concluding part of H. Kirke Swann's "Monograph of the Birds of Prey" has just appeared. The first part was published in 1924, but Swann died in 1926 when only five additional parts had been printed. Alexander Wetmore generously agreed to undertake the completion of his friend's work, and publication was resumed. Many unforeseen difficulties had been overcome, and the concluding part was finally on the presses in September 1940, when German air raids completely destroyed the London printing establishment. Fortunately, the publishers, Wheldon and Wesley, had a set of corrected proofs stored outside London, and the text was gradually reset from this copy as war-time conditions permitted. Further delays resulted when new proofs, in transit between England and America, were twice lost at sea from enemy action. The completed work stands as a monument, not only to H. Kirke Swann, but to the courage and persistence of Alexander Wetmore and the publishers.

Jean Delacour and Ernst Mayr have completed for publication a manual of the birds of the Philippine Islands. The book is illustrated by Alexander Seidel and Earle L. Poole.

W. E. Clyde Todd and J. K. Doutt of Carnegie Museum spent the spring and summer studying the birds and mammals of the tundra country on the east coast of Hudson Bay, north of Lake Minto.

William Beebe has just returned from six months' study of birds and other animals at the field station of the New York Zoological Society at Rancho Grande, Maracay, Venezuela.

Ralph Ellis has moved to Lawrence, Kansas, and has lent his remarkable ornithological library to the University of Kansas Museum of Natural History. The library (some 65,000 volumes) is perhaps the largest private collection of books on birds and mammals in the world. It includes some extremely valuable manuscripts, as well as sets of the original sketches and drawings of famous artists. Of particular interest are the large number of sketches by John Gould and 650 drawings of the birds of India by Thomas C. Jerdon.

ORNITHOLOGICAL LITERATURE

CHECK-LIST OF BIRDS OF THE WORLD, Vol. 5. By James Lee Peters. Harvard University Press, Cambridge, Mass., 1945: 6 x 9 in., xi + 306 pp. $5.00.

The publication of another volume of Peters' Check-list, which now covers 92 families, 1,009 genera, 3,344 species, and 8,007 subspecies of birds, is news of the first importance to ornithologists everywhere.

This new volume fully maintains the very high scholarly standard set in the earlier parts; it even exceeds them in fullness of treatment, detail of synonymy, and number of helpful annotations. Only the physical make-up of this volume has suffered; war-time conditions have forced the use of a poorer, less opaque, paper and the elimination of the protective gilt top.

Peters gives us no statistical recapitulation of his results, but because such a summary is of general interest and real biological importance, a tabulation of the numbers in each category under the twelve families treated in this volume is given below.

	Genera	Species	Subspecies
Trochilidae, Hummingbirds	123	327	688
Coliidae, Colies	1	6	29
Trogonidae, Trogons	8	34	103
Alcedinidae, Kingfishers	14	87	337
Todidae, Todies	1	5	5
Momotidae, Motmots	6	8	45
Meropidae, Bee-eaters	7	24	50
Leptosomatidae, Ground-rollers	1	1	3
Coraciidae, Rollers	5	16	37
Upupidae, Hoopoes	1	1	9
Phoeniculidae, Wood-hoopoes	2	6	27
Bucerotidae, Hornbills	12	46	104
TOTALS	171	561	1437

Peters has listed the Leptosomatidae first in the suborder Coracii, but otherwise follows exactly Wetmore's (1940) arrangement. Five new names are proposed in this volume, but they represent mere changes in "labels" applied to already known biological entities.

Only a few of the other changes proposed relate to birds of the area covered by the A.O.U. Check-List. Rivoli's Hummingbird, of Arizona, is listed as *Eugenes fulgens fulgens* (not *E. f. aureoviridis,* as in the Nineteenth Supplement); Salvin's Hummingbird (*Amazilia salvini*) is dropped, since it is believed to be only a hybrid; the Calliope Hummingbird becomes *Stellula c. calliope;* the Copper-tailed Trogon is represented by one subspecies (*Trogon elegans canescens*) in Arizona and by another (*T. e. ambiguus*) in "extreme southern Texas"; the Belted Kingfisher is again placed in the genus *Ceryle.*

More than half of the volume is devoted to the hummingbirds—a family that has always attracted the special attention of ornithologists and nevertheless still baffles their best attempts at classification. In the introduction, Peters makes it quite clear that he is far from satisfied with his own results, and he even suggests that the next reviser should attempt a classification based on the females, since the present arrangement over-emphasizes the secondary sexual characters of the male.

Although Peters remarks that generic differentiation has been much over-done in the Trochilidae, his own classification does little to remedy that fault. He has indeed reduced to subgeneric status several groups hitherto given full generic rank, but he ends by recognizing five more genera than did Sharpe in 1900, although only four new hummingbirds requiring generic recognition have been discovered since that time. Almost half of the genera he lists are monotypic.

It is interesting to compare the numbers of genera, species, and subspecies recognized by the last four ornithologists to revise the hummingbirds:

Sharpe	(1900):	118 genera, 570 forms;
Cory	(1918):	130 genera, 649 forms;
Simon	(1921):	189 genera, 660 forms;
Peters	(1945):	123 genera, 688 forms.

Hummingbirds exceed most other bird groups in their propensity to hybridize, and many of Peters' notes deal with this remarkable characteristic. It will be a long time before our lagging knowledge of live hummingbirds reaches a point where we understand the nature of this phenomenon and its psychological and physiological causes.

Our extraordinary ignorance of hummingbirds is strikingly demonstrated again and again. For example: two genera and nine additional species have never been seen in life by any ornithologist but are based solely on Bogotá trade skins; many others are represented by only one or two specimens and are therefore almost equally unknown as living animals.

Peters' well-balanced judgment and careful attention to every detail are evident throughout the book. He has again given us a first-class piece of work, and we wish him all speed in his great undertaking, which so immeasurably stimulates and facilitates ornithological research.—J. Van Tyne.

The Distribution of the Birds of California. By Joseph Grinnell and Alden H. Miller. Cooper Ornithological Club, Pacific Coast Avifauna No. 27, Dec. 30, 1944: 608 pp., 1 col. pl., 57 figs. $6.00 (cloth, $7.00).

Almost every year sees one or more additions to the literature on local, state and regional avifaunas. They are all useful to the growing corps of bird students; some are briefly annotated check-lists; others are well-illustrated volumes with keys, descriptions, and much textual matter on habits. Nearly all have one characteristic in common: their object is to tell the reader what birds occur or have occurred in the area in question, in what numbers, and at what times of the year. They are geographic studies, with little or no systematic or taxonomic investigation; the A.O.U. Check-List and its supplements are accepted.

A combination of circumstances makes the present list a much greater enterprise. The very large state of California has great diversity of terrain and climate, caused by numerous mountain systems. The degree of subspecific variation is not exceeded in any other part of the continent. Drs. Grinnell and Miller, as life-long students of these variations, with ample field experience, and the best regional collections in the country, have every right to express their judgment on many knotty and controversial racial problems. They are to be commended for not hesitating to depart from the taxonomy of the A.O.U. Check-List. Indeed, it would have been most unfortunate if their knowledge, opinions, and experience had been "put to sleep," as it were, in slavishly following a check-list printed in 1931. The reader, however, is cautioned against concluding that either the authors or I disbelieve in the general usefulness of a check-list prepared by a committee. The committee has undertaken an arduous and protracted labor in the hope of producing a useful general reference work, without claiming that everything is settled, and further research superfluous or impertinent. Such assumptions are too easily made by the ignorant or ill natured, who are not competent to judge whether, for example, the Black Petrel should be in a special genus, *Loomelania,* or not. But Dr. Miller has every right to believe in the validity of *Loomelania* and publish his reasons, even if to date a majority of the Check-list Committee do not. It gives me particular pleasure to defend this right, because I do not happen to think *Loomelania* necessary myself!

It follows from all this that years of systematic study underlie a work purporting from its title to be distributional. Indeed, it entailed a review of most of the birds of western North America. It also entailed a careful consideration of vernacular or "common" names. Dr. Miller does not believe in vernacular names for subspecies, but admits that this unfortunate practise has got too firm a start to be discontinued now. He has done the next best thing and devised a logical system. Every species has a name, and every subspecies of that species has a name which *clearly shows* its specific affinities. Bailey's Chickadee becomes Bailey's Mountain Chickadee. The typical subspecies also has a subspecific name. The term "Pygmy Nuthatch" is used for the species *Sitta pygmaea* as a whole; *Sitta pygmaea pygmaea* is the "Monterey Pygmy Nuthatch," not the "Pygmy Nuthatch," as in the A.O.U. Check-List. Common names are altered from person's to geographic names, whenever a short term is possible and obviously of greater meaning and more readily memorized. The subspecies of the Chestnut-backed Chickadee are quite changed around. The Chestnut-backed Chickadee of the Check-list (typical *rufescens*) becomes the Northern Chestnut-backed Chickadee, expressing the facts of its geographic range; the Nicasio Chickadee becomes the Marin Chestnut-backed Chickadee, because the county is less local than the town which happened to be the type-locality; Barlow's Chickadee becomes the Santa Cruz Chestnut-backed Chickadee, after the faunal area in which it occurs. Dr. Miller, therefore, has generally agreed with numerous recommendations along these lines, and has put them into execution. He is not so pedantic as to believe that vernacular names have a fixed code of nomenclature, which is forced to apply an imaginary law of priority in every case.

We can now consider the methods adopted in outlining the distribution of the 644 native species and subspecies admitted to the state list. Each taxonomic entity is discussed under four headings. (1) A very brief synonymy is confined to other scientific or popular names under which California records for the species in question have been published. (2) A paragraph on status is particularly commendable for summarizing any increase or decrease in range or numbers and the probable reason therefor. (3) A long paragraph on geographic range in California (in most cases very detailed) with dates of notable records and the references. In all cases where a species involves several subspecies, intermediate populations and others of doubtful status are outlined. Every effort is made to bring out all cases where something is not definitely known or settled about California birds, and the authors are far more interested in those birds normally an integral part of the California avifauna than in waifs, strays, vagrants, and accidental stragglers. (4) A final paragraph on habitat is a particularly valuable feature. It avoids any stereotyped formula or system; the preferred plant association or ecological niche is described first. The authors, happily, are slaves neither of the biome or the life-zone theories of distribution.

One of the most controversial elements in any state or local list is the basis the authors select for the inclusion of species in the list. *No* system is free from attack; in any case some people will be disappointed or offended; some arbitrary standard *must be* adopted, and the inclusion or exclusion of certain species will appear unreasonable or absurd. The larger the area and the more species involved, the more cases are bound to arise which will teeter, so to speak, on the hairline of rejection or acceptance, *no matter what criterion* is adopted. Our authors have chosen to include no species for which no specimen is extant as a voucher, which means the rejection of some species seen a number of times, in some cases of very distinctive appearance in life, such as the Reddish Egret, Little Green Kingfisher, and Canada Warbler. The only exception, open of course to attack, is the inclusion of certain stragglers, where the bird was caught in a banding trap and handled in the flesh. While not ordinarily regarded as open to attack, sight records of other stragglers are given as official records, provided that somebody else shot a specimen, though no one has ever satisfactorily explained how A's sight record is validated by B's specimen obtained somewhere else another year! Students of birds are earnestly begged to reflect on the following facts. (1) The more scientific the study, the more proof is required. (2) The more scientific the study, the less interest and importance attaches to the casual or accidental. (3) The more thorough and scientific the review of a great and diversified continental area with a rich and varied bird-life, and the more decades of research and study preceding the review, the more errors appear in records *based on specimens.* There is nothing sacrosanct about a specimen. All one has to do is to turn to the supplementary list of the present work (pp. 557–576). Eleven species are excluded because the records are sight records only. *Thirteen* species are excluded, because the original specimens are no longer extant, and *37* species are excluded in spite of existing specimens, because the specimens were misidentified, erroneously ascribed to California, represented possible escapes from captivity, or for similar reasons. No one, therefore, can claim that Dr. Miller is "picking on" the opera-glass student. He has also "picked on" a fair percentage of the world's leading ornithologists of the past 80 years! They either made mistakes or were more credulous than he. Finally, (4) no count is possible of the innumerable cases where specimens formerly referred to one subspecies are now referred to another.

I am convinced that the only way to end the absurdities of vernacular names for subspecies and to discourage amateur observers from using them is to eliminate them. I am equally convinced that the only way to discourage the amateur observers' worship of the rare vagrant is to take *all of them* out of the main body of every state list and put them into an appendix with the curtest possible mention. Scientifically, it makes little difference whether a vagrant has occurred once or five times; the year and place of capture are of little consequence; and even the month is abnormal or else within the known period of migration.

Pacific Coast Avifauna No. 27, is one of the most scholarly regional studies of North American birds ever published. It is calm and temperate scholarship, the underlying principles are well formulated in an introduction which should be read by every American ornithologist contemplating a similar work. Dr. Miller did half of it alone after Dr. Grinnell's death in 1939, and brought the first half up to date. But "we" and "our opinion" occur throughout the book, proving that Dr. Miller is a loyal gentleman as well as a scholar.—Ludlow Griscom.

Birds of Georgia. By Earle R. Greene, William W. Griffin, Eugene P. Odum, Herbert L. Stoddard, Ivan R. Tomkins, and Eugene E. Murphey. *Georgia Ornith. Soc. Occ. Paper No. 2.* Univ. Georgia Press, Athens, 1945: 6×9 in., 111 pp., 1 pl., 1 map. $2.00.

Few southern states are fortunate enough to have up-to-date, comprehensive publications on their avifauna, and there are even comparatively few local lists for southern regions. This accounts to a certain extent for the vague and sometimes erroneous statements on distribution in the last A.O.U. Check-List (1931) and in other publications of broad geographical scope. Before the appearance of the present volume there was no single publication listing all of the species of birds known to occur in Georgia. Consequently "Birds of Georgia" is welcomed as a notable contribution to the ornithology both of the state and of the South as a whole. The compilers make no pretense of their work being complete but express the hope that the volume "will provide both a sound basis for future publications and a stimulus for research in the field."

Excellent judgment has been shown in deciding which species to admit to the list and which to reject because of insufficient evidence. Even records by Audubon that do not include definite dates and specific localities have been rejected. Except in a very few instances of records relating to large and easily recognizable birds, a preserved specimen of a form is considered by the authors the primary requisite for inclusion of the form in the list. It would be well for all ornithologists, particularly compilers of check-lists and distributional synopses, to realize that in no other field of faunistic zoology are distributional records so often based on such "unprovable" data as sight records. Although the usefulness of sight records in determining frequency of occurrence, relative abundance, and type of habitat, is to be admitted, such records can rarely be accepted as real evidence of the occurrence of a species in a given region, are of questionable value in delineating accurately the range of a species, and are usually of no value whatever when they relate to subspecies. Certain works on the avifauna of the South require radical revision simply because the authors failed to scrutinize all records, to omit (or to admit only with clearly stated qualification) those about which there was any doubt, however small. Proof in science is never based on probabilities. Consequently, even if there is only the proverbial "one chance in a thousand" that a sight record of a given bird might apply to some other species (however remote the range of that other species), then the record is of little value, particularly if it constitutes the only record for the geographical area in question.

Hence the compilers are to be commended for placing this first Georgia list on a solid foundation. There are, however, a few errors in judgment: the record (p. 49) of a Yellow-bellied Flycatcher seen near Atlanta on September 21, 1930, is highly questionable, for in fall plumage the species cannot be distinguished with certainty in the field from some extremely yellow-plumaged individuals of the Acadian Flycatcher (there are even museum specimens of the two species that can be differentiated only with difficulty); sight records (p. 50) of the Least and the Alder Flycatchers in spring are subject to the same criticism.

The authors give the specific records of occurrence for birds that are uncommon in the state, as well as an outline of the local distribution of those species whose occurrence is not statewide. In this connection, however, I would remark that the Chuck-will's-widow is listed (p. 47) as breeding over the entire state though I know of no actual nesting record for extreme northern Georgia.

It is interesting to note that the authors record transient migrants as generally rare or absent in spring in southern Georgia. This shows that the "coastal hiatus" in spring migration extends eastward across the entire coastal region. Likewise of interest is the information that certain warblers that were known to breed in the Alleghenies as far south as North Carolina also breed southward to northern Georgia.

Although the main body of the work is devoted to the annotated check-list and the annotated bibliography of Georgia ornithology, there is, in addition, a list of Georgia ornithological societies and bird clubs; a list of publications devoted exclusively to Georgia birds; an ornithological map of the state with an all too brief discussion of the physiographic regions; and an historical account of Georgia ornithology which gives a brief biographical commentary on a number of naturalists, beginning with Mark Catesby (whom too often we think of only in connection with South Carolina), John Abbot, the Bartrams, the LeContes, and Alexander Gerhardt, but which omits mention of J. J. and J. W. Audubon and of a number of recent field ornithologists who have worked in the state.

The book is well printed although there are a few typographical errors; the system of indenting the second line of the paragraph beginning the account of each species is confusing to the eye; and the annotations in the bibliography might better have been set apart typographically from the titles so that the two could be differentiated at a glance; also the book lacks both an index and the "running heads" which in works of this type usually serve as useful guides to ready reference.—G. H. Lowery, Jr.

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To the Editor of the Wilson Bulletin:

Your readers may be interested to know that satisfactory progress is being made in producing manuscript for future volumes on the Life Histories of North American Birds. The material for four volumes, including all the birds on the A.O.U. Check-List from the jays to the vireos, has been in Washington for a long time, awaiting publication after the war.

Two volumes on the wood warblers are now nearly completed, awaiting a few contributions from others. I am now starting work on the next volume, to include the birds from the weaver finches to the tanagers, and I am taking this opportunity to solicit contributions of notes on habits and photographs relating to birds in the three families, Ploceidae, Icteridae and Thraupidae.

Previous contributions have been very helpful, and I hope they will continue.

Taunton, Massachusetts A. C. Bent

The Wilson Ornithological Club Library, established in 1930, is housed in the University of Michigan Museum of Zoology. It comprises some 200 books, 3,000 pamphlets and reprints, and a large collection of ornithological magazines. It currently receives 55 periodicals, as gifts, and in exchange for *The Wilson Bulletin.* The Library is maintained entirely by gifts from members and friends of the Wilson Ornithological Club. It is open to all members of the Club and to the staff of the University of Michigan Museum of Zoology. Any item in the Library may be borrowed by members of the Club 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. It has not been found necessary to set a limit upon the number of items borrowed at one time or upon the length of time they may be kept. Gifts, inquiries, and requests by borrowers should be addressed to "The Wilson Club Library, Museum of Zoology, Ann Arbor, Michigan."

BOOKS: List 3

Books added to the Wilson Ornithological Club Library since the publication of List 2 (*Wilson Bulletin* 56, No. 3, September, 1944:181.—List 1 appeared in Vol. 55, No. 3, September, 1943:209).

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NEW LIFE MEMBERS

THEODORA NELSON, Assistant Professor of Biology at Hunter College of the City of New York, received her undergraduate training at the University of Wisconsin and then went to the University of Michigan, where she received the Ph.D. degree in 1939. For several years she assisted in the ornithology courses at the University of Michigan Biological Station at Douglas Lake, and, jointly with the late Frank N. Blanchard, prepared an account of the avifauna of the whole Douglas Lake region. She has also completed for publication an extensive report on the life history of the Spotted Sandpiper.

OLIN SEWALL PETTINGILL, JR., Vice-President of the Wilson Ornithological Club, graduated from Bowdoin College in 1930 and later received the Ph.D. degree in ornithology from Cornell University. He is Assistant Professor of Zoology at Carleton College and in summer teaches the ornithology courses at the University of Michigan Biological Station at Douglas Lake. His very productive bird photography expeditions have taken him to many parts of North America, from Hudson Bay south to Florida, Louisiana, and Mexico. In addition to many shorter contributions, he has published an important monograph on the American Woodcock and a laboratory and field manual of ornithology.

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Aretas A. Saunders—5 books, 5 reprints, 1 bulletin
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R. M. Strong—6 reprints
Wendell Taber—1 reprint
Josselyn Van Tyne—11 reprints, 1 book
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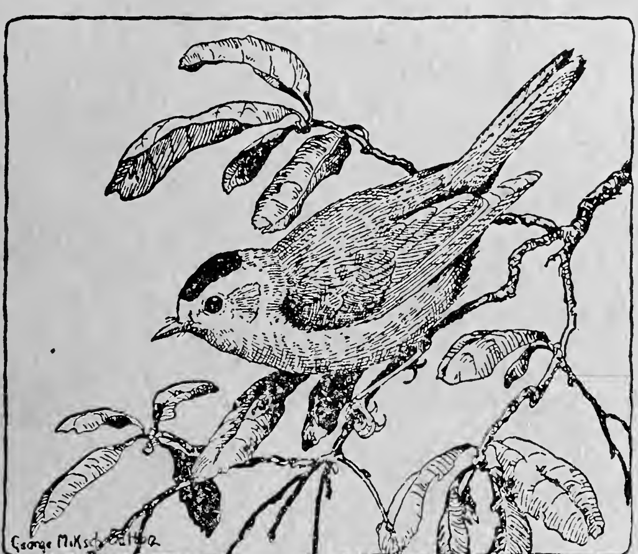

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Near Tecpán, Guatemala May 15, 1933

Nest of the Pacific Orange-bellied Redstart

(*Myioborus miniatus hellmayri*)

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STUDIES OF CENTRAL AMERICAN REDSTARTS

BY ALEXANDER F. SKUTCH

NORTH American wood warblers are highly migratory, exhibit pronounced sexual differences in coloration, and often show marked seasonal changes in plumage. So numerous are these delightful little birds in temperate North America that one is likely to forget that the family is best represented in tropical America, where the species, though few at sea-level, become ever more numerous with increasing elevation. These tropical members of the family are typically non-migratory; even among the most brilliant of them the sexes are often alike or nearly so; seasonal changes in coloration are exceptional if not entirely absent; and, as a corollary, the young birds, in many species at least, acquire the adult plumage in the postjuvenal rather than in the prenuptial molt.

During the two years I spent in bird study in the Central American highlands (1933 in Guatemala, 1937–38 in Costa Rica), I was able to learn something of the habits of three forms of *Myioborus,* a genus of brightly colored wood warblers occurring from Mexico to Bolivia, chiefly in the subtropical zone, but sometimes also in the tropical and temperate zones. Unfortunately, limitations of time prevented my making any of these three forms a major study—interesting as these birds were, they seemed in less urgent need of investigation than some of the neighboring birds of non-passerine families, which in general are less well known than the wood warblers. Yet so far as I am aware, almost nothing has been published concerning the life history of the tropical warblers, and it is to help bridge this gap in our knowledge of the family that these notes are presented. Although none of the three life histories can claim even approximate completeness, they seem to complement one another; taken together they give a fair picture of the lives of these attractive mountain forest birds.

Pacific Orange-bellied Redstart

The Pacific Orange-bellied Redstart (*Myioborus miniatus hellmayri*) is a northern representative of a group of wood warblers widely distributed in the mountainous regions of Central America and tropical South America. The species is known to range from Mexico to Peru, and several races have been described; *hellmayri* [1] is confined to the western highlands of Guatemala and extreme southwestern El Salvador. In Guatemala, I met it at many points, and in 1933 found its nest on the Sierra de Tecpán, Department of Chimaltenango, at an altitude of about 8,500 feet. I have seen it at points ranging from 2,000 to 9,500 feet above sea-level, although at both of these extremes of elevation it is rare. It is particularly abundant in the heavy, humid forests at middle altitudes on the Pacific slope, from 5,000 to 7,000 feet above sea-level, as, for example, on the wooded flanks of the Volcán Zunil opposite Santa María de Jesús, where in July and August, 1934, I found it among the most conspicuous members of the avifauna.

Appearance and habits. This warbler is a bird of striking and distinctive appearance. Most of its head, its back, wings, and most of the tail, throat, and the sides of its breast, are dark slate-color; the center of the crown is chestnut; and the outer tail feathers are broadly tipped with white; most of the breast and the belly are a beautiful bright color, something between orange and red—almost the shade of a tangerine orange. The male and female are colored so nearly alike that it is usually not possible to recognize any difference in their brightness unless one sees them side by side.

This restlessly active little bird catches a large part of its insect food upon the wing. It flits airily amid the foliage, or with consummate deftness weaves an intricate course among the branches, to reach some insect it has seen in a distant part of the tree; or it darts swiftly in pursuit of some creature that has taken flight, twisting, turning, and doubling in the air with amazing skill. In its quieter intervals of hopping and jumping among the branches it often droops its wings, and spreads its tail, displaying the broad white tips of the outer feathers, which contrast prettily with the dark slaty color of the others.

Except during the breeding season, an individual of this subspecies strictly avoids the company of its own kind but attaches itself to one of the large mixed flocks of wood warblers and other small birds that roam through the highland forests, in each of which there is usually a single Orange-bellied Redstart. Here it is conspicuous by reason of its spectacular flight, its flaming breast, and its habit of continually spreading its tail. As the breeding season approaches, the males attract still

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[1] The eggs and nestlings noted under "*Myioborus miniatus connectens*" in my paper on incubation and nestling periods (*Auk*, 62, 1945:23) are from the nest described here under "*Myioborus miniatus hellmayri*." The editor followed Hellmayr ("Birds of the Americas") in using "*connectens*" for the Guatemalan form. But van Rossem in his revision of the species (*Condor*, 38, 1936:117–118) calls the form that occurs in western Guatemala and extreme southwestern El Salvador "*M. miniatus hellmayri*, Pacific Orange-bellied Redstart" and limits the smaller *connectens* to the mountains of the interior Cordillera of El Salvador and south central Honduras, pointing out that Hellmayr had only two birds from the range of *connectens*, so that the size differences were not apparent. It is unfortunate that my two papers should not agree in nomenclature, but to avoid a more general confusion it seems best to follow van Rossem here.

further attention by their song. Although simple in phrasing, it is loud, clear, and ringing—the most forceful of all the songs of warblers I heard on the Sierra de Tecpán, except only that of the Painted Redstart (*Setophaga picta*).

Nest and eggs. On the afternoon of May 13, 1933, while climbing a steep, wooded slope on the Sierra de Tecpán, beneath fine, old, epiphyte-laden trees, I stumbled over a decaying log and frightened a small, blackish-backed bird from its nest. It flew off so rapidly that I saw it too imperfectly to be able to identify it. The nest was situated on the uphill side of a large depression in the ground, made by the uprooting of a great tree whose massive trunk lay mouldering on the slope below. The tree must have fallen some years earlier, for the sides of the hollow were already well-covered with ferns and mosses, and among these the nest was concealed. The structure consisted of a cup-shaped lower portion and a domed roof. The entrance, in the side facing out from the bank, was not round like that of the nests of other forms of *Myioborus* that I found in later years in Costa Rica, but very much wider than high. The lower cup was composed of dead leaves and fibers, thickly lined with fine fibrous material; but the substantial roof, which seemed to have been added as a separate unit, consisted largely of pine needles, with a few dead leaves of dicotyledonous plants intermixed. The three beautiful eggs that rested on the bottom of the nest were white, heavily speckled with reddish-brown, especially on the thicker end; they measured respectively 17.5 by 13.5, 17.5 by 13.5, and 17.5 by 13.1 millimeters. The tip of a frond of a small fern, rooted higher on the bank, hung prettily over the entrance, partially screening the eggs (Plate 12). Dickey and van Rossem (1938:506) describe a nest of this redstart found in El Salvador, May 17, 1927, which "was in a crevice in a vertical road bank, the site being about three feet above the road level. It was simply a ball of bright green moss which entirely filled the cavity, and the outer surface of the nest was flush with the face of the bank. The entrance was a small hole in the side. The lining was of rather wide strips of what appeared to be soft inner bark. A sheltering curtain of ferns hung down over the nest entrance, and the site was discovered only by watching the parents as they carried food to the young."

I waited till evening was approaching for the bird to come back to the nest, but it seemed reluctant to show itself in my presence. Returning on the following day, I was delighted to find an Orange-bellied Redstart sitting in the domed nest. The bird allowed me to approach almost within reach before it jumped out and flew down the slope, skimming low over the ground. I set up my tent in the depression, not two yards from the nest, for there was no other level spot in the vicinity. I seated myself inside and looked out through the tiny window for the Redstart's return. Promptly re-appearing, the bird fluttered back and forth in front of the nest, apparently not sure whether it would be quite safe to go to it in the presence of the strange brown object that had so suddenly sprung up there. Many times the Redstart approached the nest and seemed to be on the point of entering but retreated before quite reaching the goal. Finally, 10 minutes after I entered the blind, the bird was warming the eggs once more.

The next step was to mark one of the pair of Redstarts, in order to distinguish male from female with certainty. After the bird's departure from the nest, I stuck upright in the middle of the doorway a fine twig bearing a wad of cotton soaked in white enamel. Once more the bird flew back and forth in front of the nest; sometimes it alighted on a dead branch which projected from the bank just outside the blind, proving thereby that it had already lost all distrust of this strange object. Finally, before many minutes had passed, the Redstart returned to the nest and attempted to slip into it between the little paintbrush and one corner of the wide entrance but brushed lightly against the paint-soaked cotton. This seemed to disturb the bird greatly; it slipped out immediately and at once began to preen the feathers on the left side of the orange breast, where a small spot of white marred the uniform brightness. The mark was hardly conspicuous enough to satisfy me, and the Redstart was doing its best to make it less so; accordingly I left the brush in place so that the bird might make contact with it once more. Although I left it there for more than half an hour, the Redstart did not go near, and finally disappeared with another Redstart, assumed to be the male of the pair, which, during all this time, had not come near the nest but remained at a distance among the trees. Since it was now after five o'clock in the afternoon, I removed the paint-brush and went away, leaving the blind in place for the morrow.

Incubation. The following morning, May 15, in the early dawn, I slipped into the brown wigwam without disturbing the Redstart and passed the greater part of the day watching the nest. The marked bird, evidently the female, alone warmed the eggs. On returning at the end of a recess, she always flew back and forth a number of times in front of the nest, and often made several false starts to enter it. Her hesitation in going to the nest was probably not caused by the presence of the blind, for in these maneuvers she often came very close to it, and many times perched on a dead branch just outside, not two feet from my eyes. Thereby I had ample opportunity to recognize the faint paint mark on her left side, and did so at every return to the nest except three.

The Redstart sat sideways in the nest, with her long tail projecting from one corner of the wide entrance and her head constantly turned outward so that she could view her surroundings. Her bright orange-red breast and belly were concealed beneath her, and the white ends of her outer tail feathers were folded under the uniformly dark central feathers; in the nest, she was far less conspicuous than one would suppose to be possible. During the night and in rainy weather, she sat with her left wing toward the outside; but during clear days she always sat facing in the opposite direction, with her right wing outward. Since there was little, if any, wind in the deep forest where the nest was situated, I cannot explain this invariable habit. Most of the time she rested nearly motionless, seldom turning her head or adjusting the eggs beneath her; but she was ever alert to slight sounds and looked about to discover their origin. Some minutes before leaving the nest she would become restless, move her head actively, swallow, gape, and shift the eggs; these movements would lead at length to her flying off. As she winged down the mountainside, she invariably called, with sharp, metallic monosyllables very similar to the call of the Cardinal (*Richmondena cardinalis*).

I devoted a total of 12 hours to watching this Redstart incubate. From 5:40 A.M. to 2:26 P.M. on May 15, I kept vigil during weather which was largely cloudy but rainless; while from 2:55 to 6:00 P.M. on May 17 I studied her behavior in a steady, fairly hard rain. Taking the two records together, 11 sessions on the eggs ranged from 26 to 49 minutes, with an average of 37.6 minutes; 12 recesses ranged from 10 to 37 minutes, with an average of 18.2 minutes. She devoted 67.4 per cent of the 12 hours to incubation. I have not included in this record a session of only 18 minutes which was terminated when a jaguarundi cat passed stealthily, only two yards in front of the nest, and frightened the Redstart from her eggs.

It is of interest to compare the Redstart's behavior while incubating in clear weather and in the rain. During the rainy afternoon of May 17, there were two sessions of 42 and 49 minutes, respectively, and two recesses of 37 and 35 minutes. Her sessions on the eggs were not significantly longer than those in clear weather; for early in the rainless afternoon of May 15 she sat continuously for periods of 47, 38, and 45 minutes, while early in the morning she had incubated once for 38 minutes. But her three longest recesses on May 15 were only 22, 16, and 16 minutes; and the average of 10 recesses in rainless weather was only 14.6 minutes. Thus the rain had greatly increased the time she devoted to finding food, but did not increase her period of warming the eggs. This was doubtless because during a hard rain there are few insects upon the wing; and since she subsisted largely upon flying insects, she found it far more difficult to satisfy her hunger.

The male Redstart usually remained at a considerable distance from the nest. His song, when I could hear it at all, sounded from afar in the woods. Twice, however, he accompanied his mate as she returned to her eggs, calling, and singing *ch'ree ch'ree ch'ree ch'ree* in a clear, melodious voice. The female, after she had settled in the nest, answered him with a low murmur. After singing and catching insects for a few minutes in the vicinity of the nest, he flitted off among the trees, and his song grew faint in the distance. Even on these rare visits, he did not approach the nest closely.

Among the brightly colored species of North American wood warblers, the female is usually dull-colored and incubates the eggs without the assistance of the male. In many species of tropical warblers, male and female are equally brilliant in plumage, and I thought that perhaps they would prove to share the duties of the nest. But neither the male Pink-headed Warbler (*Ergaticus versicolor*), nor Hartlaub's Warbler (*Vermivora superciliosa*), nor the Orange-bellied Redstart, ever sat upon the nest. Later in Costa Rica, I found that the male Collared Redstart (*Myioborus torquatus*) and Buff-rumped Warbler (*Basileuterus fulvicauda*) likewise took no share in incubation. My experience with warblers has been duplicated with tanagers, finches, honeycreepers, orioles and other families. With few exceptions, all the members of the same family of birds follow the same general plan of incubating the eggs, and species in which the sexes are alike in color behave very much the same as species in which the sexes are greatly different. Contrary to the statements of theorists of the last century, the color of the plumage seems not to be correlated with incubation habits.

The nestlings and their care. Each day the female Redstart allowed me to come a little closer to her when I visited the nest, until finally I could bend down my head and look in at her from the distance of a foot, before she slipped out and fluttered away, "feigning injury." On May 22, this reaction was much stronger than ever before. Upon jumping from the nest at my near approach, she alighted on the ground only two yards away from me, relaxed and vibrated her wings, and moved as though in great distress. When I took a few steps toward her, she fluttered off ahead of me and alighted on the ground again to repeat the act. She did this a number of times, until I had followed her a good distance from the nest, when of a sudden she "recovered" and flew rapidly down the mountainside. Returning then to her nest, I found one little nestling, with red skin scarcely concealed by sparse gray down. It was remarkable how erect it stood—like a sentinel at his post—as it held up its widely gaping mouth for food. Then, exhausted by the momentary effort, it fell over and lay in the bottom of the nest. The occupants of the other two eggs were tapping at their shells; they hatched the following day, May 23.

The male Redstart, as we have seen, did not show much attention to his mate while she incubated; and while I watched, he never went to look into the nest. As a result, apparently, he had not become familiar with its position, and seemed to experience considerable difficulty in finding it when he first began to feed the nestlings. Just how he learned that they had hatched I do not know, for I did not replace my tent and again watch this nest until the nestling first to hatch was three days old, the other two a day younger. Even then the male seemed to waste much time in locating his children. He would come, singing, with his bill full of insects, and fly to the wrong part of the bank. Here he would apparently search for the nest, returning again and again to look for it, seeming to be surprised at not finding it where it never had been. Sometimes he spent many minutes exploring various portions of the mossy sides of the depression before he at last came to the actual nest site. On three occasions he flew away, still carrying the food intended for the nestlings. Even after he had fed them several times in my presence, he seemed unsure of their exact location. During the three hours of my vigil that morning, his memory of the nest's position seemed to improve rapidly, until at last he went directly to it as his mate did. She fed the three nestlings 10 times, in the intervals of keeping them warm; but he gave them food only 5 times, and 3 times carried away the food he had brought.

The male Redstart was not at all afraid of my tent, for he flew all around it while searching for his nestlings; but it is possible that the sudden appearance of so large an object less than six feet from the nest confused him. The tent did not in the least disturb the female, although eight days had passed since she had last seen it.

One of the nestling Redstarts vanished when a few days old, and only two lived to leave the nest. They took their departure on June 2 and 3 respectively, at the age of about 11 days, when they were scarcely able to fly, and could only hop rapidly over the ground. Since I had removed them from the nest to examine their plumage, it is likely that they left somewhat prematurely. Their upper plumage, head, throat, and a portion of the breast were sooty gray. The lower part of the breast and the belly were buff, very different from the glowing color of their parents, and they lacked the chestnut crown.

By late July, before their parents have ceased to give them food, young Orange-bellied Redstarts have molted into a plumage difficult to distinguish from that of the adults. As soon as the young are able to take care of themselves, the families break up.

In the separation of male and female after the breeding season, the Pacific differs strikingly from the Costa Rican Orange-bellied Redstart and from the Collared Redstart. Although they sang far less than they had during the fine weather of April and May, the males sang occasionally on pleasant days through most of the rainy season, which extended from mid-May to mid-October. During this period, I heard their song far more often than that of any other wood warbler on the Sierra de Tecpán; but it was not so loud and clear as it had been during the nesting season. If two males happened to come together in the same mixed flock, they sang spiritedly against each other, and finally one would drive the other out of the flock.

Costa Rican Orange-bellied Redstart

The Costa Rican Orange-bellied Redstart (*Myioborus miniatus aurantiacus*) is confined to Costa Rica, but closely similar forms are widespread in the mountains of northern and western South America. It is found only at middle altitudes. Carriker (1910:800) gives its altitudinal range as 2,000 to 7,000 feet above sea-level, but it must be very rare at 2,000 feet, for on the Caribbean slope I have never met it below 3,000 feet, and seldom even at this altitude. On the Pacific slope, I have not encountered the bird below 3,700 feet.

Appearance and habits. In plumage and habits, this Redstart is the southern counterpart of the Pacific Orange-bellied Redstart. It has the same dark slate-colored upper plumage, wings and tail, the same chestnut crown and white outer tail feathers; but the breast and belly are cadmium yellow, instead of orange-red as in the northern bird.

In the vicinity of Vara Blanca, on the northern slope of the Cordillera Central of Costa Rica, I found these redstarts very numerous between 5,000 and 6,000 feet above sea-level. Here they dwelt in the humid, moss-draped cloud-forest, but they usually avoided its darker depths and were most often seen along its bushy edges, whence they ventured forth among the scattered trees and shrubs of the adjoining fields and pastures. Yet they rarely wandered far from the woodland and the heavier second-growth thickets. They remained mated through the year. The young birds appeared to find partners a few months after they were fledged; after October I nearly always saw these redstarts in pairs. In the eastern foothills of the Ecuadorean Andes, in August and September when they were apparently not nesting, I found the related race, *Myioborus miniatus pallidiventris,* living in pairs or alone.

The Costa Rican Orange-bellied Redstart hunts among the branches of the trees less than the Pacific; it forages far more frequently among the bushes along the margin of the forest, often quite near the ground, where it sometimes alights to pick up an insect. It rarely ascends to the tops of the higher trees. It has the same sprightly, active ways as the other redstarts, and catches much of its insect food upon the wing, making short sallies out from the bushes, frequently doubling and twisting through the air in an intricate course. It is, as a rule, somewhat less spectacular in its movements than the Pacific Orange-bellied Redstart or the American Redstart (*Setophaga ruticilla*), probably because it forages so much among low bushes, often in close, tangled vegetation, rather than in the more open crowns of trees. Sometimes, as it flits about in search of insects, it spreads its tail fanwise, displaying the white outer feathers in pretty contrast to the dark central tail feathers and upper plumage. Like the Pacific Orange-bellied Redstart, it sometimes searches over the bark of trees. One April morning at dawn, I watched a male ascend the clean, smooth trunk of a medium-sized tree, searching for insects as he went. He clung to the bark, then flitted up a short distance and clung again, repeating this until he reached the branches above. Here he flitted about, his wings drooping when not in use, his tail prettily spread, and sang his sweet, homely song.

The Redstarts' almost exclusively insect diet is from time to time varied with the little white protein bodies which they pluck from the brown hairy cushions at the bases of the long petioles of the great leaves of the cecropia trees. These ovoid corpuscles, the size of a mustard seed, are the chief food of the azteca ants that make their homes in the hollow stems and branches of the trees; but when the ants are absent, as is often true at higher altitudes in the subtropical zone, the corpuscles accumulate in numbers and are eaten by small birds—wintering warblers of several kinds, small finches, honey-creepers, and ovenbirds, as well as redstarts.

Song. The song of the Orange-bellied Redstart of Costa Rica is simple; it is pleasant but neither strong nor ringing in tone: *chee chee chee chee chee chee,* the notes rising slightly in pitch toward the end. His notes are far less full and rich than those of the Pacific Orange-bellied, the Collared, or the Painted Redstart; his phrasing is less varied than that of the Collared Redstart and the American Redstart. But he does not restrict his singing to the season of courtship and nesting; he is heard in pleasant weather in every month of the year, although more rarely during the gloomy period from October to January. The call of this redstart is a weak *chip.*

Nest building. In 1938, I found the first nest of the Costa Rican Orange-bellied Redstart on March 30, when it was nearly completed. It was in a niche six feet above the base of a cut-bank eight feet high, beside a muddy mountain road along which many people passed. The little pocket in the clay wall was just big enough to contain the nest, and the site was further shielded from the elements by an overhang of root-bound earth at the top of the bank. Yet the nest, composed principally of straws, dry grass-blades and fibrous rootlets, was a roofed structure, with a round doorway in the side that faced out from the bank; and moreover, the roof had been made very thick. It may have served to shield the interior of the nest from falling particles of earth if not from the rain. The side walls were still thin, and one could see the earth of the bank through the right side of the nest. The floor of the nest, as is usual in such structures, had been left until the last; when I first looked in, the earthen bottom of the niche had not been covered over. It was to the covering and lining of the bottom that the builder devoted most attention while I watched on the morning of March 30.

Since the Redstart was too cautious to go to her nest while I stood in the roadway, in order to watch her at work I was obliged to screen myself within the border of high grass in the pasture below the road. Later, when she had become somewhat accustomed to her observer, I moved closer and stood behind a small cypress tree that had been planted beside the road. I watched for two hours, from 8:00 to 10:00 o'clock; during this period the female warbler brought material to the nest 54 times. She picked up straws, grass blades, and other fine bits of vegetation from the road and the slope above the bank, and she sometimes tried to pull exposed slender rootlets from the bank, though usually without success. Later in the morning, when she had begun to line the nest, she brought, from the woods that began a short distance back from the top of the bank, bundles of fine brown fibers, of whose origin I remained in ignorance. She also visited a thick stump, overgrown with epiphytic bushes, ferns, and mosses, which stood at the edge of the road close beside me, vanishing into its cavities and fern-shaded recesses, to re-appear with her bill full of thread-like rootlets. She was usually cautious in approaching her nest, and perched upon some fallen brush beside the bank to look about her before she entered.

At this nest the male Redstart did not help with the work of building. Most of the time while his mate worked, he remained among the bushes on the slope above the nest, where he hunted insects and often sang. From time to time he came to perch upon a slender dead stem that projected from the bank a few feet from the nest. Here he sometimes sang but mostly rested in silence. At times he hovered in front of the nest to look in; and once, while his mate was within, arranging the material that she had brought, he came to stand upon the sill of the doorway. The female evidently did not approve of this visit, for she opened her bill in a threatening attitude.

On April 1, I found another nest being built in a very different sort of position. It was on the ground on a very steep slope in a bean-patch overgrown with low weeds, about 30 feet from the edge of the forest. It occupied a slight depression in the slope, and the sill of the entrance was just level with the ground in front. The fronds of a small fern, growing above the nest, bent prettily over the domed roof; it was screened in front by a seedling cecropia tree, and on the sides by tufts of grass. The slender trunk of a fallen tree, bridging the cavity in the hillside, stretched above the nest, helping to conceal and shelter it. The nest itself resembled the first that I found; it was entirely enclosed except for the round doorway in the side facing down the slope. The walls, roof, and cupped bottom were all quite thick; they were composed of soft, fibrous vegetable materials, with some decaying grass blades intermixed. The nest was nearly finished.

The male and female Redstarts were building this nest together. Since I could not distinguish them by appearance, and the male sang very little, and not at all while he worked, I was not able to determine the relative part taken by each sex in building. The two made no attempt to come and go together as tanagers of many kinds do; each went its way independently of the other. Yet despite this lack of coordination in their movements, on 10 occasions during the course of the hour and a half between 9:00 and 10:30 o'clock, I had proof that both birds worked at the nest, since I saw the second fly up to it with material in its bill, before the first, which had already added its contribution to the structure, had left the clearing. Thus it was evident that both male and female took substantial parts in the labor of building. This was the first time that I had seen a male wood warbler of any kind help build a nest.

Among other things, the birds upon several occasions brought billfuls of the brown ramenta of a fern to their nest. I saw one of them pull the big, crowded scales from the bases of the great, thick, spine-studded petioles of the spreading fronds of a tall tree-fern that grew at the edge of the neighboring forest. While I watched these redstarts build their nest, I sat at the base of a tree on the slope above them, in plain view and at no great distance. At first, the birds, upon arriving with material in their bills, flitted about in the offing and hesitated to approach their nest, but soon they grew accustomed to my presence and went about their labors without fear.

The third nest at which I watched these Orange-bellied Redstarts work occupied a site quite different from those of the first two. A small fallen log, densely covered with slender aroids, ferns, mosses, and other epiphytic growths, lay in a pasture about 10 feet from the edge of the forest. The nest was built upon the log, and fitted snugly into a nook beneath the stems and roots of epiphytes; it was completely covered over by a thick layer of moss. The round entrance was screened by a bromeliad and the foliage of several small epiphytic shrubs. On the morning of April 5, after the cessation of the rain, I watched this nest from 9:15 to 10:15. It appeared to be finished, but the industrious builder continued to augment the already ample lining. During the course of the hour, she took material to the nest 15 times. Her mate flitted about in the vicinity, catching insects and often singing; but I saw nothing to suggest that he helped to build.

Two days earlier, I had watched yet another nest, whose builder, shier than most of her kind, would not go to her work in my presence. Here, too, I saw nothing to suggest that the male would have helped his mate to build. Quite a number of times I saw one of the pair flitting about with material in its bill, hesitating to approach the nest, but never two birds together with material. (When both members of a pair of birds build the nest, yet do not come to it together, sometimes the best way to prove that they both work is to delay their approach to the structure by standing near it and preventing the deposit of material until both have arrived with laden bills.) The following day, I spent a short while at a fourth nest, again without finding any evidence that the male helped to build. The male Redstart that took so large a share in the construction of the nest in the bean-field was evidently exceptional in his species, as he was among wood warblers in general. I wanted very much to see whether he would take an abnormal part in the subsequent duties of the nest, but unhappily it was prematurely destroyed.

The male Buff-rumped Warbler (*Basileuterus fulvicauda*) regularly takes a large share in building. I have seen a male do so at four nests.

But nest-construction by male wood warblers has only rarely been recorded; and aside from the single Costa Rican Orange-bellied Redstart and the Buff-rumped Warblers, I have never myself seen a male at work. It is possible that at the other redstart nests I watched, the male helped to build at other stages of construction, but I do not think this likely.

We have already called attention to a considerable variation in the Redstarts' nest sites: niches in cut-banks; a slight depression on a very steep slope, among sheltering vegetation; a fallen log amid low, dense epiphytic growth. But a cranny in a bank appeared to be the most favored location; 11 of the 14 nests I found in 1938 were so situated. The cottage that I occupied at Vara Blanca stood amid pastures which covered the back of a narrow ridge falling away steeply on three sides to wooded ravines or gorges. On the western side of the pasture, a footpath followed along the side of the ridge for a distance of about a quarter of a mile. Along much of its length, this path had been cut into the steep slope, making a bank, in places three or four feet high, that faced the bushy border of the woods across the path and had the grassy hillside rising behind it. This low bank, in places covered by grasses creeping down from above, in others overgrown with ferns and small native herbs, was a favorite nesting site of the Orange-bellied Redstarts. In this one long bank, eight of their nests were built between the end of March and late May. Most were well-screened by surrounding vegetation. They were well-separated, although one was only 29 feet from an occupied nest of the Collared Redstart.

I did not have the good fortune to witness the very beginning of nest building in any instance, but from the examination of completed nests I learned something about the earliest stages of construction. After the selection of the nest site, the Redstart's first care was to carry into the cavity fairly large dead leaves to serve, apparently, as a foundation for the nest. These leaves included the foliage of dicotyledonous plants and bamboos, and fragments of the fronds of ferns. Some measured as much as six inches in length. Often a number were strewn in front of the nest site, whether intentionally or by accident I cannot say. From the ground in front of one of the nests, I picked up a double handful of dead leaves which obviously had not merely fallen from neighboring trees. I found a number of niches in banks, such as might have been selected by the Redstarts for their nests, which contained a small accumulation of dead leaves, mixed at times with some straws and the like, all of which appeared to have been quite recently placed there. Apparently the Redstarts had prepared to build in these crannies but afterwards abandoned them in favor of other sites that pleased them better. Some of the pockets that contained completed nests were lined all around with dry bamboo leaves; in others, this lining was confined to the sides and bottom. The Collared Redstart likewise builds its nest upon a foundation of broad dead leaves.

The nest beside the main trail, which I had watched as the bird built on March 30, was found lying in the roadway on the following day. On April 2, this bird had a half-finished nest only four inches from the site of her first. By the afternoon of April 3, the new structure appeared to be finished, after three (or at most four) days of work—only to meet the same fate as its predecessor. Another nest, found on April 2 when newly begun, appeared complete by April 5. A late nest was found in an early stage of construction on May 19 and seemed to be finished on May 23. Accordingly, these redstarts build their roofed nests in from three to five days.

The eggs. Despite the speed with which these rather bulky nests were constructed, about a week elapsed between the completion of the work and the laying of the first egg. This long period between the end of active building and the appearance of the first egg was noted at all seven of the early nests for which information is available. But a late nest (evidently a replacement), found under construction on May 19, was completed about May 23, and contained the first egg on May 25 (See Table 1).

The Orange-bellied Redstarts at Vara Blanca generally began to build their nests during the last days of March or the beginning of April. The earliest egg was found on April 7 (Nest 7). In nine nests, the first egg was laid during the week from April 7 to 13, inclusive. (Nest 10 is included in this number, from the calculated date of laying.) The three nests found with eggs in May were probably all replacements of earlier nests that had been lost. This close synchronization in the time of laying is surprising in a bird that dwells throughout the year in a region without marked seasonal variations in climate; yet it is paralleled, in my experience, in several other kinds of tropical birds. At Vara Blanca I kept only rough notes on the weather and took records of maximum and minimum temperatures with a Six's thermometer that was probably not very accurate. During the period of my residence there, July 1937 to August 1938, the only pronounced seasonal difference in weather was that the rain storms during the period from February to August were less protracted and severe than they had been during the preceding seven months. But during April, May, and June, when the great majority of the birds were nesting, there was much cloudiness and rain, and a dearth of sunshine.

The eggs were laid early in the morning—I have four records of eggs laid before 7:30 A.M.—and at intervals of one day. Eleven nests contained each three eggs or nestlings; two contained two eggs each. The eggs were white or dull white, speckled and blotched with brown ranging from bright brown to chocolate. The pigmentation was heaviest in a wreath at the point of greatest transverse diameter, or in a cap covering the larger end. The remaining surface was more lightly spotted with the same color, the heaviness of the pigmentation varying considerably in different sets. Measurement of 20 eggs gave an average of 17.5 by 13.4 millimeters. The eggs showing the four extremes measured 18.3 by 13.9, 16.7 by 13.5 and 17.5 by 13.1 millimeters. Six eggs showed the minimum diameter of 13.1 millimeters.

Incubation apparently began with the laying of the last egg of the set. The fact that in all six nests for which information is available the eggs in a set all hatched within a period of approximately 24 hours, suggests that the Redstarts incubated little before their sets were complete. The nest that I most wanted to watch during the period of incubation—that which the male had helped to build—was prematurely destroyed; and the others seemed less important to study during this period than those of some other species of birds that then claimed my attention. It is almost certain that the female incubates without help from her mate, as in all other wood warblers for which I have information, including the related Pacific Orange-bellied Redstart and the Collared Redstart.

The incubation period varied from 13 to 15 days. Three eggs in one nest hatched 13 days after the set was completed and incubation presumably begun; three eggs in one nest hatched in fourteen days; nine eggs in four nests hatched in fifteen days. The eggs of the non-migratory Central American warblers seem generally to require a few days more incubation than those of the migratory species that breed in temperate North America. I have one record for the Collared Redstart: 15 days; one for the Pink-headed Warbler (*Ergaticus versicolor*): 16 days; seven records for the Buff-rumped Warbler: 16, 17 and (abnormally: one record) 19 days. The eggs of most North American warblers hatch after only 11 or 12 days of incubation.

The nestlings. The newly hatched Redstarts were pink-skinned and blind, and sparsely covered with down. At the age of 9 or 10 days, they were well-clothed with feathers, and after the age of 10 or 11 days, they were no longer brooded during the night. They left the nest when from 12 to 14 days of age. Six nestlings in three nests left at the age of 12 days; two in one nest, at the age of 14 days. I handled none of these nestlings after they began to be feathered, and the departures of all were probably spontaneous. At one nest (No. 11), however, I removed two nine-day-old nestlings for examination of their under plumage, which I could not otherwise see. As I lifted one from the nest, the other tried to jump out. When I had completed my notes on the plumage, I returned both young to the nest and induced them to remain there, at least until I was out of sight. But the following day the nest was empty. The nestling period of these young that had been handled was accordingly only 10 days, as compared with the 12 to 14 days of undisturbed young Redstarts.

Reproductive success. Tables 1 and 2 give the data for the 14 nests whose history is adequately known (including two replacements at the sites of earlier nests that had been despoiled). Of the 31 eggs laid, 10, or 32 per cent produced fledglings; of the 11 nests that contained these eggs, 5, or 45 per cent produced at least one fledgling. In my experience, this is about average success in reproduction among Central American birds—rather better than one would expect in the lowlands, not so good as might be found at still higher altitudes.

TABLE 1

SYNOPTIC HISTORY OF 14 NESTS OF COSTA RICAN ORANGE-BELLIED REDSTARTS
Vara Blanca de Sarapiquí, Costa Rica, 5,300–5,600 feet
March–June, 1938

Nest 1—Building March 30; destroyed by man, March 31.

Nest 1a—Building 4 inches from Nest 1, April 2; apparently completed, April 3; destroyed by man, April 6.

Nest 2—Building April 1; 3 eggs laid April 8, 9, and (presumably) 10; eggs broken and eaten, April 16.

Nest 3—Begun about April 2; apparently completed April 5; 3 eggs laid April 12, 13, and 14; 3 nestlings April 28 (14 days incubation); all dead in nest May 4.

Nest 3a—Found completed, resting on Nest 3, June 7; apparently never contained eggs.

Nest 4—Nearly completed, April 4; 3 eggs laid April 12, 13, and 14; eggs broken and eaten, April 28.

Nest 5—Nearly completed, April 4; 3 eggs laid April 12, 13, and 14; 3 nestlings, April 27 (13 days incubation); nestlings disappeared, May 4, 5.

Nest 6—Apparently completed, April 2; 3 eggs laid April 8, 9, and 10; 2 nestlings, April 25 (15 days incubation); nestlings departed May 9 (14 days old).

Nest 7—Found with 1 egg, April 7; second egg laid April 8; 2 nestlings, April 23 (15 days incubation); nestlings departed, May 5 (12 days old).

Nest 8—Apparently completed, April 6; 3 eggs laid April 13, 14, and (presumably) 15; eggs disappeared, April 18.

Nest 9—Apparently completed, April 7; 3 eggs laid April 13 to 15; 3 nestlings hatched April 30 (15 days incubation); nestlings departed May 12 (12 days old).

Nest 10—Found with 3 nestlings a few days old, April 27. Subsequent history unknown.

Nest 11—Found with 2 eggs, May 4; 2 nestlings hatched May 16; nestlings departed May 26 (10 days old—had been removed for examination).

Nest 12—Found with 3 eggs, May 4; one nestling hatched May 13 (other 2 eggs infertile); nestling departed May 25 (12 days old).

Nest 13—Found with 3 nestlings in pin-feathers, May 8; nestlings well feathered, May 16.

Nest 14—Building May 19; nest completed, May 23; 3 eggs laid May 25, 26, and 27; 2 nestlings hatched June 11 (15 days incubation); nestlings disappeared June 18. (Near site of Nest 2 and probably belonged to same pair.)

TABLE 2

Reproductive Success of the Costa Rican Orange-bellied Redstart *

	Nest	Eggs				Nestlings	
		No. laid	De-stroyed	Not hatched	Hatched	Died or lost	Left nest
	1	0	—	—	—	—	—
	1a	0	—	—	—	—	—
	2	3	3	—	—	—	—
	3	3	0	0	3	3	0
	3a	0	—	—	—	—	—
	4	3	3	—	—	—	—
	5	3	0	0	3	3	0
	6	3	0	1	2	0	2
	7	2	0	0	2	0	2
	8	3	3	—	—	—	—
	9	3	0	0	3	0	3
	11	2	-	0	2	0	2
	12	3	0	2	1	0	1
	14	3	0	1	2	2	0
Totals		31 100%	9 29%	4 13%	18 58%	8 26%	10 32%
Totals by nests		11 100%	3 27%	3 27%	8 73%	3 27%	5 45%

* Based on the nests listed in Table 1. Nests 10 and 13, whose history is unknown, are omitted.

Absence of a second brood. I continued field work in the same locality until the middle of August, but found no evidence of a second brood. The one nest whose dates suggest a second brood (No. 14) was near the site of an earlier nest from which the eggs had been lost. Wood warblers in general appear to raise only one brood in a year; in this, the species of the Central American highlands agree, so far as we know, with those that breed in the North. At lower altitudes in Costa Rica, the Buff-rumped Warbler breeds from March to August, a period long enough for two or even three broods; but I am not at all sure that the late nests are not merely repeated attempts at reproduction by birds which have earlier been unsuccessful in fledging their young.

"Injury-feigning" or distraction display. Sometimes, when interrupted while incubating their eggs or brooding their nestlings, these Costa Rican Orange-bellied Redstarts would "feign injury" in front of the nest. Since I passed almost every day, and often several times a day, along the path beside which most of these nests were situated, I enjoyed an excellent opportunity to witness these "distraction displays" and to learn something of the circumstances under which they took place. Other things being equal, whether or not a bird "feigns injury" often depends upon whether it finds a suitably clear area in which to perform; for although it has been claimed that birds are hysterical, or half-crazed, or otherwise not in full control of their faculties when they behave in this manner, they are usually sufficiently in possession of their wits not to beat their wings and flap about amid dense vegetation where there is danger of their becoming entangled and falling an easy prey to their enemies. Since all of these redstarts had, in the clear pathway in front of their nests, a suitable stage upon which to act, variations in behavior might be attributed to individual differences among the birds rather than to the varying nature of the surrounding area.

Of the eight Orange-bellied Redstarts that nested in the bank beside the path, three were never seen to make any special display upon leaving the nest. Two of these successfully reared fledglings, but the third lost her eggs when they were on the point of hatching. The remaining five varied considerably as to the stage of the nesting at which they displayed. The female of Nest 6 feigned injury soon after she began to incubate, but not thereafter, although she successfully reared her nestlings. The owner of Nest 8 gave an excellent performance the day after she began to incubate. (Two days later she lost her eggs.) The Redstart of Nest 11 displayed nine days before her eggs hatched. At Nest 7, the female feigned injury only on the day her eggs hatched. At Nest 3, the performance was witnessed three days before hatching, on the day the eggs hatched, and when the nestlings were two days old. Even in a single day, the same bird did not consistently feign injury when driven from the nest. Possibly this depended upon how long she had been sitting before she was interrupted. (See Pickwell, in Bent 1942:349.)

Usually the Redstarts sat bravely, permitting me to approach very close to them before they left the nest. Some would allow me almost to touch them; others would sit steadfast and return my gaze with eyes only a hand's breadth from my own. But a closer approach would cause them to dart past me and fly toward the neighboring woods. There was no relationship between the closeness of the bird's sitting and her display upon leaving; some of the Redstarts that would allow me to come within a few inches of touching them never displayed. Those birds that attempted to lure me from the nest by the "distraction display" usually dropped from their nests into the pathway almost at my feet, where they vibrated their relaxed wings and moved slowly, as though injured, toward the bushes on the farther side. Others would flit directly from the nest to the vegetation at the edge of the neighboring forest, where they raised and fluttered their wings, depressed their tail, and hopped mincingly from stem to stem, always keeping near the ground. Sometimes, after passing from view among the foliage, they would return to the edge and continue to perform where they caught my eye. Such behavior certainly seemed purposive, and not merely a substitute reaction.

The fledglings. When they left the nest, the young Redstarts wore a plumage very much duller than that of the adults. The head was dingy black, with no chestnut on the crown. The upper plumage, throat, and chest were dark slate-color. The lower breast and belly were buff. The outer tail feathers were white, as in the adults. This body plumage was worn only for a brief period; soon after beginning to fly, the young birds started to acquire the colors of the adults. The last remaining mark of immaturity was the dull black crown; but by mid-July, some individuals had chestnut feathers on their heads. Soon there was little difference between the adults and the young of the year. By October the young birds, now indistinguishable from the adults, appeared to have mated; for most redstarts of this subspecies were then in pairs.

Collared Redstart

The charming Collared Redstart (*Myioborus torquatus*) is confined to the mossy, humid forests of the southern highlands of Central America—in Costa Rica and western Panamá. It is the biggest and to my mind the prettiest of the Central American members of this attractive genus. Its upper plumage is black or blackish, and it has the chestnut crown-patch characteristic of the group. Its forehead, face, throat, and all the under parts are bright yellow, with a black band or collar extending across the breast, joining the black of the upper plumage. Its long tail is black, with snowy white outer feathers. Its bill and eyes are black. The sexes are alike.

Habits. Carriker (1910:799) states that in Costa Rica the Collared Redstart ranges from about 3,500 feet above sea-level up to timberline on the high volcanoes. Hence it extends considerably higher than the Orange-bellied Redstart of Costa Rica, although their two ranges overlap over a wide area. I found it very abundant on the storm-beaten northern slopes of the Cordillera Central between 5,000 and 8,000 feet above sea-level. Although essentially a sylvan bird, it frequents the bushy woodland edges, and such openings as are made by roadways or the fall of some giant tree, rather than the dark depths of the unbroken mountain forest. Sprightly, graceful, and restlessly active, it hunts its insect food at all levels from the tree-tops to the ground, yet is most often seen at middle heights. It searches over the bark of trees far more seldom than the two forms of Orange-bellied Redstart described above, but like them, it frequently catches insects on the wing. Sometimes, in the lower parts of their altitudinal range, Collared Redstarts in pairs will be found following the army ants in company with a variety of other small woodland birds. They concentrate chiefly upon the capture of such winged fugitives from the ant horde as they can snatch in the air; and their bright colors and active habits make them the most conspicuous figures in all the motley flock.

Unlike the American Redstart, Painted Redstart, and Pacific Orange-bellied Redstart, the Collared Redstart rarely lives alone during the winter months. After the separation of the young birds from their parents, which usually occurs in August or September, Collared Redstarts are most often seen in pairs. Yet even in November and December, it is not rare to find from three to five birds together.

In the wilder portions of the Costa Rican highlands, most birds are as fearless of the human presence as one will find them anywhere save on uninhabited oceanic islands. But the Collared Redstart is the most friendly of all. Sometimes, while I watched them, one of these warblers would alight on a branch so close in front of me that I might have reached out and touched it. One afternoon, while I squatted beside a wren's nest in a bushy opening in the forest, I was surrounded by a family of Collared Redstarts, consisting of parents and young already in the adult dress. Of a sudden, one of the young birds flew up to me and stood on the crown of my hat where, possibly, it had espied an insect. I remained motionless, and it lingered upon my head for several seconds, then flitted off again. At their nests, too, I found the Collared Redstarts almost fearless of me. Because of its trustful ways, the Costa Rican mountaineers sometimes call this bird *el amigo del hombre,* the friend of man.

Song. Not only is the Collared Redstart the brightest in plumage of the three forms of *Myioborus* discussed here, it is also the most gifted singer. Its delightful song is long-continued, full and mellow in tone, varied in phrasing, and easily distinguished from the simpler music of the other redstarts that I have heard. It is both longer and more powerful than the simple notes of the Orange-bellied Redstart of Costa Rica. It is far longer and more varied than the songs of the Pacific Orange-bellied and the Painted Redstarts; although it perhaps equals the former in richness of tone, it falls somewhat short—if memory is to be trusted—of the latter's strong full voice. The Collared Redstart is a notable songster among all the wood warblers. During my year at Vara Blanca, I heard it very rarely from July to February; during this period it sang far less than its neighbor, the Orange-bellied Redstart. But in March, as the breeding season approached, it entered its period of full song and was a joy to hear.

The call note of the Collared Redstart is a sharp monosyllable, *pit,* similar to the *chip* of the Orange-bellied Redstart, but distinctly sharper.

Nest building. At Vara Blanca, on the northern slope of the Cordillera Central of Costa Rica, the Collared Redstarts, although by no means rare between 5,000 and 6,000 feet above sea-level, were far less abundant than the Orange-bellied Redstarts. In 1938, I found 14 nests of the Orange-bellied but only two completed nests of the Collared. Since the two species placed their nests in similar situations, and these were accordingly equally easy to find, the number of nests discovered is probably a good index of the relative abundance in the study area of the two kinds of redstarts.

The first Collared Redstart's nest was found on April 3 when already nearly completed. It was situated in a deep recess in a vertical cut-bank beside a little-used pathway. Above the bank was a pasture with scattered trees and clumps of low, spiny palms; below the path was forest, with tangled undergrowth, falling away into a ravine. The bank was 4 feet high; the niche which sheltered the nest, 40 inches above its foot. The nest was a roofed structure with a round entrance in the side facing out from the bank. It resembled the nests of the other Central American forms of *Myioborus,* but had a thinner roof. The foundation was composed of dry bamboo leaves, others of which lay loosely in front of the doorway. The chief material of the structure was fine vegetable fibers, which in the floor and lower part of the walls were matted together to form a thick, soft fabric. The liverworts, mosses, and low herbage on the walls and about the entrance of the niche in the bank quite screened the nest from the casual glance. Two feet distant, in a more shallow cranny in this bank, was an old nest of the same kind, possibly the preceding year's nest of the same pair. Twenty-nine feet to the north, a Costa Rican Orange-bellied Redstart was building her nest in the same bank.

I sat without concealment in the path north of the Orange-bellied Redstart's nest, hoping to watch both kinds of warbler build at the same time. The Collared Redstart, whose nest was 70 feet away, went ahead with her work as though I were not there; but the Orange-bellied Redstart, whose nest was only 40 feet distant from me, feared to approach it. I made trial of various positions, and learned that the Collared Redstart was not afraid of me even when I sat within 14 feet of her nest; but the Orange-bellied Redstart continued to be shy when I was 15 yards from hers. This agreed with my earlier experience that the Orange-bellied Redstart is consistently less confiding than the Collared Redstart. Since I could find no position that gave a satisfactory view of both nests, and yet did not disturb the more wary bird, I sat with my back to the Orange-bellied Redstart and gave my attention wholly to her trustful neighbor.

At 8:00 o'clock, when I began to watch the Collared Redstart at her building, a fine drizzle was falling from the clouds that swept low above the open pasture and drifted through the tops of the trees in the neighboring forest, whence fell larger drops of moisture that had condensed on the foliage. From time to time the precipitation increased to the intensity of a light shower; and by 9:45, the rain had become hard enough to drive me to shelter. Yet despite the unfavorable weather, the Redstart kept steadily at her work. During the 105 minutes of my watch, she brought 34 billfuls of material to her nest. She found all of this material in the woods down the slope, and would arrive at the bushy edge of the woodland with her bill laden with an ample bundle of fine, light-colored bast fibers, or the brown ramenta from a fern frond. Then, after a moment's pause, she would flit across the path and come to rest on the top of the bank near her nest. Here she delayed a few seconds more, then flew out and hovered, facing the bank, and finally darted into the nest. In the deep niche she was invisible to me while she worked. Upon emerging, she sometimes rested a few moments on top of the bank; but at other times she flew directly down into the woods.

The male Redstart often followed his mate on her trips to and from the nest. Sometimes he waited at the edge of the woods while she went into the niche, but frequently he crossed the path and rested on the herbage at the top of the bank while she arranged the material. Occasionally he sang here; but more often I heard his beautiful song coming out of the woods, where I could not see him. He never brought any material to the nest.

Although I watched from a point only five yards from the nest, while sitting in the pathway without the slightest concealment, the Collared Redstarts appeared to be perfectly indifferent to my presence. When I was ready to go, I rose and stood in the path only seven feet from the nest, directly in front of it. While I waited in this position, the female arrived at the edge of the woods with her bill full of the big, brown ramenta of a fern, almost the color of her crown. After a little hesitation, she flew into the nest to deposit her burden.

I found two other nests of the Collared Redstart during April in the neighboring pasture. The first was newly begun when discovered, on April 6, in the midst of the odorous calinguero grass (*Melinis minutiflora*) on a steep slope. The bird had chosen as her nest-site a little hollow in the hillside, beside a large clod of earth, and beneath the overhanging stems of the grass growing higher up the slope. Her first step in building was to lay as a foundation a number of dry bamboo leaves, which she carried up from the edge of the woods about a hundred feet down the hillside. This nest was still not quite completed by April 18, and four days later I found it partially destroyed.

On April 24, I found another Collared Redstart building a nest beneath a decaying log, amid fallen brush in the pasture, also about a hundred feet from the edge of the forest. This nest was placed upon the sunken remains of another of the same kind, which raised it a few inches above the earth. A number of dead leaves of dicotyledonous plants, brought by the Redstart, littered the ground in front of the nest. As with the Orange-bellied Redstart, the first step in building appears to be the collection of broad, dry leaves, and many are dropped a few inches short of the nest-site. This nest appeared to be completed by April 26, contained one egg on April 30, and two—the full set—on May 1. On May 8, I found that the nest had been torn from its nook beneath the log, and the eggs had vanished. An examination of the ruins revealed that the structure had been composed of fine, light-colored bast fibers; shreds of plant epidermis; long, black fibrous roots; and large, brown ramenta of tree-ferns—all in considerable quantities. Since these two nests were prematurely destroyed, we must depend for our study of the later stages of nesting on the first, in the bank beside the path at the edge of the woods.

The eggs. On April 4, the day after I watched in the rain while she carried material into the deep recess in the bank, the female Redstart continued to add to the lining of her nest, but it appeared to be practically completed. Still, the first egg was not laid until April 10; two more were laid on the succeeding days. The three eggs were white, sprinkled all over with light brown; but the dots of color were most concentrated in a wreath about the large end. The eggs measured 19.1 by 13.5, 19.1 by 13.5 and 18.7 by 13.5 millimeters. The eggs in another set found later were similar in coloration but somewhat shorter, both measuring 18.3 by 13.5 millimeters.

Incubation. The female Redstart began to incubate on April 12, the day her set of three eggs was completed. She was already much attached to her nest and would not fly out when I stood directly in front of it. Four days later she sat so closely that I might have caught her in the niche had I cared to do so. She would allow me to look in at her with my face only a few inches from the front of the recess in the bank.

Despite the Redstart's great fearlessness, to study her mode of incubation I decided to watch from a blind; for I wished to feel quite certain that the pair would be in no wise constrained by my presence. Seated in my brown wigwam placed in the pathway a short distance from the nest, I made a continuous record of events there from 5:30 to 10:50 on the morning of April 23, 11 days after incubation had begun. The female alone incubated the eggs, and she was extraordinarily regular in her comings and goings. The eight sessions in the nest which I timed varied only from 27 to 30 minutes, with an average of 28.5 minutes. The eight recesses from incubation ranged from 7 to 13 minutes, with an average of 9.8. The Redstart sat always sideways in the nest, usually with her left side outward. Her long tail projected through the doorway at one side, while her head was turned to look out through the opposite extremity of the opening.

While I watched, the male did not once come near the nest, nor even show himself in the pathway. From time to time, but not very often, I heard his song coming out of the forest down the slope. I only once saw him accompany the female as she returned to the nest, and then only as far as the edge of the woods.

On the morning of April 24, the female Redstart sat, as was her custom, until I put my hand to the entrance of the niche. Then she slipped past it, fell to the ground at my feet, slightly lifted the tips of her wings and waved them as though helpless. She crept over the ground to the edge of the woods, still quivering her wings, then hopped slowly about, low among the bushes, continuing to vibrate her uplifted wings. This was the first time that she had used the distraction display in my presence—12 days after she had begun to incubate. On the next two days she behaved in the same fashion when I made her leave the nest because I wanted to see whether the eggs had hatched. The eggs were pipped on April 26, and hatched the following day. The female Redstart again gave an excellent "injury-feigning" display on April 30; but after that I saw no further repetition of the performance. Her use of this display was restricted to the period extending from three days before to three days after the eggs hatched.

The three eggs hatched on April 27. Since the last had been laid, and incubation begun, on April 12, the incubation period was 15 days.

The young. The nestling Redstarts had the pink skin and sparse natal down of other newly hatched wood warblers. On April 30, I found one of the three-day-old nestlings lying dead in the niche a few inches in front of the nest. It appeared to be well fed and probably had been accidentally brushed out of the nest by its mother as she departed—a mishap by no means rare among small birds. By May 7, when 10 days old, the two surviving Redstarts were well feathered. They were brooded by their mother on the night of May 6, and again on the night of May 8, but for some unexplained reason not on the night of May 7. On May 10, the two surviving nestlings left their protected niche in the bank, at the age of 13 days. I had not touched them after they began to grow feathers, and I believe that their departure was spontaneous. They bore little resemblance to their parents, for their entire upper plumage, head, throat, and breast were dark slate-color, with no trace of chestnut on the crown, and no yellow on the forehead, face, or throat. But this juvenal plumage was worn for a very short while. By the end of May, young birds of the year were beginning to acquire the adult colors. (Since I had seen no indication of nesting until late March, it is unlikely that these birds had been hatched before the middle of April, at the earliest.) In the first stages of the postjuvenal molt, the forehead, lores, lower cheeks, and throat were pale yellow, flecked with gray, over an area of irregular outline. There was a broad gray band across the chest; the lower breast and belly were yellow—brightest on the flanks, fading to whitish in the center of the abdomen. These changes were evident before chestnut feathers were visible upon the crown. The wings and tail resembled those of adults. By the middle of June, before they parted company with their parents, the young birds were difficult to distinguish from their elders. Since by August most of the Collared Redstarts were in pairs, it seems likely that the young of the year found mates very soon after becoming independent.

Summary

Three forms of *Myioborus* were studied in Central America, the Pacific Orange-bellied Redstart (*M. miniatus hellmayri*) in Guatemala, 1933; the Costa Rican Orange-bellied Redstart (*M. miniatus aurantiacus*) and the Collared Redstart (*M. torquatus*) in Costa Rica, 1937–38.

The Pacific Orange-bellied Redstart ranged from 2,000 to 9,500 feet above sea-level, but was particularly abundant in heavy, humid forests on the Pacific slope between 5,000 and 7,000 feet.

It frequently forages in the higher branches of the trees.

Outside the breeding season, the Pacific Orange-bellied Redstart avoids other redstarts of its species but attaches itself to the large mixed flocks of small birds that roam through the forest, in each of which there is usually a single Orange-bellied Redstart. If two males come together in the same mixed flock, one drives the other from the flock.

A nest with three eggs was found on May 13, 1933.

The female alone incubated, and the male did not even approach the nest during the incubation period.

In 12 hours of observation, 11 sessions on the eggs ranged from 26 to 49 minutes, with an average of 37.6 minutes; 12 recesses from incubation ranged from 10 to 37 minutes, with an average of 18.2 minutes. Of the total observation time, 67.4 per cent was devoted to incubation. In rainy weather, recesses were longer than in clear weather, but sessions on the eggs showed no significant change.

One nestling was hatched on May 22, two on May 23. They were sparsely covered with gray down.

During 3 hours of observation when the young were 2 and 3 days old, the female fed the nestlings 10 times in the intervals of brooding; the male fed them 5 times.

One nestling disappeared when a few days old. The other two left the nest on June 2 and 3, at about 11 days old (perhaps prematurely because of disturbance).

Their upper plumage, head, throat, and a portion of their breast were sooty gray; the lower part of the breast, and the belly were buff.

By late July, the young molt into a plumage very similar to that of the adults.

As soon as the young can take care of themselves, the families separate.

The Costa Rican Orange-bellied Redstart is found at middle altitudes; it is rare below 3,000 feet, abundant between 5,000 and 6,000 feet.

It forages chiefly in bushes near the ground.

The male sings in pleasant weather in every month of the year.

This redstart occurs in pairs throughout the year, the young finding partners a few months after they are fledged.

Fourteen nests were found. Nest building began during the last days of March or in early April. The nests were constructed in from 3 to 5 days. Nest sites varied: niches in a cut-bank (the favored location); hidden at the base of epiphytes on a fallen log; a slight depression in a steep slope among sheltering vegetation.

At one nest the male assisted in nest construction.

There was an average interval of a week between completion of the nest and the beginning of egg laying.

Two to three eggs were laid at one-day intervals. In 9 nests, the first egg was laid between April 7 and 13. In 3 nests (probably replacements of earlier nests), it was laid in May.

Incubation began with the laying of the last egg of the set. The incubation period varied from 13 to 15 days. All the eggs of a clutch hatched within a period of about 24 hours.

The newly hatched young were blind and sparsely covered with down. At the age of 9 or 10 days they were well-clothed with feathers, and were not brooded after the age of 10 or 11 days. They left the nest when from 12 to 14 days of age.

Of the 31 eggs laid, 10 (32 per cent) produced fledglings. Of the 11 nests that contained the 31 eggs, 5 (45 per cent) each produced at least one fledgling.

On leaving the nest, the young wore a plumage very much duller than that of the adults. By October they were indistinguishable from the adults.

The Collared Redstart ranges from 3,500 feet up to timberline and is fairly abundant between 5,000 and 8,000 feet. It is far less abundant than the Costa Rican Orange-bellied Redstart.

It forages at all levels but is most often seen at middle heights.

The species is usually seen in pairs or in groups of three to five.

A nearly completed nest was found on April 3. The male did not assist in nest building but remained in the vicinity, often accompanying the female on her trips for nest material. A second nest, newly begun on April 6, was not yet completed on April 18. A third nest, found on April 24, appeared to be completed on April 26 and contained one egg on April 30.

The first egg of a 3-egg set was laid on April 10 (6 days after the nest was apparently completed). The eggs were laid at one-day intervals.

Incubation began the day the last egg was laid. The female alone incubated. In 5 hours and 20 minutes of observation 11 days after incubation had begun, 8 sessions on the eggs varied from 27 to 30 minutes (average, 28.5 minutes); 8 recesses from incubation ranged from 7 to 13 minutes (average, 9.8 minutes). The incubation period was 15 days.

One nestling was found dead outside of the nest. The remaining nestlings were well feathered when 10 days old and left the nest when 13 days old.

By the end of May young Collared Redstarts begin to acquire the adult colors.

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BIRD DISTRIBUTION AND ECOLOGICAL CONCEPTS

A SYMPOSIUM DIRECTED BY V. E. SHELFORD *

PART 2

BIRDS OF A DECIDUOUS FOREST AQUATIC SUCCESSION

BY JOHN W. ALDRICH

BETWEEN 1930 and 1936, I conducted ecological investigations of the bird populations of the swamps and bogs (hydrosere) of northeastern Ohio from the standpoint of the biotic communities as dynamic units. Birds of the various swamp habitats were considered to be a part of a series of plant and animal communities that are constantly changing steps in the development of the climax community of the region, which in northeastern Ohio is deciduous forest.

In the larger geographical sense, climate, in conjunction with genetic-evolutionary factors and physiographic barriers, controls the specific composition of plant and animal communities in any area. But this condition is modified locally,—in the hydrarch communities of northeastern Ohio, chiefly by the water content of the habitat. Certain factors, among them temperature and light intensity, are controlled by the organisms themselves. Chief of these organisms are the dominant plants which, by virtue of their life forms (such as reed, shrub, or broad-leafed tree) modify other factors. Certain combinations of factors in aquatic succession have permitted the partial survival in northeastern Ohio of boreal relic communities (developmental stages of the coniferous forest climax) similar to those that have elsewhere retreated far to the north in the wake of the Great Glacier. The presence of relic communities of typically boreal plants and animals is probably the chief reason that some investigators include northeastern Ohio and southern New England in the Transition life zone (Merriam, *et al.*, 1910).

I believe it is possible to bring together the life zone and biome concepts and unify the nomenclature, using the life zone names where applicable (Aldrich, 1943:357), and considering biomes rather than faunas as subdivisions of life zones. On this basis, northeastern Ohio is entirely within the eastern deciduous forest biome of the Upper Austral life zone, but still contains scattered post-glacial relics of the mixed coniferous and deciduous forest type which is found commonly farther north and in the Appalachian Mountains, and is characteristic

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of the Transition life zone.[1] In this investigation the communities (including birds) were studied in both the relic coniferous (bog) and the deciduous forest (swamp) succession (Aldrich, 1943).

Table 1 shows the succession of communities and their most abundant birds in a typical swamp sere of northeastern Ohio from the water to the climax forest; Table 2 shows the breeding bird populations per

TABLE 1

SELECTED SPECIES SHOWING THE SUCCESSION OF BIRDS IN NORTHEASTERN OHIO FROM WATER TO THE DECIDUOUS FOREST CLIMAX

	1	2	3	4	5
	Water Lily	Loose-strife-Cattail	Button-bush-Alder	Maple-Elm-Ash	Beech-Maple
Pied-billed Grebe	S	S			
Common Mallard	X	S			
Virginia Rail		S	X		
Long-billed Marsh Wren		S	X		
Eastern Red-wing		S	S		
Eastern Swamp Sparrow		S	S		
Eastern Kingbird			S		
Alder Flycatcher			S		
Eastern Yellow Warbler			S		
Catbird			S	X	
Eastern Goldfinch			S	X	
Northern Yellow-throat			S	S	
Mississippi Song Sparrow			S	S	
Northern Blue Jay				P	
Eastern Hairy Woodpecker				P	P
Northern Downy Woodpecker				P	P
Eastern Wood Pewee				S	S
Eastern White-breasted Nuthatch				P	P
Black-capped Chickadee				P	P
Tufted Titmouse				P	P
Red-eyed Vireo				S	S
Eastern Oven-bird				S	S

X = present at times; P = permanent resident; S = seasonal.
Column 5 is from Williams (1936:57–58), other columns from Aldrich (1943: 389–392).

100 acres (40 hectares) in three of these communities over a period of years. The great annual fluctuations in these populations are apparently characteristic of hydroseral communities. The differences, particularly in the case of the Red-wings, Marsh Wrens, Yellow-throats, Swamp Sparrows, and Song Sparrows, were correlated with fluctuations in water level and resulting modifications of plant life.

[1] It should be noted that my concept of the Transition life zone (Aldrich and Friedmann, 1943:101) is not entirely that of Merriam (1910:map) and his followers, but includes the ecotones between the northern conifer and subalpine forests on the one hand, and between the deciduous forests and grassland on the other. That is, the zone encompasses the various forest-climax communities that have been called Lake Forest, Pine-Hemlock-Northern Hardwood Forest, Montane Forest, and Aspen Parkland.

TABLE 2

Annual Fluctuations of Bird Populations in Northeastern Ohio Swamp Sere

	1932	1933	1934	1936	1937	1938	1939	Aver.
Loosestrife-Cattail	343	352	267	124	171	476	428	323
Buttonbush-Alder	390	268	561	1073	536	555	400	526
Maple-Elm-Ash	—	88	175	75	165	127	174	121

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PART 3

BIRDS OF THE DECIDUOUS FOREST [1]

BY JOSEPH J. HICKEY

THE (broad-leafed) deciduous forest biome, as mapped by Pitelka (1941), approximates the forested region of Merriam's Carolinian zone, the humid eastern section of the Upper Austral zone. It includes, in addition, an oak-pine subclimax (made up of Carolinian and Austroriparian elements) and a pine subclimax (equivalent to the rest of the Austroriparian zone east of the Mississippi). The degree of control exercised on bird distribution by these types of vegetation has not yet been well studied. In *Florida Bird Life,* Howell follows the over-generalized bird communities of the life-zone scheme, while the specific communities of birds governed by water and vegetation are given by the

[1] Part of the author's remarks have been separately published in *A Guide to Bird Watching* (Oxford University Press, N. Y., 1943, pp. 106–118).

book's illustrator, F. L. Jaques. So many other avifaunal lists have been marked by an emphasis on bird distribution according to political subdivisions that an ecological analysis of the lists is now virtually impossible.

In Europe, a marked distinction between birds of the coniferous and deciduous forest was brought out by Palmgren (1928). Later, Lack and Venables (1939) compared the habitats used by English and Finnish birds. For the most part, species common to the two regions select the same forest types. However, seven species that select coniferous woods in Finland show no such tendency in Britain, where there is a much greater variety of broad-leafed woodland types. In the survey by Lack and Venables of 45 kinds of birds, 11 species were found to be almost entirely confined to broad-leafed woods, and 5 to coniferous woods. Such restrictions were correlated with geographical distribution, the former species being mainly southern and the latter northern.

In America, surveys and comparisons of this type are still needed. The marked effect of forest vegetation on the distribution of bird life has been studied by Hicks (1933), who has described six successive stages in the development of deciduous forest in northeastern Ohio, each with its own recognizable avian community. In New York, some 80 miles to the east, a virtually identical ecological succession of birds has been outlined by Saunders (1939), whose careful censuses have led him to postulate that the density of bird populations increases with the height of the forest canopy. This theory of bird numbers was earlier advanced in Germany by Schiermann (1934).

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PART 4
GRASSLAND BIRDS
BY O. A. STEVENS

THE species closely restricted to the grassland as a breeding ground include representatives of 10 or more diverse families and 5 orders: Marsh Hawk, Short-eared Owl, Burrowing Owl, Marbled Godwit, Upland Plover, Meadowlark, Bobolink, Brewer's Blackbird, Rock Wren, Sprague's Pipit, Nighthawk, Sandhill Crane, Horned Lark, and several sparrows.

There is some evidence of distribution corresponding to life zones. The grassland biome, extending from Mexico into Canada, may seem to be a vast natural area. Yet, though sharp lines cannot be drawn, it has definite variations. Sprague's Pipit and Baird's Sparrow nest only in the northern part; the Chestnut-collared Longspur extends a little farther south and the Lark Bunting still farther.

The return of certain individual birds to the same locality year after year shows that individuals are conditioned to definite latitudes. Plants are immobile, and although some grasses occur all over the biome, we are beginning to recognize that they, too, have races conditioned to certain localities. Much has been done by phytologists in defining physiologic races of fungi, but we know little of such races of birds and grasses.

Certain grassland birds are not limited to the biome, but choose areas with vegetation similar to the climax grassland. The Horned Lark is a characteristic prairie bird, but its range goes far beyond the grassland biome into all sorts of open spaces, especially those with short cover. It breeds in all parts of North America except the southeastern United States. It has been divided into a number of races, three of which breed in parts of the grassland biome.

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PART 5
CONIFEROUS FOREST BIRDS
BY ROGER TORY PETERSON

IN analyzing the most typical birds of the coniferous forest biome, we find that roughly one-third of them find their ranges within the great sweep of boreal forest stretching across Canada. Some examples are the Black-poll Warbler, Parula Warbler, Magnolia Warbler, Cape May Warbler, Bay-breasted Warbler, and Gray-cheeked Thrush. Roughly, another third are peculiar to the montane coniferous forests of the Western States. Some examples are the Steller's Jay, Clark's Nutcracker, Williamson's Sapsucker, and Townsend's Solitaire; the remaining third are birds that are common to the coniferous forest biome as a whole. Typical examples are the Red-breasted Nuthatch, Purple Finch, Pine Siskin, Hermit Thrush, and Olive-sided Flycatcher.

The ranges of many birds seem to conform to the outlines of the area occupied by their preferred vegetational "life form," while others occupy only parts of it and reach either their northern or their southern limits deep within it. This indicates that they are not entirely restricted in their distribution by dominant forms of vegetation. This, then, might leave room within the biotic concept for the application of something like Merriam's temperature concept, or some other modification. Thus it appears that the biome is not much more satisfactory than the life zone in describing bird distribution.

Birds which occupy the developmental stages of a biome are often found in other biomes as well. This is because the life forms of the vegetation that compose the developmental stages of one biome are often duplicated in other biomes. Birds which occupy the climax portion of a biome are most frequently restricted to that biome and are indicators of it. This is because the climax life forms are often peculiar to that one biome.

Birds appear to fit the life zone concept best in climax forest in those areas where temperature agrees with the vegetation, as, for example, in the Canadian and Hudsonian zones.

Briefly, the physical aspects, or "life form," of the vegetation seems to be the most important factor influencing land bird distribution, but this is further modified variously by climatic influences, physical barriers or other geographical factors, interspecific competition, population pressures, and probably also by other less tangible factors.

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PART 6

THE RELATIVE MERITS OF THE LIFE ZONE AND BIOME CONCEPTS

BY V. E. SHELFORD

A KNOWLEDGE of the greatest extent of the biomes, or biotic communities, is a fundamental step in making any comparison of the biome system with the life zone system. Figure 1 is a map of the principal North American biomes with the life zones superimposed. It is similar to the map by Weaver and Clements (1929: frontispiece) of which an earlier modification was published in 1932 (*Wils. Bull.,* 44: 154), but increased knowledge has made further modifications necessary.

To understand the basis for these modifications, the variations within biomes or climax areas * must be taken into account. We are

* In the legends of some maps (for example, the Weaver and Clements map mentioned here) the largest biotic communities are referred to as the "climaxes." "Climax area" would be a better term; thus the *climax area* is the area which it can be predicted will be covered by the *climax community* as shown by studies of succession.

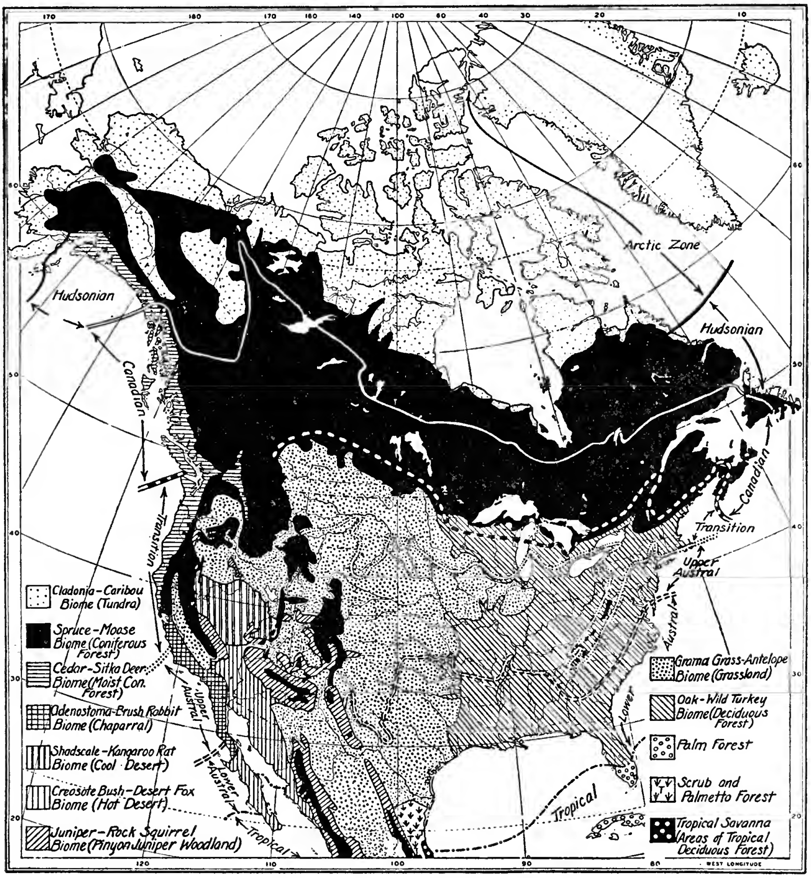

Figure 1. Diagrammatic map of the areas of the principal North American biomes, or biotic climaxes. East of the Rocky Mountains the boundaries of life zones are superimposed; complications in mountainous regions prevent the extension of these boundaries westward, but their extreme limits are indicated on the map along the Pacific coast. The mountain coniferous forests from southern Arizona to the mountains of northern Panama have never been evaluated in terms of the biome concept; hence the solid black in that region on the map may be in error. The map is a modification of one by Weaver and Clements (1929: frontispiece). The ecotones and subclimax areas shown by Pitelka (1941: figure 1) are omitted. For further explanations see text.

all familiar with the several variations of the deciduous forest climax, such as beech-maple, oak-hickory, and oak-chestnut, which are called associations or forest types. Similarly we know the meaning of tall grass, short grass, and mixed tall and short grass types of grassland, also called associations. In plant ecology, associations or types are designated by the plants of outstanding abundance in the aggregations that make up the types or associations. Some of the abundant plants of each association occur throughout the biome (binding species), while others are limited to the associations. However, usually all the most important plants of a biome are of the same "life form"; in the case of the deciduous forest, for example, they are broad-leafed trees. Important animals usually have a distribution within a biome similar to that of the plants. Modifications of the Weaver and Clements map are made necessary because of their failure (a) to include animals and (b) to give full value to life form of vegetation. It has been pointed out in the preceding papers of the symposium that life form characteristics are of great importance in the habitat preferences of birds.

In my modification of the Weaver and Clements map, the lake forest has been combined with the northern coniferous forest because there are no essential differences in the species of important animals in the two areas, and the life form is the same in both the climax and the developmental stages.

Although it could not be shown on the map, the boundary between two biomes is often very tortuous, with narrow extensions ("fingerings") of each biome penetrating the territory of the other. Often this is related to topography, the extensions of one biome being on higher ground than those of the other. A transition, or ecotone, is commonly a complex of these narrow extensions rather than a mixture on the same area of the plant and animal species characteristic of two or three biomes. This is especially true of biome boundaries in the Transition zone area and may be seen also along the boundary between the deciduous forest and grassland. The detail of such fingerings is too great to be shown except on a large-scale map. The small scale of Map 1 made it necessary to omit all ecotones as well as the mountain communities of the western and southern portions of North America. Several other areas, such as the Palm Forest, are small and have been little investigated. These have not been given biome names like those applied to the better-known communities.

In a practical way, biome and life zone systems are to be judged by the advantages or disadvantages of each when used as a guide (1) by an observer in the field; (2) in locating the boundaries of major communities; (3) in selecting indicator organisms; (4) in interpreting interactions, coactions, and reactions; (5) in interpreting community development.

1. Field observation. Since in the biome system, communities are named for the most numerous plants and animals, a student in the field can readily determine his "biological location" by the dominant and influent plants and animals (though the latter must commonly be found by special methods). The names of life zones, however, convey nothing that will help the field naturalist; he has usually to find his biological location on a life zone map. Some life zone students have characterized the zones by forest types but in limited areas only.

2. Locating the boundaries of major communities. The biome usually has quite definite limits which are observable on the basis of life forms. As noted above, a transition area is usually a complex of the narrow extensions of two or more adjoining biomes rather than a mixture of species representative of several biomes. Hence the limits of these major communities may usually be ascertained in the field and mapped to scale. There will sometimes be difficulties because of immature communities, but these can, as a rule, be distinguished by inspection of a considerable area where a series of stages converging to one community type is usually discernible. Outside the mountains, life zone boundaries follow the general trend of the isotherms (since they are based on temperature relations), and in much of the central part of the continent, the traveller cannot tell when he passes from one zone to another. It must be noted that some species are restricted to a portion of a biome on the basis of climatic differences that do not influence other species of the biome. Stevens, for example, in Part 4 of this symposium, has pointed out the limitation of the range of certain song birds to the northern great plains, which would support the idea of a Transition zone. However, the ranges of bison, antelope, and many other important species, such as dominant grasses, show no such relation to life zone boundaries, but are, in fact, cut into three parts by them. The southern boundary of the Transition zone on the great plains is based on species of less than secondary importance.

3. Selecting indicator organisms. Organisms used to indicate biomes are the plants and animals that exert an ascertainable important influence on the biotic community as a whole. They are usually abundant and obviously important so that they can be selected easily. Since they are the plants and animals of the final (climax) stage of the community, they clearly define the biome. Plants used as indicators of life zones outside of the mountains have, on the other hand, frequently been local or have belonged to relatively early developmental stages of biotic communities.

4. The biotic community viewpoint stresses interactions (coactions and reactions) of the various organisms. It carefully considers the function in the community of the population of each species, since each species contributes something to the community and has a definite effect upon it. The number of individuals per unit area is of primary importance. This interaction aspect of community dynamics was largely ignored in life zone work in earlier years, and quantitative data such as the number of animals per unit area is still rarely considered important in listing characteristic species for life zones or in mapping biotic areas.

5. Interpreting community development. The territory of a biome is the area which will be covered by the characteristic biotic climax. Within each biome's territory there are smaller areas with communities in various stages of development toward the climax. The study of

community development (succession) is one of the important features of the biome system. This development is usually ignored by life zone students and has led to confusion in the definition of zone boundaries, particularly in the southeastern United States.

Three other points of view should have brief mention, namely those of plant ecology, plant sociology, and limnology.

Plant ecologists began publication in the field of succession and distribution in terms of large communities in the early 1890's. An occasional writer took notice of animals and referred to "biotic factors," but most of the investigators have discussed plants only. To defend this position, they have relied on the dogma that all animals depend upon plants for food, shelter, and the preparation of the necessary place of abode. They have set up major communities based on plants alone; examples of these are the montane and subalpine forest and lake forests, which are not supported by animal data. The practical problems of grazing and forestry have forced them to give some attention to animals but only very recently.

Plant sociologists have presented admirable statistical methods of dealing with the details of plant populations, usually without reference to animals. A few zoologists have applied the analytic methods of the plant sociologists to animals alone. For example, Gislén (1930), working on Gullmar Fjord in Sweden, recognized more than 40 associations, whereas Peterson's map (1908) showed only 6, classified on the basis of biotic communities. Gislén fails, however, to discuss any features of community dynamics.

Limnologists have worked in great detail and with admirable precision on relatively small bodies of water. However, they have dealt mainly with internal chemical and biological changes—metabolism—rather than with the growth and distribution of communities.

But since none of these schools considers both plants and animals with their dynamic interrelationships, all fail to measure up to bioecological standards.

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University of Illinois, Champaign, Illinois

WINTER NIGHT HABITS OF BIRDS

BY A. D. MOORE

As Kendeigh (1934:343) has pointed out, "much more needs to be learned about the night habits of birds, particularly in winter." Kendeigh summarizes what is known of the winter roosting habits of a number of species. Some birds creep into the space between loose bark and the tree trunk; some cling in trunk depressions; some pass the night in natural cavities in trees, while others chisel out their own cavities. English Sparrows, alone or by groups, use thick bushes, vines next to buildings, or space in buildings. Other species find shelter in clumps of cattail or grass, or under clods. Some species gather in large numbers and spend the night close together in thick trees.

Heat Production and Temperature Regulation

Birds, in common with other warm-blooded animals, have a temperature-regulating mechanism that keeps body temperature at suitable levels. In a given case, the bird makes an adjustment to cold surroundings by first selecting a roosting place, and then by fluffing the feathers, placing the head under the scapular feathers, and perhaps huddling with other individuals. There will then be a certain demand placed on the bird because of the heat being lost. If the demand is low, it may be balanced by heat produced by the bird's lowest metabolism rate. When the demand is greater, physiological responses cause the regulating mechanism to act. Metabolism rises; that is, energy originally taken in as food is turned into heat at a greater rate, to meet the greater demand, and body temperature is maintained. If the demand (heat loss) is extreme, body temperature may be permitted to fall somewhat, and loss of heat is thereby reduced; but even so, there is danger that the bird's available store of energy will be used up, with death ensuing during the night.

This paper is not concerned with the physiological aspects of heat production and temperature regulation; but the foregoing makes it plain that since the bird's ability to produce heat is limited, its survival will often depend on its ability to keep heat loss within bounds.

Heat Loss Mechanisms

In order to know what to look for when observing the winter night habits of birds, the mechanisms or means whereby the bird loses heat should be clearly understood. The heat first travels by *conduction* from the warm skin, through the plumage, to the outer surface of the plumage. This heat is then taken away from the outer surface by two mechanisms, *radiation* and *convection*. Wherever outer surfaces of feet or plumage touch solid objects, there will also be loss by *conduction,* but this is usually small. The heat lost by radiation and convection, added together, equals the heat conducted out through the feathers. Any adjustment by which the bird can reduce the effect of any of these heat loss mechanisms will, of course, help the bird to survive night exposure to a cold environment.

Conduction. The coat of a bird, consisting of air entrapped by overlapping feathers, is an excellent insulator; that is, it is a poor conductor. Nevertheless, it does conduct heat. When the feathers are "normal" (neither pressed down, nor fluffed out) the air is almost perfectly entrapped. The heat is then conducted from warm skin to colder outer plumage surface both by means of the entrapped air and the feather material itself.

Fluffing of the feathers is the very efficient means whereby the bird can secure a large increase in thickness of the insulating coat. With the feathers erected, the coat becomes several times as thick as in the normal state.

When the feathers are completely fluffed, they cannot do a perfect job of entrapping air among them, and movement of air through the feathers would reduce the insulating effect. Nothing is known about the extent to which fluffed feathers prevent this air movement. In my opinion, air movement through fluffed feathers will be nearly negligible if the bird is completely sheltered from the wind; and there is probably not much of it, even in a fair breeze, if the bird is headed into the breeze and the fluffing is not at its extreme degree.

Convection. When the outer plumage surface is warmer than the air, the surface loses heat to the air by convection. Convection will be one or the other of two kinds,—natural, or forced.

Natural convection occurs when the air and the bird are both still: there is no wind, and the bird is quietly sitting or sleeping. The only air movement will then be that of a natural circulation that is established. The warmer surface of the plumage warms the surrounding cooler air; the warmed air, becoming less dense, rises; a sluggish natural circulation is established, and the air removes heat from the surface by natural convection. (It will be necessary to modify these remarks later, when dealing with birds in very confined quarters.)

If the bird is directly exposed to a wind, the sluggish air movement of natural convection is wiped out. The wind gives forced convection cooling. The warmed air close to the bird is now rapidly replaced by cool air. For any given temperature difference between outer surface and air, the higher the wind velocity, the greater will be the forced convection heat loss.

Radiation. Loss of heat from the outer plumage surface by radiation cannot be taken up here in full technical detail. Nevertheless, some explanation of what takes place is necessary, because much that has been written about it is confusing and erroneous. The very term *radiation* has suffered a great deal of misuse in many quarters. It is regrettably common to speak of all the heat that is dissipated by, for example, a "radiator" in a room, as *radiated* heat, even though such a body loses heat both by true radiation and by convection.

Radiant energy emitted by any surface travels in straight lines like light, and with the speed of light. At night, all of the radiant energy affecting the bird is in the long wave length (infra red) part of the spectrum. Such waves are emitted by the bird's outer plumage surface; by the ground, snow, twigs, leaves, enclosing walls of a cavity, and so on; by clouds overhead; and, in varying degrees, by the water vapor and carbon dioxide in the atmosphere, even with a perfectly clear sky.

If a bird is completely enclosed in a wooden box, or in a tree cavity, or cave, and *if* the temperature of the outer plumage surface is the *same* as the temperature of the walls of the complete enclosure, there will be *no* net loss (or gain) of heat by radiation. The outer plumage surface will emit, and therefore lose, heat by radiation; but the radiation coming from the walls will be absorbed by the plumage surface; the gain by absorption will just balance the loss by emission.

Or again, place the bird in the open, exposed to level ground below and to low, thick clouds above. If the bird's outer plumage surface should happen to be at the same temperature as the ground, and if weather conditions were not extreme, it could happen that radiation emitted by the ground and sent generally upward to the bird, plus radiation emitted by the atmosphere below the cloud and by the cloud itself and sent generally downward to the bird, might exactly balance the bird's radiation, and no net radiation loss would occur.

Or yet again, preserve the preceding conditions, except that we now remove the cloud and have a perfectly clear night sky. Radiation still comes downward from the water vapor and carbon dioxide in the clear atmosphere; but the amount of it will range from fully as much as when the low cloud was there, to somewhat less than half as much—depending, in an extremely complicated way, on ground temperature, relative humidity, and vertical distribution of temperature in the atmosphere.The highest air temperatures and humidities will cause the greatest downward radiation. Furthermore, the presence of haze complicates the situation. Haze increases the downward night radiation. Unfortunately, the relationships are so very complex that it is quite impossible to reduce atmospheric radiation to a simple set of rules.

The absence of haze and clouds usually means lessened downward radiation; low temperature and low humidity still further reduce it. Thus, on clear, cold winter nights, downward radiation being received by the bird's upper surfaces may be much less than the radiation emitted by those surfaces. A severe net loss of radiation energy will ensue. Thus the bird finds it necessary to *get under* an opaque cover—and it is important for us to increase the accuracy of our observations on the nature of that cover.

If the cover is thick (or if made up of numerous layers of thin leaves) the temperature of the lower layers of the cover will closely approach the temperature of the air and ground; or, if these are different, it will be intermediate between the two temperatures. Such a cover will send downward much more radiation than would come from a clear, cold sky.

If a bird is found sleeping apparently directly exposed to the sky, but in a deep ravine, then it is receiving ground radiation from below, from the sides, and even to some extent from above. Exposure to the sky is of small consequence if the area of sky, as viewed from the bird's position, is small.

If a flock of birds settles in a tree, the individuals need not be in contact in order to reduce radiation losses. From the position of any one bird, if the view in all directions is largely covered by other birds, then the birds are effectively radiating to each other: a *completely* surrounded view would result in no radiation loss whatever. However, the outermost birds would radiantly lose heat from their exposed-view surfaces. (Do the outermost birds sometimes move in after a while, and let others take turns at exposure?)

Enclosed Roosts

A complete enclosure, such as a tree cavity with one small opening, insures freedom from wind. Instead of high loss from forced convection, there is the lesser natural convection effect that transfers heat from the bird to the air, and then from the air to the walls. This double-step transfer (bird to air, then air to walls) occurs when there is plenty of air space. But another complication arises. If the cavity is small, with perhaps an inch or less of air space between bird and wall, free natural convection currents may be largely slowed down by interference effects; the air would be relatively stationary, and the heat going by air would largely be *conducted* by air from bird to wall. The situation is misleadingly simple. Apparently, all we have is a warm bird, cold walls, and some air between; but the heat transfer problem is really highly complicated. As in the case of the atmospheric radiation problem, there is no hope of reducing it to simple rules.

In addition to the heat loss across the air by convection or conduction, as the case may be, there will, of course, be radiation loss, for the walls will be colder than the outer plumage surface.

If the wall of a tree cavity is hard unrotted wood, one small bird could do little toward raising the wall temperature. But if the wall has an insulating layer of dry rot or other lining, the wall itself would conduct heat outward less fast; and if the bird fits the cavity fairly well (or if several birds crowd in to add their heating effects), the temperature of the walls may very well rise appreciably through the night and serve to reduce the loss on critical nights to a rate permitting the birds to survive.

Another factor is the size of the tree or branch in which the cavity is located. More often than not, winter night temperatures are lower than day temperatures. As the night progresses, a tree will cool. The larger the tree size at cavity level, the less the cavity wall will drop in temperature during the cooling process.

Still another factor is cavity size as related to fluffing ability. Rowan (1925:299), who has done a great deal of work with small birds in the very cold winters of Alberta, should be quoted: " . . . a friend who keeps a food-tray on her window-sill throughout the winter at Red Deer, Alberta, has informed me that Chickadees frequently come to feed in the early mornings during the very cold spells, with patches of ice on the head, particularly around the eyes. From the curled condition of their tail-feathers it is evident that they have spent the night huddled in holes." Now, if the hole is only small enough to curl the tail-feathers, no harm is done; but if it is so small that fluffing of the body feathers is seriously interfered with, the full effectiveness of the bird's natural insulating coat is not realized.

Open Roosts

Wind. A bird choosing not to sleep in a complete enclosure is exposed to wind. Observations on the wind actually affecting a bird offer great difficulty. However, the "wind facts" are of great importance to the bird. I have found nothing recorded in the literature about actual air movements past a sleeping, exposed bird in the natural state. Here, certainly, is a difficult but fruitful field for observation.

We do have weather station records of wind velocities. If a bird should consent to roost for the night next to the whirling anemometer cups, then the wind velocity records usually available would have considerable meaning. But the bird sleeps in a more suitable habitat. What is the wind velocity where the bird actually roosts?

A great deal of work has been done in recent years on the structure of winds. I have had to study some of the published research, and I think it will be well to mention some examples.

A wind sweeping over bare, flat ground at 10 miles per hour, 5 feet up, may typically be going at from 3 to 5 m.p.h. half a foot above the ground; and, at 25 feet above (where it might be measured by a weather station), it moves at from 12 to 18 m.p.h.

Next consider a wind which, like the one above, has a speed of 10 m.p.h. at 5 feet from the ground; but in this case, there is a brushy bush growth 3 feet high. Among the bush tops, the velocity may be only 1 or 2 m.p.h.; and further down, if the bushes are thick, it might drop to far less. At the 25-foot level, the speed may be somewhere around 25 m.p.h.

One series of tests covered an orchard situation, the trees being in rows. Tree height was 10 feet. A 27 m.p.h. wind at the 25-foot level resulted in a 10 m.p.h. wind between the tree rows. The velocity through the leafy trees themselves was probably between 2 and 5 m.p.h.

To cite one more situation, a 10 m.p.h. wind at the 5-foot level blows over 6-inch grass. A little above grass-top level, the velocity is about 2.5 m.p.h. But down in the grass, depending on level and thickness of grass, the velocity would be anything from perhaps 1 m.p.h. near the tips, down to a very low value close to the ground.

Further, the bird may be counted on to take advantage of ground irregularities, valleys, cliff indentations, and so on; and, if in a tree, to seek the leeward side of the trunk or entanglements of leaves.

Think of a bird nestled down in a thick clump of grass. Ten miles away, a weather station located on a stretch of flat ground is recording a low temperature and a night wind of 25 m.p.h. But the bird is located on the lee side of a forested hill, where the velocity at the 5-foot level may be only 5 m.p.h., and a few inches above the ground, inside the bird's grassy shelter, the actual wind speed may be less than half a mile per hour. If drifting snow has covered the windy side of the clump, the bird may experience no wind whatever.

It is out of the question to suggest that all observers of winter night habits of birds should always take to the field equipped with instruments for measuring wind speeds at the actual site. But the fact is that an "educated guess" at wind speed at the site would be more significant than a wind speed as measured at a weather station somewhere else in the same county. Better yet, there will be many situations and occasions when the timing of a bit of fluff or a puff of smoke will yield valuable information. Smokers are always ready to produce the smoke. Others can light punk, or oily rags. A stop-watch can be used for timing; or one can learn to count seconds quite accurately. The distance can be measured off, or paced.

If a roosting place is in a tree, the smoke source should be elevated on a pole, in order to measure the velocity at the roost level as nearly as may be, and through the site itself. If the roost is in a bush, it would be well to measure at a level one foot above the bush top, and again, if possible, through the bush at roost level. If the bird is in a grass clump, measure at one foot above grass-top level, or at whatever level is practicable; also, release some smoke on the windy side of a typical clump, and observe the smoke entering the clump,—how much does the smoke hang around inside the clump?

In making these suggestions, it is realized that some may have trouble in carrying them out; and further, so much variation occurs in ground contours, cover, and so on, that the suggestions are quite incomplete. What we need is ideas growing out of experience.

Finally, when there is a very cold wind at night, the bird that is in a complete enclosure of some kind will experience little or no wind;

and the bird not so enclosed may usually be expected to have found a lee, or a place in a thicket in a ravine, where the wind amounts to little more than an occasional puff and some irregular eddying. Such an irregular, occasional flow may be difficult to measure; but at least, the general behaviour of some released smoke can be described. Any information of this kind will be new and valuable.

Temperature. Here again, data from a distant weather station can be very misleading. Owing to differences in altitude, types of wind, exposure to clear sky, air stratification, and so on, there may be several, and sometimes many, degrees difference between a weather station temperature, and the temperature at the spot where the bird is. If a steady wind is blowing at the site, the air temperature taken within a few feet of the level of the bird's roost will probably be near enough. The more nearly windless the site is, the more necessary it is to place the thermometer at about the level of the bird's location, and not more than 10 or 20 feet distant horizontally. In any case, one must wait for the thermometer to stabilize its reading.

The thermometer is affected by radiation. Radiation effects sometimes cancel out, permitting the thermometer to record the true temperature of the air. However, one certainly cannot count on this happening. In the daytime, with a thermometer placed in the sunlight, the reading may be increased very considerably above air temperature. But even at night (especially with full exposure to clear skies) radiation can affect the reading. If the temperature is taken with the thermometer unshielded, it should be so recorded—along with the amount of sky exposure.

In weather station work, air temperatures are obtained by mounting the thermometer in a ventilated box. Such a box would hardly be portable, but a simple shielding device that will be far better than nothing, can be made from a piece of heavy cardboard. Punch a hole in the middle, and insert the bulb end of the thermometer through the hole until the bulb is perhaps an inch from the cardboard. When the cardboard is held horizontally, the bulb can be adjusted to be completely shielded from the sky.

Observing, Recording, Reporting

Eventually, accumulated experience will enable someone to develop a record-form for field use. The development and use of such a form would be most desirable. But so many variables enter in that I, at least, do not feel able to attempt the design of a form at this stage. It is quite possible that a single, general form would turn out to be a nuisance, and that we may have to develop particular forms for groups of related species. The next best thing, a list of suggested items to cover, is presented below.

Geographical location.
Dates and exact times of observations.

Lay of the land: General description for a mile or so around, with notes on forestation, etc.

Habitat: Elements of growth, local ground formation in relation to shielding from sky, from wind, etc. Hill top, valley bottom, or intermediate situation. Nearness to bodies of water which might prevent extreme fluctuations in temperature.

Site: Description of tree roost, cavity, clump, bark shield, etc.

Radiation cover: Overhead cover—description; in what degree does it shut off view of sky?

Weather station data: Location of nearest station. (Wind, temperature, and precipitation data should be reported from it when possible. This will help to emphasize the fact that the bird's survival may depend upon highly localized conditions.)

Temperature: How measured and where.

Wind: Velocity, how measured and where.

Number of birds: Estimate if accurate count is impossible.

Spacing of roosting birds: Average distance between the members of a group or flock. In close contact or not?

Adjustment of body feathers: Degree of fluffing (direct measurements and flashlight photographs are needed). If exposed, is the bird pointed into the wind?

Discussion

Kendeigh (1934), Baldwin and Kendeigh (1932), and Benedict (1938) will serve to introduce the reader to the large and growing literature on the bird's metabolism and temperature regulation. The literature relative to heat loss mechanisms is enormous and scattered through many fields in physics and engineering; reference to such literature is therefore omitted here.

Gathering of pertinent data on the survival of birds on cold nights is an almost virgin field of endeavor. If the bird's thermal problem is approached as an engineering problem to which a numerical solution is desired, it bristles with difficulties; but even an amateur can acquire a good understanding of the factors affecting heat loss, thereby becoming competent to observe and record much-needed data. Critical comparison of the data will be certain to yield illuminating results.

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GENERAL NOTES

Colorado nesting records of Starlings.—Starlings (*Sturnus vulgaris*) are now firmly established in Colorado, although they are not observed commonly. The first were taken in this state December 17, 1938 (R. B. Rockwell, *Wils.Bull.*, 51, 1939:46), and they have been recorded many times since, being quite numerous in the winter.

George Breiding (*Wils. Bull.*, 55, 1943:247) reported that an adult Starling was carrying food into a cracked tile of a silo near Lowry Field, Denver, Colorado, on May 16, 1943. He could not see the young, but heard them calling, and a week later he saw two young Starlings in a willow near by.

On May 25, 1945, I collected a set of five eggs, the first of this species to be secured in the state, from near Barr, Colorado. The nest was a bulky construction of grass in a hole in a box elder, about seven feet from the ground. I observed another nest, with large young, in this same general location on June 15, 1945.—ROBERT J. NIEDRACH, *The Colorado Museum of Natural History, Denver, Colorado.*

Robin using abandoned Cardinal nest.—In Hillsdale Park, Baltimore, in 1945, the nest of a Cardinal (*Richmondena cardinalis*) that had stood abandoned and empty for more than two weeks was taken over by Robins (*Turdus migratorius*) and used well into the period of incubation, at which time it was destroyed by human interference. The nest was in a position that Robins themselves might have chosen: in a tangle of honeysuckle about six feet up in an 8-foot redbud tree. It was constructed chiefly of honeysuckle vine, with a foundation of dead leaves and a lining of grass; it was fresh and clean, and the Robin made no noticeable alteration. Measured after some days' use by the Robin, it was 3 inches high by 5½ inches wide outside; the interior was oval in shape, 3½ inches long by 2½ wide, and 2½ deep. These figures differed hardly at all from the measurements of a newly made Cardinal's nest close by.

I inspected the nest daily between April 15 (when I first found it) and April 26, and irregularly between April 26 and May 1, always finding it empty. On the evening of May 5, however, it held a Robin's egg, which I marked. At 10:22 A.M. and 1:48 P.M. on May 6 there was still only that one egg, but between 9:54 and 11:35 A.M. (E.S.T.) on May 7, a second egg was laid; on May 8, a third; on May 9, a fourth. The eggs measured (in the order laid): 27.5 x 20.0 mm.; 28.0 x 20.0 mm.; 27.5 x 20.0 mm.; 27.0 x 19.5 mm.

There are few published instances of Robins using strange nests; Howell (*Amer. Midl. Nat.*, 28, 1942:529–603) describes their use of a Blue Jay nest and cites five instances from the literature of casual laying by Robins in other birds' nests. —HERVEY BRACKBILL, *4608 Springdale Avenue, Baltimore 7, Maryland.*

Absorbent for use in the preparation of scientific skins.—For several years I have used in the preparation of bird skins a finely ground cellulose (through a 150-mesh screen). I have found this "flock" much more effective than other absorbents. By alternate application of water and cellulose powder and removal of the powder with a soft brush, every trace of blood can be removed from the feathers, which are left in a fluffy, natural condition. The powder, particularly when moistened with a solvent for fats, is also very serviceable in removing grease from feathers. Its use during skinning to absorb blood and other liquids is obvious.

"Cotton flock" is made from cotton, "alpha flock" from wood pulp produced by a chemical process that renders it especially absorbent. The flocks, used largely in the production of molding compounds from synthetic resins, are commercially available, selling at about 10 cents a pound when bought in quantity. —A. W. SCHORGER, *168 N. Prospect Avenue, Madison, Wisconsin.*

Black and White Warbler feeding young of Worm-eating Warbler.—On June 2, 1945, while exploring a ravine in Good Hope Township, Hocking County, Ohio, John Wolfe, Fred Norris, W. Kelton Jones, Ralph J. Reynolds, and I found a nest with young of the Worm-eating Warbler (*Helmitheros vermivorus*). We watched the parents feed the young several times, and then saw a Black and White Warbler (*Mniotilta varia*) come to the same nest and feed the young birds.

As long as the Black and White Warbler remained perched in the small beech sapling at the base of which the nest was placed, the Worm-eating Warblers, although they remained in the immediate vicinity, did not seem much concerned. But when the Black and White Warbler would drop down to the nest, the Worm-eating Warblers would fly to the nest site and attack him. The Black and White Warbler would stand his ground until he could feed the young, which, on three or four occasions, he was able almost to finish before the parent birds could reach him. In one instance, the Worm-eating Warblers tore the food from his beak and themselves gave it to the young.

We watched from excellent viewing points not more than 30 feet from the nest. Before leaving, we examined the nest, which contained six Worm-eating Warbler nestlings, and were given a demonstration of the fearlessness of this species. In their attempts to protect the young, the parents came within an arm's reach of us. The Black and White Warbler did not participate in the defense, but it did attempt to draw us away from the nest by "injury feigning."

This phenomenon may be explained in part by the similarity in nesting sites chosen by the two species. Both are ground-nesting birds, and both often place the nest at the base of a sapling or tree stump. The association was, therefore, perfect for the Black and White Warbler and his response to the stimulus normal. —Gene Rea, *1836 North High Street, Columbus, Ohio.*

REPORT OF THE NOMINATING COMMITTEE

For the fourth year the Wilson Ornithological Club must conduct its annual election of officers and members of the Council by mail. Your Committee offers the following nominations for 1946:

President: George Miksch Sutton
First Vice-president: Olin Sewall Pettingill, Jr.
Second Vice-president: Harrison F. Lewis
Secretary: Maurice Brooks
Treasurer: Burt Monroe
Councillors: Milton B. Trautman, Rudolf Bennitt, George H. Lowery, Jr.

In addition to the slate offered above, any Active, Sustaining, or Life Member of the Wilson Ornithological Club is eligible for office. You are urgently requested to mail your votes to the Secretary whether you choose to support the slate given above, or whether you choose to write in the names of other eligible members for one or all of the offices.

Ralph Yeatter
W. J. Breckenridge
Ernst Mayr, *Chairman*

EDITORIAL

We are sorry to learn that, because of the pressure of other work, Milton Trautman will give up the Treasurership of the Club at the end of 1945. We are all much indebted to him, for the job is a difficult and very time-consuming one. The financial position of the Club is now better than it has ever been before, and much of the credit for this happy situation should go to the Treasurer, who has worked at his job so devotedly for the past three years.

Reuben M. Strong has very generously given the Club his back file of *The Wilson Bulletin* to be sold for the benefit of the Endowment Fund. We are also happy to report that Dr. Strong has given the Club Library his complete set of that very rare periodical, *The Curlew,* predecessor of *The Wilson Bulletin.* It was published in seven numbers from October 1888 to April 1889, and it contains the only contemporary record of the founding of our organization. The December 1888 issue records the founding of the "Wilson Chapter of the Agassiz Association" at Fall River, Massachusetts, on December 3 and publishes its constitution. *The Curlew* was designated the official organ. The officers were J. B. Richards, of Fall River, President, and Lynds Jones, of Grinnell, Iowa, Secretary. It is interesting to read in that first publication the plan that "our principal work will be on the nesting habits" of birds. The next issue of *The Curlew* contains more detailed plans and instructions to the members, closing with these words of sound and mature advice from the youthful Secretary: "Make no notes from memory, but jot them down in your notebook at the time they occur. Do not give general terms, such as 'late in March' or 'early in May,' but give the exact date . . . . "

The Editor is always glad to answer letters of inquiry from Club members about the books, reprints, and periodicals in the Club's Library. Members who have the *Bulletins* published during the last three years will find the books in the Library listed there in three installments (September issues for 1943, 1944, 1945), and an indication of the Club's principal holdings of pamphlets was published in September 1943, but meanwhile a great many gifts have been received.

We are grateful to the many people who have helped us edit the 1945 *Bulletin.* Special mention should be made of the assistance received from Maurice Brooks, Ludlow Griscom, J. J. Hickey, Margaret B. Hickey, Harrison F. Lewis, Harold Mayfield, Ernst Mayr, Olin S. Pettingill, Jr., Frank A. Pitelka, George M. Sutton, and Milton B. Trautman.

As predicted by Alfred Gross (*Maine Audubon Bulletin,* 1, 1945: 80), another of the periodic flights of Snowy Owls is invading the northeastern states this winter. A committee will prepare a report on this flight similar to the report on the flight of 1941 (*Wilson Bulletin,* 55, 1943: 8-10). The cooperation of Wilson Club members is requested. The committee will need to know the locality, inclusive dates, and numbers of owls seen. New England records should be sent to Alfred Gross (Bowdoin College, Brunswick, Maine) and Michigan records to C. T. Black (Game Division, Conservation Department, Lansing, Michigan). L. L. Snyder (Royal Ontario Museum of Zoology, Toronto 5, Ontario) will handle Ontario records and will forward records from other states and provinces to the respective representatives who are to be appointed later.

OBITUARY

Frank M. Chapman died in New York City on November 15, 1945, at the age of eighty-one. Curator in the American Museum of Natural History from 1888 to 1942, he also served as associate editor of *The Auk* (1894 to 1911) and founded *Bird-Lore,* which he edited for thirty-six years (1899-1934). A versatile man of great energy and powers of concentration, he became an acknowledged leader in such diverse fields as editing, wildlife conservation, museum exhibits, popularization of bird study, bird photography, zoogeography, and taxonomy. His sixteen books and scores of articles and shorter contributions brought not only a world-wide reputation among bird students but also recognition for himself and for the whole field of ornithology by the general public.

Ornithological News

The American Ornithologists' Union held its Sixty-third Annual Meeting in Cambridge on October 24. Because of travel difficulties the meeting was restricted to a one-day business session. Maurice Brooks, the appointed representative of the Wilson Ornithological Club on the Council, was unable to attend the meeting; Earle A. Brooks served as representative in his stead.

The Brewster Medal was awarded to H. Albert Hochbaum for "The Canvas-back on a Prairie Marsh." The check-list committee was instructed to proceed with the preparation of a final manuscript for a fifth edition of the A.O.U. Check-List of North American birds. The manuscript will probably be completed within a year.

The following officers and councilors were elected: President, Hoyes Lloyd; Vice-Presidents, R. C. Murphy and J. Van Tyne; Secretary, Lawrence E. Hicks; Treasurer, Frederick C. Lincoln; Councilors, Clarence Cottam, J. J. Hickey, George M. Sutton, and John W. Aldrich.

The members of the Union elected one Fellow, Jean M. Linsdale, and eight Members, A. Marguerite Baumgartner, A. D. Cruickshank, H. Albert Hochbaum, Francis H. Kortright, G. C. Munro, George J. Wallace, Leonard Wing, and Albert Wolfson.

At the suggestion of the officers of the Detroit Audubon Club, the Detroit Institute of Arts presented recently (October 20 to December 1) an exhibition of "American birds and their painters and sculptors." Edgar P. Richardson, Director of the Institute, prepared a remarkable historical series of bird drawings, paintings, and sculptured figures, beginning with the work of prehistoric man. The exhibition showed the work of more than fifty artists, many not commonly included in bird art exhibits, such as Peter Rindisbacher, Edward Walsh, John White, André Thevet, the Peales, Alexander Rider, and Alexander Wilson. Another unusual feature of the exhibition was the detailed and carefully written commentary accompanying the work of the artists. A complete showing of modern artists in the field was not attempted, but that group was well represented by the work of Fuertes, Allan Brooks, Jaques, and Sutton.

Wilson Ornithological Club Library

The following gifts have been recently received. From:

Robert Goslin—1 reprint
Horace Groskin—1 reprint
Harold M. Holland—1 journal
Leon Kelso—1 pamphlet
George H. Lowery, Jr.—1 book
Harry A. McGraw—46 journals, 4 reprints
Minnie B. Scotland—1 reprint
O. A. Stevens—1 pamphlet
R. M. Strong—8 journals

ORNITHOLOGICAL LITERATURE

A NATURALIST IN CUBA. By Thomas Barbour. Little, Brown and Co., Boston, 1945: 5½ × 8 in., x + 317 pp., 16 pls. $3.00.

Probably no American is better qualified than Thomas Barbour to write about Cuba. His more than thirty trips to Cuba in the past thirty-six years have taken him to even the most remote parts of that beautiful island. His devouring curiosity and his encyclopedic knowledge of all fields of biology have enabled him to profit fully from his great opportunity. The result is a book worthy of a place on our shelves with the classic "naturalist" volumes of Bates and Belt.

The two chapters devoted to birds will not only provide a delightful introduction to Cuban birds for many beginners, but they will also furnish more advanced students with much valuable data on the habits and the status, past and present, of Cuban birds. Unfortunately, scientific names are largely omitted from the bird chapters (although they are invariably used in full in the chapter on bats, which follows), and even the vernacular names are in some cases hardly adequate for identifying the species being discussed without recourse to the author's "Cuban Ornithology" (1943)—from which, indeed, a number of the bird accounts are copied in full. Following the modern trend, the publishers have removed the capital letters from the proper names of birds in most cases (forgetting to do so in the case of the Caracara and the Jacana) and have thus provided further difficulties for the reader. In certain examples, these two practices result in passages which will surely be confusing to some readers. On page 132 we find ourselves reading about "little yellow rails." I am afraid that few readers will instantly realize that Barbour is talking about *Porzana flaviventer,* the little neotropical rail related to our Sora, and not *Coturnicops noveboracensis,* the Yellow Rail of all North American bird books. A possible third complication in the field of vernacular nomenclature results from Barbour's sometimes following that curious custom which we ornithologists have of using two or more vernacular names for a single species. We head our account "Bob-white" and then write entirely about "quail"; or we list the "Osprey" and then discuss the "Fish Hawk."

The additional chapters of especial interest to the naturalist deal with reptiles and amphibians, mammals, cave hunting (which here means hunting *in* caves), and the Soledad garden. Six other chapters (one of them called an appendix), describing and interpreting the island and its people, complete an absorbingly interesting book on Cuba as seen by a great naturalist.—J. Van Tyne.

BIRDS OF KENTUCKY. By Jesse Dade Figgins. University of Kentucky Press, Lexington, Kentucky, 1945: 6½ × 9⅝ in., 366 pp., 9 pls., 2 figs., 1 map. $2.50.

This dull, poorly illustrated, thoroughly disheartening book was published under a grant from the Haggin memorial trust fund. Since it obviously was not designed to rouse popular interest (the only bird picture in it is a Goshawk drawing by Fuertes, used without giving credit, and forced into service as a diagram to show a bird's topography), we naturally expect it to be an authoritative reference work to which we can turn for concise information concerning bird-life *in Kentucky.* What we find instead is a mass of carelessly chosen general information about species which may or may not have been recorded from Kentucky; sketchy, often inaccurate, descriptions of these birds; and discursive, futile comments as to the subspecies known or thought to occur within the boundaries of the State. Stumbling page by page through the book in our vain search for migration dates; for maps showing the distribution of such species as the Downy Woodpecker, Hairy Woodpecker, Black-capped Chickadee, and Carolina Chickadee, which are known to be represented by more than one race; for occasional reference to specimens in the principal bird collections made within the State, or for evidence that these collections have been studied; and for reference to such important extra-limital work as that carried on by A. F. Ganier at Reelfoot Lake, Tennessee, we marvel that in such an 'enlightened age' as ours it is possible for so poor a book as this to appear. Furthermore, bearing in mind that younger bird students are even now being confused and misled by it, we earnestly wish there were some way of recalling the whole edition before more harm is done.

The University of Kentucky Press is wholly to blame for this gross misuse of funds. This publishing house could have secured the editorial assistance of some able Kentucky ornithologist or of some out-of-State authority and brought out a book which would have given bird students a sound basis for further work. To be sure, a good editor would have thrown out completely such sections as that on 'Color Terminology' (pp. 35-39); rewritten and considerably enlarged the introduction; presented a complete, accurate bibliography rather than a hit-and-miss list of titles; and, most important of all, worked out a valid philosophy and central purpose for the book. He would have spent long hours in re-evaluating the work of early authors, and possibly would have discarded as worthless the statements of Gilbert Imlay. He would have hunted down meagre but dependable data on old stuffed birds in hardware stores and in the museums of small colleges. He would have identified with great care specimens collected recently in this extremely interesting part of the United States. His list very likely would have been smaller than the present one. He would have indicated clearly that certain species were included on doubtful grounds. But the soundness and vitality of such a book would now be stimulating a desire to tackle and solve the problems of Kentucky bird distribution rather than killing enthusiasm for such work, as this volume does, through its cynical and lazy assumption that because a given bird has been recorded in an adjoining State, or somewhere along the Mississippi or Ohio River, it is practically a Kentucky bird anyway and therefore hardly worth going after; and through its repeated and ill-considered reference to the American Ornithologists' Union Committee on Nomenclature as a mysterious hierarchy bent on settling all subspecies problems independently of any taxonomic work the rest of us may do.

Now for the list itself. The author states (p. 39) that 354 bird species and subspecies "occur, or formerly occurred" in Kentucky; yet 361 forms, including four which have been introduced, are listed and discussed. Of these at least two should not have been even mentioned—the Mottled Duck (p. 84) and the American Raven, *Corvus corax sinuatus* (p. 219). The author's inclusion of these invalidates to some extent every statement in the book, causing us seriously to question his sight records for the Brewer's Blackbird (p. 300) and Boat-tailed Grackle (p. 301), and even to suspect that his specimen of Bicknell's Thrush (p. 245) may not actually have the measurements of this small race. Thus distrustful do we become of anyone who can hypnotize himself into believing it possible to distinguish *Corvus corax sinuatus* from *Corvus c. principalis,* or a female Mottled Duck from a female Mallard, in the field *in Kentucky* without obtaining so much as a feather in corroboration. In strict fairness to the author it should be said that we have not seen his original manuscript and therefore are not certain that it was his intention to give the American Raven and Mottled Duck full ranking in his list. Perhaps the editor was wholly to blame for such serious errors as these.

It is not possible, even with careful reading of the book, to determine whether certain species have actually been taken in Kentucky, or found breeding, or observed in migration. Most of the subspecific names, fortunately, are based on Dr. Wetmore's careful studies of Kentucky specimens; but it is all too plain that no effort was made by author or editor to find additional examples of this or that geographical race in the collections of A. F. Ganier, Burt Monroe, Robert Mengel, the Western Kentucky Teachers' College, or the State Teachers' College at Morehead.

In short, an adequate, up-to-date 'Birds of Kentucky' remains to be written. It is to be hoped that ornithologists will not feel obliged to refer to the present work too frequently lest, in so doing, they lead the younger generation into consulting, and possibly into imitating, an unworthy work.—George Miksch Sutton.

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AFFILIATED SOCIETIES

THE GEORGIA ORNITHOLOGICAL SOCIETY completed a major project on March 15 with the publication of "Birds of Georgia. A Preliminary Check-list and Bibliography" (University of Georgia Press), the first complete check-list and bibliography that has been compiled for the state. The Society plans to follow this technical publication with a popular bulletin on common birds of the state to supply the demands of schools, Boy Scouts, 4-H Clubs, garden clubs, and others. Thus the Society is devoting its energies to compiling and publishing material designed to stimulate active interest in ornithology.

Despite the fact that all the younger and most active members of the Society have been in the armed services, the Society has maintained its membership and improved its financial position during the past year. Publication of the *Oriole* has continued. A spring meeting, consisting of a business session, a field trip, and the showing of colored movies by Thomas D. Burleigh, was attended by about 45 members.—EUGENE P. ODUM, *President*

NEW LIFE MEMBERS

Herbert L. Stoddard, Sr., has been professionally engaged in wildlife work since 1905. The period from 1910 to 1924 was devoted to museum preparation and ornithological field work for the Milwaukee Public Museum and the Field Museum of Natural History. Since that time he has specialized in the study of upland game birds, especially the Wild Turkey and the Bob-white. His notable book on the latter species was awarded the Brewster Medal by the American Ornithologists' Union in 1935. In addition to working extensively on the avifauna of Georgia, where he now lives, he has carried on field investigations in Wisconsin (on Bob-white), Minnesota (on the Ruffed Grouse), Arizona (on Gambel's Quail), France and England (on the Gray Partridge and Ring-necked Pheasant).

Dr. Max Minor Peet, surgeon and ornithologist, accompanied his first zoological expedition for the University of Michigan in 1904 while still a high school boy. That expedition, and another in 1905, provided material for his paper on bird migration and those on the birds of Isle Royale, and the Porcupine Mountains, Michigan. He received the M.D. degree from the University of Michigan in 1910, then served in Rhode Island Hospital, the University of Pennsylvania, and the Philadelphia General Hospital. In 1916 he returned to the University of Michigan, where he is now Professor of Surgery and Chief of the Neurological Division of the University Hospital. He is a member of the Society of Neurological Surgeons and of the American Surgical Association; a Fellow of the American College of Surgeons and of the American Medical Association. In 1932 he was a member of the University of Michigan expedition to the Chisos Mountains, Texas. Since then he has made bird collecting an integral part of the medical trips which frequently take him to distant parts of the country.

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*Abbott, Cyril Edward, Wesley Junior College, Dover, Delaware 1937
Abbott, Jacob Bates, Whitehall, Haverford, Pennsylvania 1945
Adams, I. C. Jr., 104 Aldeah Ave., Columbia, Missouri 1933
Addy, Charles Edward, Upton, Massachusetts 1941
*Adelson, Richard Henry, 34 Wensley Dr., Great Neck, Long Island, New York 1938
*Aiken, Max J., 420 North Darling Ave., Fremont, Michigan 1945
*Aldrich, John Warren, Fish and Wildlife Service, Washington, D.C. 1930
Alexander, Donald C[hild], 127 Durant St., Lowell, Massachusetts 1937
Alexander, Gordon, Department of Biology, University of Colorado, Boulder, Colorado 1936
Alexander, Maurice Myron, 99 Mansfield Ave., Willimantic, Connecticut .1945
Allan, Philip F[arley], 1801 Carleton Ave., Ft. Worth, Texas 1939
*Allen, A[rthur] A[ugustus], Fernow Hall, Ithaca, New York 1914
Allen, Durward Leon, Rose Lake Wildlife Experiment Station, Route 1, East Lansing, Michigan 1933
Allen, Francis H[enry], 215 La Grange St., West Roxbury, Massachusetts .1941
Allen, Mrs. J. Owen, 4319 Hueco St., El Paso, Texas 1945
*Allen, Otis W., 504½ W. Market St., Greenwood, Mississippi 1944
Allen, Theodore, 2520 Mulberry Ave., Muscatine, Iowa 1942
Allin, A[lbert] E[llis], Provincial Laboratory, Fort William, Ontario, Canada 1943
Allyn, Capt. Paul Ricard, Waverly, Illinois 1944
*Alperin, Irwin, 540 West 40th St., Miami Beach 40, Florida 1939
Alpert, Bernard, 260 West End Ave., New York City 23 1939
Amadon, Dean, % Thorup, Route 1, Middleton, New York 1935
Amidon, Mrs. Hilda Farnum, 282 Sigourney, Hartford, Connecticut 1942
*Ammann, George Andrew, Game Division, Michigan Department of Conservation, Lansing 13, Michigan 1935
Anderson, Anders H[arold], Route 5, Box 331, Tucson, Arizona 1937
Anderson, John M., East Orwell, Ohio 1938
Anderson, R[udolph] M[artin], National Museum of Canada, Ottawa, Ontario, Canada 1937
Andrle, Robert Francis, 59 Blantyre Rd., Buffalo 16, New York 1944
Anthes, Clarence A[lvin], 713 Hamilton Ave., Waukesha, Wisconsin 1939
Anthony, Jesse D., 722 1st Ave., E., Grand Rapids, Minnesota 1944
Applegate, Mrs. Edith, 2209 Trenton St., Houston 10, Texas 1945
Appleton, J[ohn] S[parhawk], Simi, California 1936
*Armstrong, Miss Virginia, Musketaquid Rd., Concord, Massachusetts 1939
Arnett, John Hancock Jr., 6200 Ardleigh St., Germantown, Philadelphia, Pennsylvania 1944
Arnold, Elting, R.F.D. 3, Box 27, Wilson Lane, Bethesda, Maryland 1941
Arnold, Rev. Jay, 20 N. Pine St., York, Pennsylvania 1945
Ashley, Capt. James Franklin, 740 Santa Clara Ave., Alameda, California .1945
*Ashton, Randolph, 800 Crown St., Morrisville, Pennsylvania 1941
*Austin, Dr. Oliver L[uther], Box 236, Tuckahoe, New York 1930

[1] This list is compiled as of November 1, 1945. The Secretary would appreciate immediate notification of any omission of names, changes in address, or errors in the spelling of names, the use of titles, the class of membership, or the exact year of first election to membership.

Ayer, Mrs. N[athan] Edward, 1300 Hillcrest Dr., Pomona, California 1936
**Aylward, David A., 20 Spruce St., Boston 8, Massachusetts 1945
Ayres, Charles C. Jr., 922 N. Green St., Ottumwa, Iowa 1944
Baechle, Rev. John W[illard], C.P.P.S., St. Joseph's College,
Collegeville, Indiana 1943
Baer, Miss Myrtle W., 1237 N. Jefferson St., Milwaukee 2, Wisconsin ..1941
*Bailey, Alfred Marshall, Colorado Museum of Natural History,
City Park, Denver 6, Colorado 1928
**Bailey, Harold H[arris], Box 6333, 820 Alhambra Circle, Coral Gables,
Florida 1908
Bailey, Mrs. H. M., 1020 Jones St., Sioux City 18, Iowa 1918
***Baker, Bernard William, Marne, Michigan 1938
*Baker, John H[opkinson], 1165 Fifth Ave., New York City 1930
Baker, Rollin Harold, Box 171, Eagle Lake, Texas 1938
*Baker, William C[alvin], 559 Euclid St., Salem, Ohio 1931
Baldwin, Mrs. Amy G., 6335 Kimbark Ave., Chicago 37, Illinois 1943
**Baldwin, Stephen Glidden, 406 Adams Bldg., Danville, Illinois 1945
**Ballard, Albert Donald, 1326 S. Stanislaus St., Stockton 35, California ..1944
*Banfield, Capt. A. W. Frank, 932 A. Avenue Rd., Toronto, Ontario,
Canada 1945
Banks, Clinton S., 202 Wilma Ave., Steubenville, Ohio 1945
Banta, Miss Edna, Spencer, Indiana 1945
*Barber, Bertram A., Department of Biology, Hillsdale College,
Hillsdale, Michigan 1945
**Barbour, Thomas, Museum of Comparative Zoology,
Cambridge 38, Massachusetts 1945
Barkalow, Frederick Schenck Jr., 207 Washington Ave., Marietta,
Georgia 1936
**Barker, Donald J., 1426 Nottingham Rd., Orlando, Florida 1945
Barlow, James H., 1913 Dewey Ave., Rochester 13, New York 1945
Barnes, William Bryan, Room 10, State House Annex, Indianapolis,
Indiana 1941
*Bartel, Karl E[mil] Edgar, 2528 West Collins St., Blue Island, Illinois ..1934
*Bartlett, Guy, 1053 Parkwood Blvd., Schenectady 8, New York 1938
*Bartlett, Wesley H., 425 Beech Ave., Ames, Iowa 1936
*Bartsch, Paul, U.S. National Museum, Washington 25, D.C. 1894
*Bashour, Lt. Fred, Concho Field, San Angelo, Texas 1945
*Batchelder, Charles Foster, 7 Kirkland St., Cambridge, Massachusetts ...1927
Batchelder, Edgar M[arden], 690 Lynnfield St., Lynn, Massachusetts ...1941
Bates, Charles Evarts, Box 34, East Wareham, Massachusetts 1945
Bates, James Worth, 811 Woodlawn Rd., Steubenville, Ohio 1945
Battell, Harriet Chapman (Mrs. F. L.), 2812 Arbor St., Ames, Iowa 1942
*Baumgartner, Frederick Milton, Department of Entomology,
A. & M. College, Stillwater, Oklahoma 1935
Baumgartner, Milton D., 311 McGeorge St., Stillwater, Oklahoma 1944
*Baumgras, Philip S., Swan Creek Wildlife Experiment Station,
Allegan, Michigan 1945
Baxter, Miss Jean, 24654 West Lake Road, Bay Village, Ohio 1945
**Baxter, William, Mayflower Apts. C-503, Wilmington, Delaware 1945
Bear, Robert Murray Jr., 12 Ledyard Lane, Hanover, New Hampshire ..1945
Beard, Elizabeth Browne (Mrs. Allen Shelby), 9904 Berwick Rd.,
Rosedale Gardens, Plymouth, Michigan 1942
Beardslee, Clark Smith, 132 McKinley Ave., Kenmore, New York 1942
Beardslee, Miss Margaret Hortense, 410 S. Prospect St., Box 327,
Ravenna, Ohio 1941
Beatty, Harry A[ndrew], % R. Kerr, 2350 Creston Ave., Bronx 53,
New York City 1936

Beck, Rollo Howard, Planada, California 1943
Becker, George C[harles], Port Edwards, Wisconsin 1941
Becker, Mrs. Paul A., 251 East Phelps, Owatonna, Minnesota 1944
Bedell, Miss Marie L., 1430 West 20th St., Lorain, Ohio 1940
Bednarz, Felix L. Jr., 1665 Taunton Rd., Birmingham, Michigan 1944
*Beebe, Ralph, 4169 Tenth St., Ecorse 18, Michigan 1924
*Beebe, William, 33 W. 67th St., New York City 1944
*Beeghley, James L[eon], Route 1, Lee Run Rd., Poland, Ohio 1933
Behle, William H[arroun], Department of Biology, University of Utah, Salt Lake City, Utah 1935
*Behrend, Fred William, 406 Broad St., Elizabethton, Tennessee 1944
Belcher, Paul Eugene, 988 Jefferson Ave., Apt. 3, Akron, Ohio 1938
*Bellrose, Frank Jr., Illinois Natural History Survey, Havana, Illinois 1935
*Bennett, Clare Helmer, Biology Department, State University, Bowling Green, Ohio 1945
*Bennett, Logan J[ohnson], Pennsylvania State College, State College, Pennsylvania 1934
*Bennett, Miss Mary A[llison], 623 E. Carroll St., Macomb, Illinois 1933
*Bennett, Walter W., 5617 Harcourt Ave., Los Angeles 43, California 1945
*Bennitt, Rudolf, Department of Zoology, University of Missouri, Columbia, Missouri 1932
Benson, Mrs. Mary Heydweiller, 369 Seneca Parkway, Rochester 13, New York 1937
Benson, Seth Bertram, 645 Coventry Rd., Berkeley, California 1930
*Bent, Arthur Cleveland, 140 High St., Taunton, Massachusetts 1893
Berger, Capt, Andrew J[ohn], 418 Hazel Ave., Ellwood City, Pennsylvania 1940
Bergstrom, E[dward] Alexander, 9 Huntington St., Hartford 5, Connecticut 1943
*Biaggi, Virgilio Jr., Stone Laboratory, Put-in-Bay, Ohio 1945
Biddle, John, 16811 Fernway Rd., Shaker Heights 20, Ohio 1945
*Biette, Robert N., Pennellville Road, Brunswick, Maine 1945
***Billington, Cecil, 21060 Thirteen Mile Rd., Birmingham, Michigan 1939
Binnington, Miss Nora L[ouise], 6006 Cabanne Place, St. Louis, Missouri .1941
Birkeland, Henry, Roland, Iowa 1934
Bishoff, Miss Edna L., 2608 E. 6th St., Superior (East End), Wisconsin .1945
Bishop, Howard Elmer, 206 W. Packer Ave., Sayre, Pennsylvania 1941
**Bishop, Dr. Louis B[ennett], 450 Bradford St., Pasadena 2, California ..1903
Bissonette, Thomas Hume, Trinity College, Hartford 6, Connecticutt ...1939
*Bivins, Stephen T., Btry C, 134th F.A. Bn., Ft. Bragg, North Carolina ..1945
Black, Charles Theodore, Route 3, Grand Ledge, Michigan 1935
**Blackstone, Jess, 39 N. Spring St., Concord, New Hampshire 1945
*Blain, Dr. Alexander W[illis], 2201 Jefferson Ave., E., Detroit, Michigan .1902
Blair, Charles H., 209 Ellery Ave., Jackson, Michigan 1943
*Blake, Emmet R[eid], Chicago Natural History Museum, Chicago 5, Illinois 1939
Bliese, John C[arl] W[illiam], Address unknown 1944
*Blincoe, Ben[edict] Joseph, Route 1, Box 363, Dayton, Ohio 1919
Blincoe, Edith S. (Mrs. B. J.), Route 1, Box 363, Dayton, Ohio 1926
*Boggs, Ira Brooks, West Virginia University, Morgantown, West Virginia 1938
*Bole, Benjamin Patterson Jr., 2717 Euclid Ave., Cleveland 15, Ohio 1938
Bolt, Benjamin F[ranklin], 1110 Armour Blvd., Kansas City, Missouri ..1914
*Bond, James, 1900 Race St., Philadephia 3, Pennsylvania 1945
Bond, Richard M[arshall], P.O. Box 1671, Portland 7, Oregon 1936

Borell, Adrey Edwin, Soil Conservation Service, Box 1314, Albuquerque, New Mexico 1936
*Borror, Donald J[oyce], Department of Zoology and Entomology, Ohio State University, Columbus, Ohio 1927
Boulton, Rudyerd, 3317 Dent Place, N.W., Washington, D.C. 1942
Bourlière, Dr. F., Animal Nutrition Laboratories, Dairy Bldg., Cornell University, Ithaca, New York 1945
Bowdish, Beecher S[coville], Demarest, New Jersey 1921
Bowen, Leon W[alker], 77 Evergreen Ave., Bloomfield, New Jersey 1942
Bowers, J. Basil, 381 51st St., Oakland 9, California 1942
*Bowman, Lawrence L[incoln], Route 2, Ambler Rd., Canton, Ohio 1935
Boyd, Miss Elizabeth M[argaret], Mount Holyoke College, South Hadley, Massachusetts 1941
Boyd, Ivan L[ouis], Box 182, 1003 8th St., Baldwin, Kansas 1944
Boyer, Edgar, 3852 Charlotte St., Kansas City, Missouri 1945
Boyes, Mrs. Edwin G., 19164 Pennington Drive, Detroit 21, Michigan ..1945
*Brackbill, Hervey [Groff], 4608 Springdale Ave., Baltimore 7, Maryland.1942
Bradley, Miss Hazel Louise, 137 W. Morrell St., Jackson, Michigan 1944
Bradley, Homer L., Lacreek National Wildlife Refuge, Martin, South Dakota 1939
**Braman, Mrs. Myrtle, 206 W. Stayton Ave., Victoria, Texas 1945
Brand, Charles Salmon, Address unknown 1941
Brandenburg, Miss Arminta A[lice], State Hospital, Toledo, Ohio 1941
**Brandreth, Courtenay, Ossining, New York 1939
*Brecher, Leonard C[harles], 1900 Spring Drive, Louisville 5, Kentucky ..1939
*Breckenridge, Walter J[ohn], Museum of Natural History, University of Minnesota, Minneapolis, Minnesota 1929
Breiding, George H[erbert], 108 West Woodruff, Columbus 1, Ohio 1942
Brereton, E[wart] L[ount], Box 99, Barrie, Ontario, Canada 1943
***Bretsch, Clarence, 690 Broadway, Gary, Indiana 1925
Brigham, Edward M[orris] Jr., Kingman Memorial Museum, Battle Creek, Michigan 1931
*Brigham, H[erbert] Storrs Jr., 3817 Sedgwick Ave., New York City 63 ..1942
Brimley, Clement S., Division of Entomology, North Carolina Department of Agriculture, Raleigh, North Carolina 1942
Bristow, Harry Sherman Jr., Pine Ave., Cedars, Delaware 1942
*Brooks, Earle A[mos], 166 Plymouth Rd., Newton Highlands, Massachusetts 1933
***Brooks, Maurice Graham, Division of Forestry, Morgantown, West Virginia 1927
Broun, Maurice, The Northfield, East Northfield, Massachusetts 1935
Brown, Clarence D., 222 Valley Rd., Montclair, New Jersey 1938
Brown, E. E., Davidson College, Davidson, North Carolina 1945
Brown, N. Rae, Forest Insect Laboratory, Box 975, Sault Ste Marie, Ontario, Canada 1945
*Brown, Virginius Elholm, Biology Department, Taylor University, Upland, Indiana 1942
Brueggemann, Miss Anna L[ouise], 584 Sheridan Ave., Columbus 9, Ohio .1943
*Bruns, James Henry, 724 Whitney Bldg., New Orleans 12, Louisiana ..1941
*Bryens, Oscar McKinley, 231 S. Main St., Three Rivers, St. Joseph Co., Michigan 1924
Buchanan, Forest Wendell, Amsterdam, Ohio 1939
*Buchheister, Carl W., 1006 Fifth Ave., New York City 28 1943
Buckstaff, Ralph Noyes, Oshkosh Public Museum, Oshkosh, Wisconsin ..1941
Bundy, M[alcolm] F[oland], Route 2, Atlanta, Indiana 1941
**Burelbach, Maj. Martin J., 510 W. 4th St., Chattanooga 3, Tennessee ..1942

Burget, Russel Lincoln, 526 Devon Place, Toledo, Ohio 1944
Burland, Lee J[ohnson]), Ballston Lake, New York 1939
*Burleigh, Thomas D[earborn], Department of Zoology, Louisiana State University, Baton Rouge, Louisiana 1922
****Burns, Franklin Lorenzo, Berwyn, Pennsylvania ....Founder
Burr, Dr. Irving Wingate, 265 Littleton St., West Lafayette, Indiana 1945
Burroughs, Raymond Darwin, Department of Conservation, Lansing, Michigan 1937
*Burt, William Henry, Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1928
*Burtch, Verdi, Branchport, New York 1924
*Butchart, G. Reeves, 123 N. State St., Ann Arbor, Michigan 1943
*Butler, Lawrence Michael, Address unknown 1940
Cadbury, Joseph Moore, Johnson Court 1, 16 E. Johnson St., Germantown, Philadelphia, Pennsylvania 1943
Cadman, Frederick L., 20 Exchange Place, New York City 5 1945
Cagle, Fred R., Museum, Southern Illinois Normal University, Carbondale, Illinois 1942
*Cahalane, Victor H[arrison], National Park Service, Merchandise Mart, Chicago 54, Illinois 1933
Calhoun, John Bumpass, Department of Entomology and Zoology, Ohio State University, Columbus 10, Ohio 1935
Calvert, William J[onathan] Jr., 615 N. Pelham Rd., Jacksonville, Alabama 1942
Campbell, Mrs. Edith Abbot, Lyme Rd., Hanover, New Hampshire 1945
Campbell, John David, 319 Ford St., Geneva, Illinois 1944
Campbell, John Howard, Med. Det., Madigan Convalescent Hospital, Ft. Lewis, Washington 1945
*Campbell, Louis W[alter], 4531 Walker Ave., Toledo 12, Ohio 1926
*Campbell, Miss Mildred F[lorence], 29 N. Hawthorne Lane, Indianapolis 1, Indiana 1938
*Capps, Beryl F[ranklin], 167 W. Robinwood, Detroit 3, Michigan 1939
Carnes, Mrs. Herbert E., 25 Kenwood Rd., Tenafly, New Jersey 1944
*Carpenter, Floyd S., 2402 Longest Ave., Louisville 4, Kentucky 1934
Carpenter, Mrs. Lana L., 915 Mendocino Ave., Berkeley 7, California ..1945
*Carroll, Lt. Col. Robert P., 8 Honeysuckle Hill, Lexington, Virginia 1942
***Carrothers, Miss Vera, 14704 Alder Ave., East Cleveland 12, Ohio 1938
*Carruth, Dorothy Ferrell (Mrs. Wade H.) Box 912, Corpus Christi, Texas.1945
*Cartwright, Bertram William, 59 Elm Park Rd., Winnipeg, Manitoba, Canada 1930
Case, Leslie Delos Sr., 714 West Madison St., Ann Arbor, Michigan 1938
Cassel, J[oseph] Frank[lin], 1529 Dauphin Ave., Wyomissing, Pennsylvania 1940
Castle, Eugene Spencer, 80 S. State St., Elgin, Illinois 1936
*Cater, Milam Brison, P.O. Box 133, Millboro, Virginia 1944
**Chamberlin, Charles A[biel], 1221 Mt. Rose Ave., York, Pennsylvania ..1945
*Chamberlin, C[harles] E[dward], Box 186, San Marcos, Texas 1944
**Chambers, W[illie] Lee, Robinson Rd., Topanga, California 1909
Chance, Edgar P[ercival], Gurdons, Witley, Godalming, Surrey, England .1941
*Chapin, James P., American Museum of Natural History, 79th St. and Central Park West, New York City 24 1945
Chapman, Floyd B[arton], 1944 Denune Ave., Columbus, Ohio 1932
Chapman, Lawrence B., 1 Woodridge Rd., Wellesley 81, Massachusetts .1940
Chapman, Mrs. Naomi Fran, Flossmoor, Illinois 1945
*Chase, Henry B. Jr., 517 Decatur St., New Orleans 16, Louisiana 1932

**Chatham, Comdr. Thurmond, 3331 O St., N.W., Washington, D.C. 1945
**Church, Charles Thomas, 70 Pine St., New York City 5 1945
Chutter, Miss Mildred C., Box 229, Athens, Ohio 1936
Clapp, G[eorge] Howard, Pabst Farms, Oconomowoc, Wisconsin 1941
Clark, James Robert, Route 3, Bucyrus, Ohio 1945
*Clarkson, Mrs. Edwin O., Winghaven, 248 Ridgewood Ave.,
Charlotte, North Carolina 1940
Clemens, William Bryson, Dublin High School, Dublin, Georgia 1942
Clement, Roland C[harles], 49 Tremont St., Fall River, Massachusetts ..1941
*Clow, Miss Marion, Box 163, Lake Forest, Illinois 1929
Coats, Miss Ruth Emily, 702 E. 1st St., Tillamook, Oregon 1942
*Coffey, Lt. Ben Barry Jr., 672 N. Belvedere, Memphis, Tennessee 1927
Cogswell, Howard L[yman], 3807 Sierra Grande St., Pasadena 8,
California 1944
*Cole, Leon J[acob], Department of Genetics, University of Wisconsin
College of Agriculture, Madison 6, Wisconsin 1921
*Coles, Victor, 2910 Grasselli Ave., Westwood, Cincinnati, Ohio 1929
Collias, Lt. Nicholas E., Department of Zoology, University of
Chicago, Chicago, Illinois 1945
Common, Mrs. James A., 141 Flower Ave., W., Watertown, New York .1945
Compton, Miss Dorothy M., 22 Wilton St., Princeton, New Jersey 1945
*Compton, Lawrence Verlyn, 409 W. Webster St., Pittsburg, Kansas 1923
*Congdon, Dr. Russel T[hompson], Medical Arts Bldg., Wenatchee,
Washington 1944
Conn, Robert Carland, 769 Park Ave., Bound Brook, New Jersey 1945
**Conover, [Henry] Boardman, 6 Scott St., Chicago 10, Illinois 1944
Conway, Albert E., 123 Pennock Place, Media, Pennsylvania 1939
*Cooch, [Fredrick] Graham, 685 Echo Dr., Ottawa, Ontario, Canada ..1945
*Cook, Miss Fannye Addine, State Fish and Game Commission,
2550 N. State St., Jackson, 44, Mississippi 1925
Cooley, Miss Eleanor Graham, R.F.D., Berwyn, Maryland 1936
Coombes, Robert Armitage Hamilton, Sea Bank, Bolton-le-Sands,
Caraforth, Lancashire, England 1936
Corn, Lawrence R., 329 N. 41st St., Camden, New Jersey 1945
*Cottam, Clarence, Fish and Wildlife Service, Merchandise Mart,
Chicago 54, Illinois 1929
Cottrell, George William Jr., 70 Lake View Ave., Cambridge 38,
Massachusetts 1941
*Court, Edward J., 6415 Barnaby St., N.W., Chevy Chase, Maryland,
Washington, D.C. 1944
Craighead, Frank C., 5301 41st St., N.W., Washington, D.C. 1941
Crane, Mrs. Myrick, Wonalancet, New Hampshire 1945
Crosby, John Alexander, 56 Broadway Ave., Toronto, Ontario, Canada ..1943
Cross, Edmund R[ust], 1751 University Ave., San Diego 3, California ...1941
*Cruickshank, Allan Dudley, Highland Hall, Rye, New York 1939
Cruttenden, John Rudy, 2020 Main St., Quincy, Illinois 1945
Cunningham, James W., 3009 E. 19th Terrace, Kansas City, Missouri 1935
*Currier, Edmonde S[amuel], 8541 N. Chicago Ave., St. Johns
Station, Portland, Oregon 1930
*Curtis, Robert A., Candia, New Hampshire 1945
*Dahlberg, Wendell O[scar], 11312 S. Michigan Ave., Chicago 28, Illinois .1939
Dambach, Charles A., Department of Biology and Entomology,
Ohio State University, Columbus 10, Ohio 1934
Damon, David, 724 Sixth St., Ames, Iowa 1933
Danner, May S. (Mrs. John M.), 1646 Cleveland Ave., N.W.,
Canton, Ohio 1921

**Darden, Mrs. Colgate W[hitehead], Executive Mansion, Richmond, Virginia 1943
Davey, Dr. Winthrop N[ewbury], University Hospital, Ann Arbor, Michigan 1941
*Davidson, William Mark, National Research Center, Beltsville, Maryland.1933
Davis, Clifford Vernon, 224 S. Church, Bozeman, Montana 1945
Davis, David E[dward], 721 Elmwood Ave., Wilmette, Illinois 1940
Davis, George, Route 5, Murfreesboro, Tennessee 1936
Davis, George W., 148 Northfield St., Montpelier, Vermont 1941
*Davis, L[ouie] Irby, Box 988, Harlingen, Texas 1933
Davis, W[illiam] B., Department of Fish and Game, College Station, Texas 1938
Dear, Lt. Col. L[ionel] S[extus], P.O. Box 127, Port Arthur, Ontario, Canada 1939
Dechen, Mrs. Lillian Orvetta, 14 Summer St., Port Dickinson, Binghamton 6, New York 1939
*Decker, C[harles] O., 6450 Kenwood Ave., Chicago 37, Illinois 1938
Dehner, Rev. Eugene William, 638 Stewart Ave., Ithaca, New York 1944
***Delacour, Jean T., 995 Fifth Ave., New York City 1944
Delavan, Wayne G., Route 2, Box 61, Bronson, Kansas 1943
De Long, Mrs. W. C., Clarion, Iowa 1945
*DeLury, Ralph Emerson, Dominion Observatory, Ottawa, Canada 1920
Denton, J[ames] Fred Jr., 1314 Meigs St., Augusta, Georgia 1945
DePuy, Margaret Kalke (Mrs. John S.), 4758 Lake Shore Rd., Port Huron, Michigan 1944
Derleth, August William, Sauk City, Wisconsin 1940
**de Schauensee, Rodolphe Meyer, Devon, Pennsylvania 1945
**DeSelm, Lt. Hal R[awie], H. & S. Co., Base Depot, Camp Elliott, San Diego 44, California 1943
***Desmond, Hon. Thomas C[harles], Box 670, Newburgh, New York 1942
*Deusing, Murl, Milwaukee Public Museum, Milwaukee, Wisconsin 1937
Devitt, Otto Edmund, 218 Eglinton Ave., E., Toronto, Ontario, Canada ..1935
Dice, Lee Raymond, Laboratory of Vertebrate Biology, University of Michigan, Ann Arbor, Michigan 1943
Dickinson, J[oshua] C[lifton] Jr., Department of Biology, University of Florida, Gainesville, Florida 1939
Dickinson, Mrs. William Winston, 2006 Reid Ave., Bluefield, West Virginia 1942
Dierker, William W[ilfrid], 4186a Sacremento St., St. Louis 15, Missouri.1944
*Dietz, Robert Austin, 220 Beechwood Rd., Ridgewood, New Jersey 1944
Dille, Fred Monroe, 822 Grand Ave., Nogales, Arizona 1912
Diller, Oliver Daniel, 1433 Beall Ave., Wooster, Ohio 1945
Dingle, Edward von Siebold, Huger, South Carolina 1921
*Dixon, Miss Clara, Department of Zoology, University of Michigan, Ann Arbor, Michigan 1945
*Dixon, J[ames] B[enjamin], Route 1, Box 688, Escondido, California ..1936
Dobbins, H[ugh] C[linton], 1456 Clifton Blvd., Lakewood 7, Ohio 1941
*Dodge, Victor K[enney], 137 Bell Court West, Lexington, Kentucky 1935
Doering, Hubert R., 2 Midland Gardens, Bronxville 8, New York 1945
Domm, Lincoln V[alentine], Whitman Laboratory of Experimental Zoology, University of Chicago, Chicago 37, Illinois 1936
Donaghho, Walter Raymond, % Washington State College P. O., Pullman, Washington 1945
Donaldson, Harry Byron, 18 Second St., Mt. Clemens, Michigan 1943
*Douglass, Donald W., Department of Conservation, Game Division, Lansing 13, Michigan 1929
*Downer, Alice Porter (Mrs. C. T.), Address unknown 1945

Downing, Paul E[arl], 835 Waukegan Ave., Highland Park, Illinois 1943
Drey, Miss Minniejane, 616 Foster St., Evanston, Illinois 1945
Dreyfoos, Wallace David, 1212 Virginia Ave., N.E., Atlanta, Georgia ...1941
Drum, Miss Margaret, 217 South St., Owatonna, Minnesota 1937
*Dudley, John M[unchie],20 Germain St., Calais, Maine 1944
Duer, Harry E., 9304 Edmunds Ave., Cleveland, Ohio 1941
*Duffield, Marjorie Olney (Mrs. John W.), 1180 Cragmont Ave., Berkeley 8, California 1940
***Dugan, Dr. William Dunbar, McCaw General Hospital, Walla Walla, Washington 1945
*DuMont, Philip A[tkinson], Fish and Wildlife Service, Merchandise Mart, Chicago 54, Illinois 1928
*Duncan, Donald Pendleton, 5841 Nickerson Ave., Chicago 31, Illinois ...1936
Dundas, Lester Harvey, Braham, Minnesota 1943
Dusi, Julian L[uigi], Blacklick, Ohio 1941
*Duvall, Allen Joseph, Fish and Wildlife Service, Washington 25, D.C. 1942
*Eagleson, Joseph P., 85 East Gay St., Columbus 15, Ohio 1943
*Eastman, Whitney H[askins], % General Mills, Inc., Chamber of Commerce Bldg., Minneapolis, Minnesota 1941
*Eastwood, Sidney Kingman, 5110 Friendship Ave., Pittsburgh 24, Pennsylvania 1928
Eaton, Stephen W[oodman], 808 South Main St., Geneva, New York ...1942
*Edge, Mrs. Charles N[oel], 1215 Fifth Ave., New York City 29 1931
*Edwards, Robert Davis, 81 Hamilton St., Hamilton, New York 1945
*Edwards, Capt. Robert L., 81 Hamilton St., Hamilton, New York 1945
*Eifert, Virginia Snider (Mrs. H. D.), Illinois State Museum, Springfield, Illinois 1941
*Eifrig, Charles William Gustave, Windermere, Orange Co., Florida 1907
Eisenmann, Eugene, 110 West 86th St., New York City 1942
*Ekblaw, George Elbert, 511 W. Main St., Urbana, Illinois 1914
*Ekblaw, Walter Elmer, Clark University, Worcester, Massachusetts 1910
**Eklund, Dr. Carl Milton, Minnesota Department of Health, University Campus, Minneapolis 14, Minnesota 1945
*Eklund, Carl R[obert], Proof Division, Eglin Field, Florida 1944
Ekse, Mrs. Kay Elizabeth, 609 Wisconsin, Huron, South Dakota 1945
Elder, William Hanna, 5136 Kimbark, Chicago, Illinois 1938
*Elliott, Richard M., 1564 Vincent St., St. Paul 8, Minnesota 1940
Ellis, Miss Hazel R[osetta], Kenka College, Kenka Park, New York 1942
***Ellis, Ralph, 12 Administration Bldg., University of Kansas, Lawrence, Kansas 1926
Emerson, David L[owell], 25 Everett Ave., Providence, Rhode Island ..1939
*Emerson, Guy, 16 Wall St., New York City 1938
*Emilio, S[hepard] Gilbert, Route 4, Laconia, New Hampshire 1929
Emlen, John Thompson Jr., Psychobiological Laboratory, Johns Hopkins Hospital, Baltimore, Maryland 1936
Empey, Miller, Freeland, Michigan 1939
*English, Pennoyer Francis, Department of Zoology, Pennsylvania State College, State College, Pennsylvania 1934
Ennis, James H[arold], Cornell College, Mt. Vernon, Iowa 1942
*Erickson, Mary M[arilla], University of California Santa Barbara College, Santa Barbara, California 1930
Erickson, Ray C[harles], 1104 Washington Ave., St. Peter, Minnesota ..1939
*Errington, Paul L[ester], Iowa State College, Ames, Iowa 1932
*Eslinger, Kenneth N[elson], Box 67, Harvel, Illinois 1944
Etz, Mrs. Elizabeth Cecilia, Thornhedge, Wheeling, West Virginia 1940

**Eustice, Edith C. (Mrs. A. L.), 1138 Sheridan Rd., Evanston, Illinois ..1944
*Evans, Dr. Evan Morton, 550 Park Ave., New York City 1929
Evans, Ulmont L., 3112 S. Fourth St., Shelbyville, Illinois 1945
**Everett, Miss Louise A., 3824 Pillsbury Ave., S., Minneapolis, Minnesota..1944
*Fables, David George, 421 Walnut St., Roselle Park, New Jersey 1944
Faegre, David [Colin], Stoddard, New Hampshire 1940
Fahrenholz, Fred E[mery], 2912 Elmo Place, Middleton, Ohio 1942
Fales, John H[ouse], 1917 Elkhart St., Silver Spring, Maryland 1939
**Fargo, William G[ilbert], 506 Union St., Jackson, Michigan 1923
*Farner, Donald S[ankey], % C. S. Copps, 4332 North 32nd St., Omaha 11, Nebraska 1941
Farquharson, Miss Jessie, 2338 Marshall Ave., St. Paul 4, Minnesota 1944
Farquharson, Miss Mildred Grace, 2338 Marshall Ave., St. Paul 4, Minnesota 1944
Feighner, Miss Lena Veta, 298-1 S. Tremont St., Kansas City, Kansas ..1935
Feigley, Miss Margaret Denny, 544 Chestnut St., Winnetka, Illinois 1944
Findlay, Miss Violet L[iberty], Board of Education, 11th and Washington Sts., Wilmington, Delaware 1943
Finster, Miss Ethel B., Louisburg College, Louisburg, North Carolina ...1931
Fischer, Richard B[ernard], 140-19 Beech Ave., Flushing, New York 1942
Fleetwood, Raymond J[udy], Piedmont Wildlife Refuge, Round Oak, Georgia 1931
Fleugel, James Bush, 1104 American National Bank Bldg., Kalamazoo, Michigan 1942
Flick, Miss Katherine Jane, 5150 W. Pierson Rd., Flint 7, Michigan 1944
Floyd, E[arl] Pershing, 107 S.E. Second St., Pryor, Oklahoma 1939
*Floyd, Judge Joseph Larke, 1009-11 George Harter Bank Bldg., Canton, Ohio 1903
*Foote, Maurice E[dwin], R.F.D. 1, Mantua, Ohio 1932
Ford, Edward R[ussell], Newaygo, Michigan 1914
Forsyth, Mrs. Louise [Ann], 71 Lebanon Rd., Hanover, New Hampshire .1940
Fox, Adrian C[aspar], Box 1451, Lincoln, Nebraska 1937
France, H[orace] Owen, 6042 Ellis Ave., Chicago, Illinois 1941
Freer, Marion F. (Mrs. R. Lloyd), 4 Lenox Place, St. Louis 8, Missouri..1942
**French, Mrs. Elizabeth Thomas, 1801 Las Lomas, Albuquerque, New Mexico 1943
Frey, Edward Snively, 517 Hummel Ave., Lemoyne, Pennsylvania 1944
Frost, Herbert Hamilton, "Pen Craig," Newport, Rhode Island 1941
Frye, O. Earle Jr., 432 Avenue A, N.E., Winter Haven, Florida 1940
Fryman, Miss Kathryn E[lizabeth], 409 Elm St., Wyandotte, Michigan ..1943
Fuller, Raymond Tifft, Winterton, New York 1943
Funsten, R[andolph] Fairfax, 1515 Delmar Blvd., St. Louis, Missouri ..1944
*Furniss, Owen C[ecil], Port Alberni, Vancouver Island, British Columbia, Canada 1934
*Gabrielson, Dr. Ira N[oel], Fish and Wildlife Service, Washington, D.C. ..1913
Gaillard, Stephen Lee, 9 Lee Place, Bronxville, New York 1942
Gaines, Jack Raymond, 411 W. Koch St., Bozeman, Montana 1945
Galley, John E., 3543 E. 22nd St., Tulsa 4, Oklahoma 1945
*Gammell, Dr. Robert T[heodore], Kenmare, North Dakota 1943
**Ganier, Albert F[ranklin], 2112 Woodlawn Dr., Nashville, Tennessee 1915
*Gardner, Irvine M., % Hudson Bay Co., Clyde River Post, Baffin Island, N.W.T., Canada 1945
Garrett, Miss [Mary] Lois, 1709 Chestnut St., Kenova, West Virginia ..1942
Garrison, David L[loyd], Pagan Point, Wianno, Massachusetts 1940
Garst, Miss Virginia Louise, De Soto, Indiana 1944

Garth, Lt. John S., Station Hospital, Boca Raton AAF, Boca Raton, Florida 1945
Gashwiler, Jay S., Maine Wildlife Research Unit, University of Maine, Orono, Maine 1944
Gatterdam, Paul C[hristoffers], 2539 Edgewood Place, LaCrosse, Wisconsin 1940
Gaulding, Luther Willard Jr., 1002 College Ave., Tifton, Georgia 1944
Gavin, Angus, Eskimo Point, via Churchill, Manitoba, Canada 1942
Geren, Roy S., Continental, Ohio 1945
Gershten, Miss Blossom, 2816 Cortland St., Brooklyn 24, New York 1944
Gerstell, Richard, Pennsylvania Game Commission, Harrisburg, Pennsylvania 1939
Gibbs, Walter C., Whitehall, Michigan 1941
Giddings, Calvin John, American Fork, Utah 1945
Gier, Dr. Herschel Thomas, Ohio University, Athens, Ohio 1937
Gifford, Harold, 3636 Burt, Omaha, Nebraska 1936
Gilbert, Gareth, 2422 Indianola Ave., Columbus, Ohio 1943
Gilbert, Miss Kathryn Helen, 714 1st Ave. W., Grand Rapids, Minnesota. 1945
**Gillen, Harold W., Denslow Rd., New Canaan, Connecticut 1944
Gillette, D[elbert] A[sa], Route 5, Yakima, Washington 1942
Giltz, Maurice L[eroy], 841 Lincoln Way, N.W., Masillon, Ohio 1939
Ginn, William Edward, 511 East Van Buren, Columbia City, Indiana 1941
Givens, Laurence S[pessard], Box 67, St. Marks, Florida 1943
Glenn, Robert W., 509 Orchard Ave., Avalon, Pittsburgh 2, Pennsylvania. 1934
**Glover, Ray J[ames], R.D. 1, Addison, Pennsylvania 1943
Gloyd, Howard K[ay], Chicago Academy of Sciences, 2001 N. Clark St., Chicago 14, Illinois 1925
**Goetz, Christian John, 3503 Middleton Ave., Cincinnati 20, Ohio 1930
Good, Ernest E[ugene], Route 1, Van Wert, Ohio 1937
Goodman, John David, 204 W. Grimes St., Fairfield, Iowa 1944
*Goodridge, Edwin Tyson, Province Line Rd., Princeton, New Jersey 1944
*Gordon, J[esse] Halford, 139 East Second Ave., Roselle, New Jersey 1942
*Goslin, Charles R[ussell], 726 E. King St., Lancaster, Ohio 1940
Goslin, Robert M[artin], 316 Wilson Ave., Columbus 5, Ohio 1936
**Gough, William McDonald, 28 Baby Point Rd., Toronto, Canada 1944
*Gram, Margaret Edwards (Mrs. H. James Gram, Jr.), 409 Notre Dame Rd., Grosse Pointe 30, Michigan 1941
Grannis, Harriet Dudley (Mrs. J. Kidwell), Flemingsburg, Kentucky 1944
Granrud, Capt. Walter Hjalmer, McNair Hall, Box 58, Fort Sill, Oklahoma 1941
*Grant, Cleveland P[utnam], 245 Davis St., Mineral Point, Wisconsin 1928
Graves, Miss Katherine [Cynthia], 1209 North Illinois St., Apt. 28, Indianapolis 2, Indiana 1942
*Gray, William Arthur, Room 646, 224 S. Michigan Ave., Chicago 14, Illinois 1938
Greeley, Fred[erick], 1121 Rutledge St., Madison, Wisconsin 1942
Green, N[orman] Bayard, Training School, Marshall College, Huntington, West Virginia 1943
Green, Miss Rhoda J[anet], Science Museum, Minneapolis Public Library, Minneapolis 3, Minnesota 1940
**Greene, Albert E., 517 Oswego St., Ann Arbor, Michigan 1939
Greene, Earle R[osenbury], 22 Virginia Court, New Orleans 19, Louisiana. 1930
Greenhalgh, Clifton M., Kanab, Kane Co., Utah 1939
*Gregory, Stephen S[trong] Jr., Box N, Winnetka, Illinois 1922
Griffin, Donald R[edfield], Biological Laboratories, Harvard University, Cambridge, Massachusetts 1941

Grimes, S[amuel] A[ndrew], 825 S. Shores Rd., Jacksonville 7, Florida ..1924
*Grimm, William C[arey], P.O. Box 424, Linesville, Pennsylvania 1939
*Grinnell, Lawrence I[rving], 710 Triphammer Rd., Ithaca, New York ..1939
*Griscom, Ludlow, Museum of Comparative Zoology, Cambridge 38,
Massachusetts 1937
Griswold, J. A., Address unknown 1941
Grose, E. R., Sago, West Virginia 1939
Groskin, Horace, 210 Glenn Road, Ardmore, Pennsylvania 1937
*Gross, Alfred Otto, 11 Boody St., Brunswick, Maine 1927
*Grossenheider, Richard P., 5415 Gilmore Ave., St. Louis, Missouri 1941
*Guelf, George F., Brockport, New York 1944
*Gunderson, Harvey Lorraine, % H. H. Gunderson. Gary, Minnesota 1941
Gunn, Maj. William H., Longue Pointe, Ordnance Depot,
Montreal, P.Q., Canada 1945
Hadeler, Miss Catherine Wilma, 900 Harmon Ave., Dayton 9, Ohio 1945
*Hadley, Thomas E., 48 Wellesley Dr., Pleasant Ridge, Michigan 1944
Haecker, Frederick Woods, 506 S. 52nd St., Omaha, Nebraska 1938
*Hagar, Mrs. Jack, Box 339, Rockport, Texas 1930
*Hague, Florence S., Sweet Briar College, Sweet Briar, Virginia 1931
Haight, Robert Duane, 2035 Bay Shore Blvd., Rochester 9, New York...1945
Haines, T. P., Biology Department, Mercer University, Macon, Georgia ..1941
*Hainsworth, William P[ickard], 216 Railroad Ave., North Andover,
Massachusetts 1930
Hall, Lt. Fred T., Fabius, New York 1937
Haller, Frank D[enver], 125 S. Second St., Coshocton, Ohio 1940
*Hallman, Roy Cline, Box 826, Panama City, Florida 1928
*Hamerstrom, Lt. Frederick N. Jr., 6th Alt. Trg. Unit, 235th AAF Bu.,
Biggs Field, El Paso, Texas 1934
*Hamilton, William J[ohn] Jr., Department of Zoology, Cornell
University, Ithaca, New York 1933
Hammond, Merrill C[lyde], Upham, North Dakota 1939
Hampe, Irving E., 5559 Ashbourne Rd., Halethorpe, Baltimore 27,
Maryland 1945
*Handlan, John Welty, 409 41st St., S.E., Charleston 4, West Virginia ..1932
*Handley, Charles Overton, Virginia Polytechnic Institute,
Blacksburg, Virginia 1925
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*Hann, Harry W[ilbur], Department of Zoology, University of Michigan,
Ann Arbor, Michigan 1930
Hanna, Wilson Creal, 141 East F. St., Colton, California 1936
Hanson, E[lmer] C[harles], 1305 Wisconsin Ave., Racine, Wisconsin 1940
Happ, George Bippus, Principia College, Elsah, Illinois 1935
Hardy, [Cecil] Ross, Dixie Junior College, St. George, Utah 1940
*Harkness, Reed B., 4908 Laclede Ave., St. Louis 8, Missouri 1942
*Harper, Francis, 224 S. Chester Rd., Swarthmore, Pennsylvania 1930
Harrell, Byron Eugene, 1594 Stanford Ave., St. Paul, Minnesota 1943
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**Harriot, Samuel C[arman], 200 W. 58th St., New York City 19 1934
Harrison, H[arold] H[olmes], The Valley Daily News, Tarentum,
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*Hart, Frank Elmer, 2499 Medary Ave., Columbus 2, Ohio 1943
Hartley, Albert Thomas, Columbiana, Ohio 1944
*Hartman, Frank A[lexander], Hamilton Hall, Ohio State University,
Columbus, Ohio 1941
*Hartwell, Arthur M[owry], 1506 Mt. Curve, Minneapolis, Minnesota ..1940

*Haskin, J[oseph] R[obert], Box 65, Babson Park, Florida 1944
Haskins, Mrs. Edith D., 39 Park St., Hanover, New Hampshire 1941
Hausler, Mrs. M., 7348 Paxton Ave., Chicago, Illinois 1936
**Havemeyer, Henry O[sborne], Mahwah, New Jersey 1930
*Hawkins, Arthur S., Reg. Sta. Hosp., AAAF, Amarillo, Texas 1936
Hawkins, B. L., Hamline University, St. Paul 4, Minnesota 1936
Hawksley, Mrs. Janet P., 123 Lafayette Circle, Cincinnati, Ohio 1942
**Hebard, Frederick V[anuxem], 1500 Walnut St. Bldg., Philadelphia 2, Pennsylvania 1940
Hedges, Harold C[harles], Route 2, Lake Quivira, Kansas City, Kansas ..1940
*Hefley, Harold M[artin], Department of Biology, Texas Technological College, Lubbock, Texas 1942
Heft, Orvil F., 15790 Lindsay, Detroit 27, Michigan 1945
*Heidenkamp, Joseph, Jr., 538 Glen Arden Drive, Pittsburgh 8, Pennsylvania 1942
Heiser, J[oseph] M[atthew] Jr., 1724 Kipling St., Houston, Texas 1939
*Hendrickson, George O[scar], Department of Zoology, Iowa State College, Ames, Iowa 1933
*Henry, C. J., Lower Souris Refuge, Upham, North Dakota 1933
Henwood, Mrs. Ethel May, 609 W. Ohio St., Urbana, Illinois 1941
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***Hicks, Lawrence Emerson, Ohio Wildlife Research Station, Ohio State University, Columbus, Ohio 1925
Hiett, Lawrence D[avison], 1945 Ottawa Drive, Toledo 6, Ohio 1929
*Higgins, Harold G[uymon], 352 N. 1st E., Price, Utah 1941
Hill, Herbert Oliver, 61-63 Irving Place, New York City 3 1938
Hill, Julian Werner, 1106 Greenhill Ave., Wilmington 56, Delaware 1935
Hill, Raymond W., 3316 Kenmore Rd., Shaker Heights, Cleveland 22, Ohio 1941
*Hill, Walter P., 409 South 6th Ave., La Grange, Illinois 1939
*Hillmer, Davis B., 8228 Woodward Ave., Detroit 2, Michigan 1926
*Hilton, Dr. David C[lark], 305 Continental Bldg., Lincoln, Nebraska ...1918
*Hinds, Frank J., Biology Department, Western Michigan College of Education, Kalamazoo, Michigan 1935
Hindwood, K. A., Wingello House, Angel Place, Sydney, Australia 1945
*Hinshaw, Thomas D[oane], 1827 San Juan Ave., Berkeley 7, California..1926
Hobson, Dorothy Madden (Mrs. L. G.), 1309 N. Penn, Apt. 39, Indianapolis 2, Indiana 1935
*Hochbaum, Hans Albert, Delta, Manitoba, Canada 1942
*Hoff, Clayton M., 810 Blackshire Rd., Wilmington, Delaware 1943
Hoffman, Paul William, 8415 Kenyon Ave., Wauwatosa 13, Wisconsin ..1940
Hoffmeister, Linus C[hristian], 504 W. Ripa Ave., Lemay 23, Missouri..1939
Hofslund, Pershing B[enard], Milaca, Minnesota 1944
*Holland, Harold May, Box 615, Galesburg, Illinois 1915
Holsen, James N., 444 Clark Ave., Kirkwood 22, Missouri 1944
Horner, William A[rchibald], Address unknown 1943
Horton, Louise D. (Mrs. M. B.), 360 Prospect St., Fall River, Massachusetts 1941
Hostetter, D[avid] Ralph, Eastern Mennonite School, Harrisonburg, Virginia 1937
Hotchkiss, Neil, Patuxent Research Refuge, Bowie, Maryland 1940
Hough, Mrs. Eleanor Sloan, 4820 Olentangy Blvd., Columbus, Ohio 1941

Howard, William J[ohnston], 5518 Fairglen Road, Chevy Chase 15, Maryland 1940
Howe [Henry] Branch Jr., 414 W. Ponce de Leon Ave., Decatur, Georgia. 1943
Howell, Joseph C[orwin], Department of Zoology, Oklahoma A & M College, Stillwater, Oklahoma 1938
Hoyt, George B[rown], 2603 Habersham Rd., Atlanta, Georgia 1941
*Hoyt, J[ohn] Southgate Y[eston], 820 W. Third St., Williamsport 15, Pennsylvania 1936
*Hughes, George Thomas, R.F.D. 2, Plainfield, New Jersey 1929
**Hughes, Dr. W. W., Embro, Ontario, Canada 1944
Hulbert, Lloyd Clair, 529 West Grand River Ave., East Lansing, Michigan 1938
*Hunt, Ormond Edson, General Motors Bldg., 3044 West Grand Blvd., Detroit 2, Michigan 1937
Hurley, John B[eatty], 401 S. 17th Ave., Yakima, Washington 1937
Hurst, John W. Jr., 522 S. 6th St., Bozeman, Montana 1945
Hutchinson, Arthur E., 715 Mission Canyon Rd., Santa Barbara, California 1940
Hyde, Lt. A[rthur] Sidney, 4th Photo Procurement Det., A.P.O. 925, San Francisco, California 1939
Hyder, Albert E., Department of Botany, Ohio State University, Columbus 10, Ohio 1945
Ingersoll, Albert M[ills], 908 F Street, San Diego 1, California 1921
**Ingersoll, Marion C[rory] (Mrs. Raymond V.), 4 East 66 St., New York City 21 1942
Ivor, H. Roy, Route 1, Cooksville, Ontario, Canada 1945
*Jackson, C[icero] F[loyd], Director of Biological Institute, University of New Hampshire, Durham, New Hampshire 1936
*Jackson, Francis Lee, 541 Hammond St., Chestnut Hill, Massachusetts .. 1941
Jameson, Everett Williams Jr., 179 Highland Ave., Buffalo, New York .. 1941
*Janvrin, Edmund R[andolph] P[easlee], 38 E. 85th St., New York City. 1942
Jaques, F[rancis] L[ee], 610 West 116 St., New York City 27 1939
Jaquith, Barbara Elizabeth (Mrs. L. E.), 72 Hudson Dr., Toronto 5, Ontario, Canada 1943
Jenkins, James H[obart], 1204 W. Chestnut, Mt. Vernon, Ohio 1939
*Jenner, William, 806 W. Davis St., Fayette, Missouri 1933
*Johnson, Clifford O., 987 Fourteenth St., Marion, Iowa 1944
*Johnson, Mrs. Oscar, 38 Portland Place, St. Louis, Missouri 1931
Johnson, Perry Frank, 2918 S. Anthony Blvd., Fort Wayne 5, Indiana .. 1935
*Johnson, Robert A[nthony], 150 East St., Oneonta, New York 1930
Johnson, William M[cNutt], Route 4, Knoxville, Tennessee 1939
Johnston, Miss Verna R[uth], Stockton Junior College, Stockton, California 1941
*Jonah, Miss Christie May, 221 Anderson St., Hackensack, New Jersey .. 1942
*Jones, Harold C[harles], Thomas Berry College, Mount Berry, Georgia .. 1929
Jones, John C[ourts], 718 Garfield St., Eveleth, Minnesota 1931
****Jones, Lynds, 352 W. College St., Oberlin, Ohio .... Founder
*Jones, S[olomon] Paul, 509 West Ave., N., Waukesha, Wisconsin 1921
Jones, Victor E[mmons], University of Idaho, Southern Branch, Pocatello, Idaho 1938
Jorae, Miss Irene Frances, Central Michigan College of Education, Mt. Pleasant, Michigan 1942
Jorns, Byron C[harles], 3275 Gregory St., Madison, Wisconsin 1943
*Jung, Clarence [Schram], 6383 N. Port Washington Rd., Milwaukee 9, Wisconsin 1921
Jurica, E., Lisle, Illinois 1940

Kahmann, Karl W., Route 2, Hayward, Wisconsin 1941
Kahn, Dina H[ope] (Mrs. Reuben L.), 1122 Michigan Ave., Ann Arbor, Michigan 1938
*Kalmbach, Edwin Richard, Fish & Wildlife Service, 546 Custom House, Denver 2, Colorado 1926
*Kase, John C[harles], Versailles, Indiana 1937
Kautz, Lorin G., White River Refuge, St. Charles, Arkansas 1944
*Keating, F[rancis] Raymond Jr., 519 5th Ave., S.W., Rochester, Minnesota 1944
*Keck, Warren N., Coe College, Cedar Rapids, Iowa 1944
*Kelker, George Hills, School of Forestry, U.S.A.C., Logan, Utah 1938
**Keller, Lt. Richard T[homas], 717 S. 16th St., St. Joseph, Missouri 1943
Kelly, Evelyn (Mrs. George A.), 2300 North LaSalle Gardens, Detroit 6, Michigan 1935
*Kelsey, Homer Stone, Box 402, Nyack, New York 1945
*Kelso, Leon H[ugh], 1370 Taylor St., N.W., Washington 11, D.C. 1930
Kemp, John H. Jr., 232 Circle Ave., Ridgewood, New Jersey 1945
Kendall, Mrs. Herbert E., 7 Ayer St., Nashua, New Hampshire 1945
*Kendeigh, S[amuel] Charles, Vivarium Bldg., University of Illinois, Champaign, Illinois 1923
Kendrick, Miss Muriel Sherburn, 201 Pleasant St., Laconia, New Hampshire 1945
Kerr, Mrs. Mary Helen, 1290 Delaware, Springfield, Missouri 1943
Key, Mrs. J. Frank, Buena Vista, Virginia 1945
Kiefer, Elizabeth D[eyo] (Mrs. Francis), 243 Gratiot Blvd., Port Huron, Michigan 1941
*Kieran, John, 4506 Riverdale Ave., New York City 63 1942
Kindler, Mrs. Grace E[mma], Sheridan Drive, Route 1, Lancaster, Ohio.1937
Kirby, Edward Vincent, 5259 Union Ave., Chicago 9, Illinois 1945
Kirk, Allan D[ixon], 14 Forest Hill Road, Wilkinsburg, Pennsylvania ..1939
*Klinkerfuss, Mrs. G. H., 340 Bermuda Ave., Normandy, Missouri 1941
*Klinkerfuss, Dr. G. H. 340 Bermuda Ave., Normandy, Missouri 1941
Kluge, Miss Helen H[enrika], Woodtick Road, Waterbury 63, Connecticut 1942
*Knapp, Elmer Leslie, R.F.D. 2, Troy, Pennsylvania 1930
Knollmeyer, Capt. Lewis Edward, University of Wisconsin, Sterling Hall, Madison, Wisconsin 1945
Knox, Miss Margaret R[ichardson], 4030 Park Ave., Indianapolis 5, Indiana 1937
Koch, Peter, Cincinnati Museum of Natural History, Cincinnati 10, Ohio.1939
Koehler, Mrs. Arthur, 109 Chestnut Street, Madison, Wisconsin 1941
Koestner, E. J., Box 263 Piper City, Illinois 1938
Kolb, C[harles] Haven Jr., 5021 Midwood Ave., Baltimore 12 , Maryland.1937
Korgen, Miss Mollie, 1919 East 3rd St., Duluth 5, Minnesota 1944
**Kortright, Francis H[erbert], 5 St. Edmunds Dr., Toronto, Ontario, Canada 1943
Kossack, Charles W., 715 S. Division St., Barrington, Illinois 1945
Kramer, Theodore C[hristian], Department of Anatomy, East Medical Bldg., Ann Arbor, Michigan 1939
Kraus, Douglas L[awrence], Princeton, Massachusetts 1942
Kreag, Keith K., Route 2, Box 196, Lansing, Michigan 1942
Kritzler, Lt. Henry, 3627 216th St., Bayside, New York 1945
Krug, Howard H[enry], Chesley, Ontario 1944
*Krutzsch, Miss Barbara Ellen, 3025 Meridian St., Apt. 401, Indianapolis, Indiana 1945
Kuitert, Capt. Louis Cornelius, 706 Florence St., Kalamazoo, Michigan.1938

*Kutz, George Carl, 705 S. Holcombe St., Stillwater, Minnesota 1944
*Kutz, Harry Leon, Chaumont, New York 1939
*Kyllingstad, Henry C[arrell], Mountain Village, Alaska 1940
*Lacey, George Macrae, 121 S.E. 13th St., Miami, Florida 1945
Lacey, Miss Mifton H., Box 614, Canton, Ohio 1939
Laffoon, Jean Luther, 1401 W. 3rd, Sioux City, Iowa 1940
Lagler, Karl F., Department of Zoology, University of Michigan, Ann Arbor, Michigan 1941
***Lambert, Bert H., 16854 Wildemere Ave., Detroit, Michigan 1936
*Lambert, Robert John Jr., 2802 Kenmore Ave., Dayton, Ohio 1945
Lanyon, Wesley E[dwin], 23 E. Wheelock St., Hanover, New Hampshire.1943
*La Rivers, Ira, P.O. Box 1493, Reno, Nevada 1945
*Larrabee, Austin Park, Yankton College, Yankton, South Dakota 1921
Larson, Capt. Goodman Kenneth, 1611 Ashland Ave., St. Paul, Minnesota 1945
*Laskey, Amelia Rudolph (Mrs. Frederick Charles), Graybar Lane, Nashville 4, Tennessee 1928
Lattin, Jack Daniel, 5726 W. Ohio St., Chicago, Illinois 1945
Lawrence, William Hobart, 1410 Decatur St., N.W., Washington 11, D.C..1943
Lay, Daniel Wayne, % Game, Fish and Oyster Commission, Austin, Texas.1939
Lea, Robert B[ashford], 24 North Worth Ave., Elgin, Illinois 1940
Lee, Maj. Howard J[ames], U.S. Army Hospital, Camp Carson, Colorado Springs, Colorado 1941
Leedy, Daniel L[ovey], Ohio Wildlife Research Station, Ohio State University, Columbus, Ohio 1936
Leenhouts, Miss Pearle Esther, Pease Road, Williamson, New York 1941
Legg, William C[larence], Mt. Lookout, West Virginia 1939
*Leopold, Aldo, 424 University Farm Place, University of Wisconsin, Madison 6, Wisconsin 1928
Leopold, A[ldo] Starker, Monte Libano 640, Mexico D.F., Mexico 1940
Levy, Alice K[lund] (Mrs. H. P.), 235 East 22nd St., Apt. 11T, New York City 10 1941
*Lewis, Harrison Flint, Lands, Parks and Forest Branch, Department of Mines and Resources, Ottawa, Ontario, Canada 1939
Lewis, Brother Hubert, Cretin High School, St. Paul, Minnesota 1940
*Lewy, Alfred, 2051 East 72nd Place, Windsor Park Station, Chicago, Illinois 1915
Lieftinck, John E., 80 Byers Ave., Akron 3, Ohio 1945
Lincoln, Frederick Charles, Fish and Wildlife Service, Washington, D.C..1914
Lindzey, James S[hotwell], 901 West 22nd St., Wilmington, Delaware..1942
*Linsdale, Jean M[yron], Jamesburg Route, Monterey, California 1928
Linton, M[orris] Albert, 315 E. Oak Ave., Moorestown, New Jersey 1941
*Literaty, Miss Nadine M., 2129 Brown Road, Lakewood 7, Ohio 1945
Livergood, Elmer, 271 Harvard Blvd., Steubenville, Ohio 1945
Lloyd C[lark] K., 11 North Elm St., Oxford, Ohio 1925
*Lloyd, Hoyes, 582 Mariposa Ave., Rockcliffe Park, Ottawa, Ontario, Canada 1922
Lockley, R. M., Skokholm Bird Observatory, Dale, Haverfordwest, Pembrokeshire, Wales, Great Britain 1940
Lodge, William R[alph], Route 3, Box 1, Cuyahoga Falls, Ohio 1935
Long, Chester, 39 N. Kealing Ave., Indianapolis 1, Indiana 1943
Longley, William H[oward], 334 S. Albert Ave., St. Paul 5, Minnesota ..1943
Loop, George Andrew, 205 S. Keystone Ave., Sayre, Pennsylvania 1944
Lord, Frederick P[omeroy], 39 College St., Hanover, New Hampshire..1939
Lovell, Harvey B., 3011 Meade Ave., Louisville 4, Kentucky 1936
*Low, Seth Haskell, Box 253, Cherokee, Oklahoma 1931

***Lowery, George H[ines] Jr., Museum of Zoology, Louisiana State University, University, Louisiana 1937
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*Ludwig, Claud C[ecil], 506 Wilson Bldg., Lansing, Michigan 1938
Ludwig, Dr. Frederick Edwin, U.S. Naval Hospital, Portsmouth, Virginia.1941
Lum, Miss Elizabeth C[aroline], Box 355, College Park, Maryland 1940
*Lunk, William Jr., 29 Bell Run Road, Fairmont, West Virginia 1937
Lupient, Miss Mary L[ouise], 212 S. E. Bedford St., Minneapolis, Minnesota 1944
*Luthy, Ferd Jr., 306 N. Institute, Peoria, Illinois 1937
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MacArthur, John Wood Jr., 200 Glencairn Ave., Toronto, Ontario, Canada 1941
MacDonald, Donald L[aurie], 72 Alexandra Blvd., Toronto, Ontario, Canada 1941
MacLean, Miss Dorothy W[illiams], 21 Ashley St., Hartford, Connecticut 1939
*MacLulich, D[uncan] A[lexander], 144 Mavety St., Toronto, Ontario, Canada 1933
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*McAtee, Waldo Lee, Fish and Wildlife Service, Merchandise Mart, Chicago 54, Illinois 1911
McCabe, Robert A[lbert], 424 University Farm Place, Madison, Wisconsin 1942
McCamey, Lt. Benjamin Franklin Jr., 301 E. Yale, Orlando, Florida ..1945
*McClary, Miss Susan C., North Main St., Windsor, Vermont 1945
McClure, H[owe] Elliott, 1609 P Street, Ord, Nebraska 1942
*McCormack, Richard John, 815 W. Breckenridge, Ferndale, Michigan..1945
*McCue, Earl Newlon, Box 104, Morgantown, West Virginia 1941
*McCullagh, E[rnest] Perry, 2020 E. 93rd St., Cleveland, Ohio 1937
McDonald, Malcolm, P.O. Box 42, Ann Arbor, Michigan 1936
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McGeen, Daniel S., 144 Garfield Ave., Waukesha, Wisconsin 1944
McGraw, Harry A[rthur], 1600 5th Ave., Altoona, Pennsylvania 1936
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McIntosh, William B[axter], 414 Oakridge Blvd., Lynchburg, Virginia ..1942
McKeever, Otto Donald, Box 143, Rensselaer, Indiana 1943
McKinley, George G., 104 North Western Parkway, Louisville 12, Kentucky 1945
McKinney, Mrs. Walter A., 244 East 29th St., Tulsa 5, Oklahoma 1945
*McKnight, Edwin T[hor], 5038 Park Place, Friendship Station, Washington, D.C. 1936
*McMath, Robert R., Route 4, Pontiac, Michigan 1934
McMurray, Arthur A., 2110 Fairfax Ave., Nashville 5, Tennessee 1939
McMurry, Frank B[ailey], Box 1032, Yuma, Arizona 1939
McNish, Edgar Mann, Madison, Tennessee 1940
Mace, Miss Verna M[arie], Department of Physiology, Veterinary Bldg., Colorado State College, Fort Collins, Colorado 1943
Mack, H[orace] G[ordon], % Gilson Mfg. Co., Ltd., Guelph, Ontario, Canada 1937
Magath, Thomas Byrd, Mayo Clinic, Rochester, Minnesota 1935
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Magney, Mrs. G. R., Scandia, Minnesota 1940

Malley, Philip P., 114 Glendale Rd., Upper Darby, Pennsylvania 1935
Manners, Edward Robert, 216 New Broadway, Brooklawn, New Jersey..1942
Manville, Richard H[yde], Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1941
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Markle, Jess Matthew, Route 3, Box 336A, Madera, California 1943
Marshall, [Harry] Morton, Route 1, Pamplin, Virginia 1944
Marshall, Raymond O., Route 2, Columbiana, Ohio 1945
*Marshall, Terrell, 372 Skyline Drive, Park Hill, North Little Rock, Arkansas 1944
Marshall, William H[ampton], Division of Entomology and Economic Zoology, University Farm, St. Paul 8, Minnesota 1942
**Martin, John E. H., Ancaster, Ontario, Canada 1944
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Mason, Miss Esther, 2523 Montgomery St., Louisville 12, Kentucky 1941
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Mead, Frank W[aldreth], 227 Brighton Rd., Columbus, Ohio 1941
Meade, Gordon M[ontgomery], Strong Memorial Hospital, 260 Crittenden Blvd., Rochester, New York 1937
Mellinger, E[nos] O[ren], North Lima, Ohio 1939
Meltvedt, Burton W., Paullina, Iowa 1930
Mendall, Howard L[ewis], 28 Pendleton St., South Brewer, Maine 1936
Meng, Heinz Karl, 116 Miller St., Ithaca, New York 1943
Mengel, Robert Morrow, % Arthur D. Allen, Glenview, Kentucky 1937
Meritt, James Kirkland, 99 Battle Rd., Princeton, New Jersey 1944
***Merry, Miss Katherine, General Delivery, Wenatchee, Washington 1944
Meryman, Richard S., Groton School, Groton, Massachusetts 1945
Messner, Clarence John, 308 McKinley, Grosse Pointe 30, Michigan 1944
**Metcalf, H[omer] N[oble], Box 175, Harvey, Illinois 1944
*Metcalf, Zeno P[ayne], State College Station, Raleigh, North Carolina ..1900
*Meyer, Henry, Zoology Department, University of Tennessee, Knoxville, Tennessee 1939
Michaud, Howard H[enry], 824 N. Main St., West Lafayette, Indiana ..1938
*Michener, Harold, 418 North Hudson Ave., Pasadena 4, California 1926
*Miles, Merriam Lee, Box 709, Vicksburg, Mississippi 1941
Miles, Eleanor B. (Mrs. Philip E.), 1900 Arlington Place, Madison 5, Wisconsin 1943
Miller, Alden H[olmes], Museum of Vertebrate Zoology, Berkeley 4, California 1930
Miller, Mrs. Alice, 2200 Belmont, Dearborn, Michigan 1944
Miller, Mrs. Clarence Heath, 1354 Herschel Ave., Cincinnati 8, Ohio 1941
*Miller, Douglas Scott, 122 Lawrence Ave. E., Toronto, Ontario, Canada ..1939
Miller, Loye H[olmes], University of California, 405 Hilgard Ave., Los Angeles 24, California 1939
Miller, Raymond Foster, Baker University, Baldwin City, Kansas 1945
Miller, Richard F[ields], 2627 N. 2nd St., Philadelphia 33, Pennsylvania.1942
Mills, Robert H[enry], 2466 Medary Ave., Columbus 2, Ohio 1941
Milnes, Miss Hattie K[ernahan], 331 Gowen Ave., Mt. Airy, Philadelphia 19, Pennsylvania 1935
*Minich, Edward C., 1047 Fairview Ave., Youngstown 2, Ohio 1923

*Mitchell, Harold Dies, 378 Crescent Ave., Buffalo, New York 1936
Mitchell, Mrs. R. V., Four Winds Farm, Route 1, Canton, Ohio 1943
*Mitchell, Mrs. Osborne, Route 1, Streetsville, Ontario, Canada 1933
**Mitchell, Walton I[ungerich], 398 Vassar Ave., Berkeley 8, California .. 1893
Moeran, E[dward] H[enry], 541 Bronx River Road, Yonkers, New York. 1940
Mohler, Levi L[app], 716 S. 18th St., Lincoln, Nebraska 1942
**Monk, Lt. Harry C[rawford], 406 Avoca St., Nashville 5, Tennessee 1920
*Monroe, Burt L[eavelle], Ridge Rd., Anchorage, Kentucky 1935
*Monson, Gale, 2728 E. Helen St., Tucson, Arizona 1933
*Moore, Miss Dora, 60 E. Mulberry St., Athens, Ohio 1934
Moore, George A[zro], 289 Admiral Rd., Stillwater, Oklahoma 1928
Moore, George M[itchell], Nesmith Hall, University of New Hampshire, Durham, New Hampshire 1942
Moore, Miss Jeanne [Ellen], 718 Onondaga St., Ann Arbor, Michigan ... 1943
Moore, Miss Laura Brooks, French Creek, West Virginia 1941
Moore, Robert Thomas, Route 1, Box 28A, Pasadena, California 1939
Moran, James Vincent, 1 Alfred St., Jamaica Plain, Boston 30, Massachusetts 1943
Morgan, Allen Hungerford, Cochituate Road, Wayland, Massachusetts... 1943
Morrell, Charles K., 119 E. Maxwell St., Lexington, Kentucky 1943
Morrell, Miss Elsie, 1311 White Ave., Knoxville 16, Tennessee 1942
*Morse, Margarette Elthea, 11501 Mayfield Rd., Cleveland 6, Ohio 1921
*Moseley, Edwin Lincoln, University Museum, Bowling Green, Ohio 1925
*Moser, Edward Randolph, Aberdeen, Idaho 1944
**Moser, R[euben] Allyn, R.F.D. 1, Benson Station, Omaha 4, Nebraska.. 1940
Moul, Edwin Theodore, 4 Hill St., York, Pennsylvania 1942
*Mousley, William H[enry], 4073 Tupper St., Westmount, Montreal, Canada 1922
**Mudge, Edmund W. Jr., 4105 Averill Way, Dallas, Texas 1939
Mueller, Walter J[osef], 3043 N. Prospect Ave., Milwaukee, Wisconsin.. 1936
*Muirhead, Miss Peggy, Carleton College, Northfield, Minnesota 1940
Munro, J[ames] A[lexander], Okanagan Landing, British Columbia, Canada 1935
*Munter, Rear Admiral W[illiam] H[enry], 4518 52nd Ave., N.E., Seattle 5, Washington 1933
Murdock, James Ingram, 311 Irving Ave., Glendale 1, California 1940
*Murie, Adolph, Jackson, Wyoming 1932
*Murie, O[laus] J[ohan], Jackson, Wyoming 1934
Murphey, Eugene Edmund, 432 Telfair St., Augusta, Georgia 1935
*Murphy, Paul C[harles], 935 Goodrich Ave., Apt. 10, St. Paul 5, Minnesota 1944
Murray, Rev. J[oseph] J[ames], 6 White St., Lexington, Virginia 1931
Musselman, T[homas] E[dgar], 124 South 24th St., Quincy, Illinois 1940
**Myers, Frank M[arcel], Section C-2, Bhs. 820, L.A.A.F., Laredo, Texas.. 1944
Nash, Lt. Nathaniel C[ushing] IV, 1 Reservoir St., Cambridge, Massachusetts 1941
*Neff, Johnson Andrew, 546 Custom House, Denver, Colorado 1920
*Nelson, Arnold Lars, 3256 Van Hazen St., N.W., Washington, D.C. 1932
Nelson, Charles E[llsworth] Jr., 124 Oxford Rd., Waukesha, Wisconsin.. 1937
Nelson, Edwin L[ewis], 77 Adelaide Ave., New Brunswick, New Jersey.. 1939
Nelson, Mrs. Esther Marie, 515 E. Minnehaha Parkway, Minneapolis 9, Minnesota 1945
***Nelson, Miss Theodora, 315 East 68th St., New York City 21 1928
Nelson, Urban C., Soil Conservation Service, Stillwater, Minnesota 1939
Netting, M[orris] Graham, Carnegie Museum, Pittsburgh 13, Pennsylvania 1941

Nevius, Mrs. Richard, Route 1, Greenville, Tennessee 1940
*Newlin, Lyman W., Deephaven Park, Route 3, Wayzata, Minnesota ..1945
Newman, Barnett, 343 East 19th St., New York City 3..............1942
Newton, Earl T[homas], 5500 College St., Kansas City 4, Missouri 1939
*Nice, L[eonard] B., 5725 Harper Ave., Chicago 37, Illinois 1932
*Nice, Mrs. Margaret Morse, 5725 Harper Ave., Chicago 37, Illinois 1921
*Nichols, Charles K[etcham], 212 Hamilton Road, Ridgewood, New Jersey 1933
Nichols, John Treadwell, American Museum of Natural History, 79th St. and Central Park West, New York City 24 1941
*Nichols, L[eon] Nelson, 331 East 71st St., New York City 1937
Nicholson, Donald J., 1224 Palmer St., Orlando, Florida 1945
Nicholson, Wray H., 2520 Depauw St., Orlando, Florida 1945
*Nickell, Walter Prine, Cranbrook Institute of Science, Bloomfield Hills, Michigan 1943
*Nielsen, Mrs. G. W., Tiffin, Ohio 1945
Nirenberg, Marshall Warren, Route 2, Box 114, Orlando, Florida 1945
Nordquist, Lt. Theodore C., 1423 James Ave., N., Minneapolis 11, Minnesota 1941
Noren, Oscar B., 16241 Inverness, Detroit 21, Michigan 1945
Norris, Robert Allen, 505 W. 8th St., Tifton, Georgia 1941
Norris, Russell T[aplin], Route 7, Butler, Pennsylvania 1939
*Norse, William J[ohn], 531 West 211th St., New York City 34 1939
North, George W[ebster], 249 Charlton Ave., W., Hamilton, Ontario, Canada 1941
*Northrop, Myron, 7932 Delmar, University City 5, Missouri 1945
Norton, Mrs. Margaret E[astman], 2206 Sheffield Dr., Kalamazoo, Michigan 1944
Nyc, Fred[erick] F[rancis] Jr., Box 869, Brownsville, Texas 1943
*Oberholser, Harry Church, Cleveland Museum of Natural History, 2717 Euclid Ave., Cleveland 15, Ohio 1894
*O'Conner, Miss Esther [Laura], 4344 Locust Ave., Kansas City 4, Missouri 1940
*Odum, Eugene P[leasants], Department of Zoology, University of Georgia, Athens, Georgia 1930
Oliver, Miss Mary C[lara], Ganado Mission, Ganado, Arizona 1934
**Olsen, Humphrey A., Pikeville College Library, Pikeville, Kentucky 1941
Olson, Mrs. Gladys E[lizabeth], 17906 Lake Rd., Lakewood 7, Ohio 1942
Ommanney, G. G., % Post Office, Hudson Heights, Quebec, Canada 1944
*O'Reilly, Ralph A. Jr., 11892 Ohio Ave., Detroit 4, Michigan 1936
**Osborn, Hon. Chase S[almon], Sault Ste Marie, Michigan 1943
*Osgood, W[ilfred] H[udson], Chicago Natural History Museum, Chicago 5, Illinois 1910
*Otis, Charles H[erbert], Department of Biology, Bowling Green State University, Bowling Green, Ohio 1937
Ott, Frederick Louis, 2527 North Wahl Ave., Milwaukee 11, Wisconsin..1941
*Overing, Robert, R.F.D. 4, Raleigh, North Carolina 1930
*Owre, Oscar T., 2625 Newton Ave., S., Minneapolis, Minnesota 1935
Packard, W. H., Address unknown 1944
Painton, Dr. Harry R., P.O. Box 1208, Las Vegas, Nevada 1939
*Palmer, Ralph S[imon], Department of Zoology, Vassar College, Poughkeepsie, New York 1934
*Palmer, T[heodore] S[herman], 1939 Biltmore St., N.W., Washington, D.C. 1914
*Palmquist, Clarence O., 7400 N. Odell Ave., Chicago 31, Illinois 1945
*Parker, Dean Roberts, Texas Technological College, Lubbock, Texas 1944

*Parker, Henry M[elville], 122 School St., Concord, New Hampshire 1941
Parlee, Miss Phyllis Gertrude, Route 4, Mt. Airy, Maryland 1945
Partch, Max L[orenzo], 613 W. Prairie St., Columbus, Wisconsin 1940
*Patterson, Lt. Robert, U.S.S. Clarence K. Bronson, % Fleet P.O., San Francisco, California 1943
Pearson, Miss Dorothy, 19 Lincoln St., North Weymouth, Massachusetts.1944
*Peartree, Edward William, 425 S. State St., Oconomowoc, Wisconsin 1941
*Peasley, Mrs. Harold R[aymond], 2001 Nash Drive, Des Moines, Iowa..1934
Peelle, Miles L., 329 Rice St., Adrian, Michigan 1940
***Peet, Dr. Max Minor, 2030 Hill St., Ann Arbor, Michigan 1935
Penner, Lawrence R., Department of Zoology, University of Connecticut, Storrs, Connecticut 1940
*Perner, Miss Margaret E., 3463 Woodridge Rd., Cleveland Heights 21, Ohio 1943
*Peters, Harold S[eymour], 107 River Rd., Ashley Forest, Charleston, South Carolina 1924
*Peterson, Alfred, Box 201, Brandt, South Dakota 1931
Peterson, Mrs. C[harles] E[mil], Madison, Minnesota 1936
*Peterson, Roger Tory, 1206 Mt. Vernon Blvd., Alexandria, Virginia 1942
Peterson, Stella Freeman (Mrs. Theodore), 80 Oaklawn Ave., Battle Creek, Michigan 1941
Petrides, George A., 112 Forest Ave., Rockville, Maryland 1942
***Pettingill, Olin Sewall Jr., Carleton College, Northfield, Minnesota 1930
**Phelps, William H[enry], Apartado 2009, Caracas, Venezuela 1940
**Philipp, Frederick B[ernard], 99 John St., New York City 1940
*Phillips, Allan Robert, 113 Olive Rd., Tucson, Arizona 1934
*Phillips, Cyrus Eastman, 255 Polk St., Warsaw, Illinois 1944
Phillips, Richard Stuart, 834 Liberty St., Findlay, Ohio 1944
*Pickwell, Gayle B[enjamin], State Teachers' College, San Jose, California.1923
Pieczur, Walter Henry, 1143 Rogers Ave., Brooklyn 26, New York 1945
Pierce, Robert Allen, Nashua, Iowa 1941
*Pirnie, Miles David, W. K. Kellogg Bird Sanctuary, Augusta, Michigan..1928
Pitelka, Frank Alois, Museum of Vertebrate Zoology, University of California, Berkeley 4, California 1938
Pittman, James Allen, 436 S. Osceola, Orlando, Florida 1945
Plath, Karl, 2847 Giddings St., Chicago, Illinois 1942
**Poole, Cecil A[very], 830 Chapman St., San Jose 11, California 1942
*Poor, Hustace Hubbard, 112 Park Ave., Yonkers 3, New York 1935
*Porter, Thomas Wayne, Ohio City, Ohio 1938
*Potter, Julian K[ent], 437 Park Ave., Collingswood, New Jersey 1915
Potter, Louis Henry, R.F.D. 2, West Rutland, Vermont 1941
Potter, Nathan S. III, 2002 Geddes Ave., Ann Arbor, Michigan 1945
*Pough, Richard H[ooper], 33 Highbrook Ave., Pelham 65, New York ...1938
*Powell, Roger Warren, Lincoln Auto Court, Cheyenne, Wyoming 1944
Prather, Millard F[illmore], 1129 Brown-Marz Building, Birmingham 3, Alabama 1940
Pratt, Eva Eldridge (Mrs. Charles H.), Ossipee, New Hampshire 1945
*Preble, Edward Alexander, 3027 Newark St., Washington, D.C. 1929
*Preble, Norman A[lexander], Department of Biology, Bowling Green State University, Bowling Green, Ohio 1941
*Presnall, Mrs. Clifford C[harles], Lake Zurich, Illinois 1930
Price, Homer F., Payne, Ohio 1944
*Prill, Dr. Albert G., Main St., Scio, Oregon 1921
**Procter, William, Bar Harbor, Maine 1937
Prucha, Miss Alma H., 3052 N. Maryland Ave., Milwaukee 11, Wisconsin.1942
*Pueschel, Paul, 520 Drexel Ave., Glencoe, Illinois 1939

Putman, William Lloyd, Dominion Entomological Laboratory, Vineland Station, Ontario, Canada 1945
Putnam, Loren Smith, Department of Zoology, Ohio State University, Columbus, Ohio 1942
*Pyle, George W[inner], S. Valley Rd., Box 604, Paoli, Pennsylvania 1939
Quam, Mrs. Mary Battell, 141 Joralemon St., Brooklyn 2, New York 1944
Quay, Thomas L[avelle], Route 2, Box 34, Van Buren, Arkansas 1939
Quimby, Don C., 4742 Garfield Ave., S., Minneapolis, Minnesota 1942
Ragusin, Capt. Anthony V[incent], Box 225, Pascagoula, Mississippi 1937
Rahe, Carl W., 4666 Turney Road, Cleveland 5, Ohio 1931
Ramsden, Charles Theodore, 8 & 19 Vista Alegre, Santiago, Cuba 1914
Randall, Robert Neal, Georgetown, Colorado 1939
Rapp, William F[rederick] Jr., 203 East Green St., Champaign, Illinois ..1941
*Rebmann, G. Ruhland, Jr., 729 Milbrook Lane, Haverford, Pennsylvania.1941
*Reeder, Miss Clara Maude, 1608 College Ave., Houghton, Michigan 1938
*Reese, Mrs. Hans H., 3421 Circle Close, Shorewood Hills, Madison 5, Wisconsin 1941
Reid, Vincent Howard, 1022 S. 29th St., Omaha, Nebraska 1945
Remington, Charles Lee, 5570 Etzel Ave., St. Louis, Missouri 1944
Rett, Egmont Z[achary], Museum of Natural History, Santa Barbara, California 1940
Rice, Mrs. Harry Wilson, 3940 Richfield Rd., Minneapolis, Minnesota ..1940
Richdale, Lancelot Eric, 23 Skibo St., Kew, Dunedin S.W. 1, New Zealand 1945
**Richman, William, Woodstown, New Jersey 1945
*Ricker, W[illiam] E[dwin], Department of Zoology, Indiana University, Bloomington, Indiana 1943
Riggs, Carl D[aniel], 5312 N. New Jersey St., Indianapolis, Indiana 1943
*Rinehart, Edwin P[aul], 1013 Wyandotte Bldg., Columbus, Ohio 1944
Riner, Miss Alice, 115 S. Estelle, Wichita 7, Kansas 1939
Ring, Mrs. Lonnie Joe, Box 963, Alamo, Texas 1945
Ritchie, R. C., 60 Chatsworth Drive, Toronto, Ontario, Canada 1942
Ritter, Rhys T[heophilus], R.D. 4, Bethlehem, Wheeling, West Virginia..1944
*Roads, Miss Myra Katie, 463 Vine St., Hillsboro, Ohio 1914
Robbins, Chandler S[eymour], Patuxent Research Refuge, Bowie, Maryland 1941
Roberts, Homer D[onald], 1011 Hazel St., Birmingham, Michigan 1943
**Roberts, Thomas S[adler], Museum of Natural History, University of Minnesota, Minneapolis, Minnesota 1914
***Rogers, Charles Henry, East Guyot Hall, Princeton, New Jersey 1903
Rogers, Capt. Gerald Talbot, Junior Pilot, Africa-Orient Division, Pan American Airways, Miami, Florida 1945
*Rogers, Irl, 402 Alturas Ave., Modesto, California 1937
*Rogers, Mrs. Walter E., P.O. Box 385, Appleton, Wisconsin 1931
*Rollo, Mrs. W. E., Otis Road, Barrington, Illinois 1942
*Rompf, Mrs. Frank W., Box 925, Alamo, Texas 1945
***Root, Oscar M[itchell], Brooks School, North Andover, Massachusetts ..1940
Rorimer, Irene T. (Mrs. J. M.), % Empire Plow Co., 3140 East 65 St., Cleveland 4, Ohio 1938
Rosene, Walter Jr., 1212 Jupiter, Gadsden, Alabama 1942
*Rosewall, O[scar] W[aldemar], Department of Zoology, Louisiana State University, University, Louisiana 1931
Ross, C[harles] Chandler, 7924 Lincoln Dr., Chestnut Hill, Philadelphia, Pennsylvania 1937
Ross, Hollis T., 29 South 2nd St., Lewisburg, Pennsylvania 1945

*Rudd, Dr. Clayton G[lass], 315 Medical Arts Bldg., Minneapolis, Minnesota 1944
Ruderman, Miss Claire, Department of Biology, University of Rochester, Rochester, New York 1944
Ruecker, Miss Emilie, Seapowet Ave., Tiverton, Rhode Island 1943
*Rysgaard, George Nielson, Museum of Natural History, University of Minnesota, Minneapolis, Minnesota 1937
*Sage, Evan V., Route 3, Waterloo, Iowa 1944
Sandve, J[oseph] Reuben, 883 23rd Ave., S.E., Minneapolis, Minnesota ..1943
*Satterthwait, Mrs. Elizabeth Allen, 806 W. Ohio St., Urbana, Illinois 1925
Saugstad, N[els] Stanley, Route 4, Minot, North Dakota 1939
*Saunders, Aretas A[ndrews], 361 Crestwood Rd., Fairfield, Connecticut.1934
*Saunders, George B[radford], Fish and Wildlife Service, 1623 N.W. Washington St., Brownsville, Texas 1926
*Savage, James, Buffalo Athletic Club, Buffalo, New York 1939
Sawyer, Miss Dorothy, R.F.D. 1, Unadilla, New York 1937
Schantz-Hansen, Donald [Ernst], Forestry Station, Cloquet, Minnesota..1944
Schaub, Mary Hall (Mrs. J. B.), 1040 Isabella St., Wilmette, Illinois ..1939
Schierbaum, Miss Ethel, Route 1, Edwardsville, Illinois 1945
Schmidt, Lt. John R., Sqdn. S., Br. 4, L.A.A.F., Lincoln, Nebraska 1945
*Schneider, Miss Evelyn J., University of Louisville, Belknap Campus, Louisville, Kentucky 1935
*Schorger, A[rlie] W[illiam], 168 N. Prospect Ave., Madison, Wisconsin ..1927
**Schramm, Wilson Cresap, 321 Kensington Rd., Syracuse, New York 1944
Schreck, J. D., 289th Repl. Co., 3rd Plat., A.P.O. 781 R, % P.M., New York City 1945
*Schuette, Chal H., Detachment of Patients, England General Hospital, Atlantic City, New Jersey 1942
Schumm, William George, 302 C. St., LaPorte, Indiana 1944
*Schwall, Eugene E[dward], New Concord, Ohio 1943
*Schwartz, Charles Walsh, Route 6, Columbia, Missouri 1943
Scotland, Minnie B[rink], 42 Continental Ave., Cohoes, New York 1938
*Scott, John William, 1409 Garfield St., Laramie, Wyoming 1937
Scott, Thomas G[eorge], Zoology Department, Science Bldg., Ames, Iowa.1936
Scott, W[alter] E[dwin], Mendota Beach Heights, Madison 5, Wisconsin.1938
Seaberg, John A[rthur], Veterans Administration, Minneapolis 6, Minnesota 1944
Seeber, E[dward] L[incoln], 186 Wabash Ave., Kenmore 17, New York.1944
Seeley, George Mervil, 461 High St., Long Branch, New Jersey 1945
Seibert, Henri C., 2102 E. 98th St., Chicago 17, Illinois 1941
*Sener, Miss Ruth, 233 Charlotte St., Lancaster, Pennsylvania 1943
Serbousek, Miss Lillian, 1226 Second St., S.W., Cedar Rapids, Iowa 1935
*Shaffer, Chester M[onroe], 809 S. 4th St., Chickasha, Oklahoma 1934
Shaftesbury, Archie D., Women's College, University of North Carolina, Greensboro, North Carolina 1930
Sharp, Ward M., Red Rock Lakes Refuge, Monida, Montana 1936
Shaughnessy, Mrs. Martin, One Washington Terrace, St. Louis, Missouri..1944
Shaver, Jesse M[ilton], George Peabody Teachers College, Nashville, Tennessee 1922
Shaw, Dr. Charles H[icks], Bremen, Ohio 1941
Shaw, Mrs. Elizabeth Martin, 2312 Stuart Ave., Richmond 20, Virginia..1943
**Shearer, A[mon] R[obert], Mont Belvieu, Chambers Co., Texas 1893
*Shelar, Keller, State Teachers College, Slippery Rock, Pennsylvania 1940
*Shelford, Victor E[rnest], Vivarium Bldg., University of Illinois, Champaign, Illinois 1931

Sheppard, Roy Watson, 1805 Mouland Ave., Niagara Falls, Ontario, Canada 1933
Sherwood, John Willitts, 34 Hebbron St., Salinas, California 1936
Shields, Louise (Mrs. Alston B.), 511 B Nancy St., Charleston, West Virginia 1945
Short, Wayne, 1006 Fifth Ave., New York 28, New York 1941
Shortt, Terence Michael, Royal Ontario Museum of Zoology, Queen's Park at Bloor St., Toronto, Ontario, Canada 1941
Shubeck, Paul P[eter], 440 Bond Street, Elizabeth 1, New Jersey 1943
*Shultis, Newton, South Newberry, New Hampshire 1945
Sibley, Charles G., 1438 Hawthorne Terrace, Berkeley, California 1942
Sibley, Norman Othello, Route 2, Whittemore, Michigan 1945
Simmons, Mrs. Amelia C., 2007 N. Holton St., Milwaukee 12, Wisconsin.1943
***Simmons, Edward McIlhenny, Avery Island, Louisiana 1942
*Simon, Miss Tina, Wave Barracks 402, Naval Air Station, Patuxent River, Maryland 1945
Sims, Harold L[ee], 714 St. Philip St., Thibodaux, Louisiana 1942
Skaggs, Merit Bryan, 2066 Alton Road, East Cleveland 12, Ohio 1934
Skutch, Alexander F., San Isidro del General, Costa Rica 1944
Slack, Miss Mabel, 1004 Everett Ave., Louisville, Kentucky 1934
*Smith, A[rthur] F[rancis], Manning, Iowa 1934
*Smith, Bertram H., 512 Harries Bldg., Dayton, Ohio 1944
*Smith, Frank R[ush], Route 2, Box 100, Laurel, Maryland 1910
Smith, George A., Quarryville High School, Quarryville, Pennsylvania 1945
*Smith, Harry M[adison], 2007 Calumet Ave., Whiting, Indiana 1936
Smith, J. Donald, 1359 Sargent Ave., St. Paul 5, Minnesota 1939
*Smith, Lewis McCuen, 8040 St. Martins Lane, Chestnut Hill Station, Philadelphia, Pennsylvania 1931
Smith, Luther E[ly], 1554 Telephone Bldg., 1110 Pine St., St. Louis, Missouri 1941
*Smith, Oliver L[edlie], 15 York Ave., Towanda, Pennsylvania 1944
Smith, Orion O., 1539 Crosby St., Rockford, Illinois 1936
Smith, Robert Leo, Route 1, Reynoldsville, Pennsylvania 1945
*Smith, Roy Harmon, 183 N. Prospect St., Kent, Ohio 1936
Smith, Thomas [Price], Osage Ave., Anchorage, Kentucky 1941
Smith, Wendell Phillips, Wells River, Vermont 1921
Snapp, Mrs. R. R., 310 W. Michigan, Urbana, Illinois 1940
Snyder, L[ester] L[ynne], Royal Ontario Museum of Zoology, Queen's Park at Bloor, Toronto 5, Ontario, Canada 1929
Snyder, Richard Craine, 431 Clark St., South Orange, New Jersey 1940
Sooter, Clarence Andrew, 402 Hester St., Stillwater, Oklahoma 1940
Soper, J[oseph] Dewey, 827 Riverwood Ave., Fort Garry, Winnipeg, Manitoba, Canada 1937
Spangler, Miss Iva M., 128 E. Foster Parkway, Fort Wayne, Indiana 1939
Spawn, Gerald B., 1101 2nd St., Brookings, South Dakota 1941
*Speirs, Mrs. Doris Huestis, 17 Wolfrey Ave., Toronto, Ontario, Canada..1936
Speirs, J[ohn] Murray, 17 Wolfrey Ave., Toronto, Ontario, Canada 1931
*Spencer, Miss O[live] Ruth, 1030-25 Avenue Court, Moline, Illinois 1938
Sperry, Charles Carlisle, 1455 S. Franklin St., Denver 10, Colorado 1931
Spofford, Walter R. II, Vanderbilt University Medical School, Nashville, Tennessee 1942
Stabler, Robert M[iller], Glen Mills, Pennsylvania 1939
Staebler, Lt. Arthur E[ugene], U.S. Public Health Service, Miami Beach 39, Florida 1937
**Stahl, Miss Majoretta Jean, Kimberly, West Virginia 1942
Stanford, Jack A[rchibald], 553 S. First St., Ann Arbor, Michigan 1941
Stark, Miss Wilma R[uth], 1701 16th, N.W., Washington, D.C. 1939

Starrett, William C[harles], % W. C. Starrett, 105 Glen Oak Court, Peoria, Illinois 1933
Stearns, Edwin I. Jr., 92 Farragut Rd., Plainfield, New Jersey 1945
*Stebbins, Miss Fannie A[dell], 31 Ely Ave., West Springfield, Massachusetts 1935
*Steffen, Earnest William, 1000 Maplewood Drive, Cedar Rapids, Iowa ..1944
Steggerda, Morris, Kennedy School of Missions, Hartford 5, Connecticut.1941
Stegle, Joseph James, 220 Pondfield Rd., W., Bronxville, New York 1944
Stephens, T[homas] C[alderwood], Morningside College, Sioux City, Iowa 1911
*Stevens, O. A., State College Station, Fargo, North Dakota 1926
Stevenson, Henry M[illis] Jr., Emory and Henry College, Emory, Virginia 1943
Stevenson, Lt. H[orace] Godwin Jr., Address unknown 1939
Stevenson, James O[sborne], 118 N. Birmingham Place, Tulsa 4, Oklahoma 1943
*Stewart, Paul A[lva], Leetonia, Ohio 1925
Stewart, Robert Earl, Patuxent Research Refuge, Bowie, Maryland 1939
*Stickney, Mrs. Albert Jr., % H. E. Herrick, Woodmere, Long Island, New York 1935
*Stillwell, Jerry E., 8160 San Benito Way, Dallas 18, Texas 1935
**Stine, Miss Perna M., Route 4, Sumner, Illinois 1931
***Stoddard, Herbert Lee, Sherwood Plantation, Route 5, Thomasville, Georgia 1916
Stokes, Allen W., 629 Church Lane, Philadelphia 44, Pennsylvania 1945
Stone, Harry H[erbert] Jr., Box 101, Sturbridge, Massachusetts 1941
Stoner, Mrs. Dayton, New York State Museum, Albany, New York 1945
Stophlet, John J[ermain], 2612 Maplewood Ave., Toledo, Ohio 1934
Storer, Robert Winthrop, Museum of Vertebrate Zoology, Berkeley, California 1938
Storer, Tracy I[rwin], Division of Zoology, University of California, Davis, California 1928
Stratton, Miss Nellie Mary, 209 Cutler St., Allegan, Michigan 1945
Street, Thomas M., Bottineau, North Dakota 1940
***Strehlow, Elmer William, 721 W. Mason St., Green Bay, Wisconsin 1941
Stringham, Emerson, Box 1085, Prescott, Arizona 1940
Stromgren, Carl, General Delivery, Iowa City, Iowa 1944
****Strong, R[euben] M[yron], 5840 Stony Island Ave., Chicago, Illinois.Founder
Struck, Kuno H[erbert], 1003 First National Bank Bldg., Davenport, Iowa 1942
Strunk, William Franklin, 700 Madison Ave., Morgantown, West Virginia.1944
Stupka, Arthur, Great Smoky Mountains National Park, Gatlinburg, Tennessee 1935
***Sturgeon, Myron T., Michigan State Normal College, Ypsilanti, Michigan.1934
Sturgis, S[ullivan] Warren, 66 Marlboro St., Boston, Massachusetts ...1941
*Sturm, [William] Louis, Sheffield Road, Glendale, Ohio 1943
*Suthard, James G[regory], 1881 Raymond Ave., Longbeach 6, California.1936
***Sutton, George Miksch, Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1920
*Swanson, Gustav [Adolph], 5245 N. Sawyer, Chicago 25, Illinois 1927
*Swedenborg, Ernie D[avid], 4905 Vincent Ave. S., Minneapolis 10, Minnesota 1929
Swoger, Arthur [Glenn], 1655 Shady Ave., Pittsburgh 17, Pennsylvania..1943
*Taber, Wendell, 3 Mercer Circle, Cambridge, Massachusetts 1936
Tabor, Miss Ava Rogers, 305 Canal Blvd., Thibodaux, Louisiana 1940

*Taintor, Mrs. Elizabeth Taber, 11 Story Street, Cambridge, Massachusetts 1945
Tallman, Wm. S[weet] Jr., 4 Linden Place, Sewickley, Pennsylvania ...1940
*Tanger, Mrs. C. Y., 318 N. President Ave., Lancaster, Pennsylvania 1943
Tanghe, Leo J[oseph], 120 Barnard St., Rochester, New York 1943
Tanner, James Taylor, 16½ No. Church St., Cortland, New York 1937
Tatum, Miss Bernice, 1105 Lowell, Kansas City 2, Kansas 1943
*Taverner, P[ercy] A[lgernon], 45 Leonard Ave., Ottawa, Ontario, Canada 1905
*Taylor, Aravilla M[eek], Lake Erie College, Painesville, Ohio 1936
***Taylor, Arthur Chandler, Irving Zuelke Bldg., Appleton, Wisconsin 1929
***Taylor, Mrs. H. J., 900 Santa Barbara Road, Berkeley, California 1916
Taylor, Miss Joanne, 1176 Shattuck, Berkeley, California 1941
*Taylor, Walter P[enn], 254 Faculty Exchange, College Station, Texas ..1937
Taylor, William Ralph, Museum of Vertebrate Paleontology, University of Kansas, Lawrence, Kansas 1940
*Teachenor, Dix, 1020 West 61st St., Kansas City, Missouri 1923
*Templeman, Wilfred, Government Laboratory, Water St., East, St. John's, Newfoundland 1943
Thacher, S. Charles, 2918 Brownsboro Road, Louisville 6, Kentucky ..1942
*Thomas, Edward S[inclair], 319 Acton Rd., Columbus, Ohio 1921
*Thomas, Mrs. Rowland, R.F.D. 3, North Little Rock, Arkansas 1937
Thompson, Daniel Q., USS Joseph T. Dickman, APA 13, % F.P.O., San Francisco, California 1945
Thomsen, Mrs. H. P., % Louis Larsen, Route 3, Box 406, Beloit, Wisconsin 1945
*Thornton, William James, Box 1011, Birmingham, Alabama 1940
***Thorp, George B[oulton], Carnegie Museum, Pittsburgh 13, Pennsylvania 1935
Thorpe, James David, 9 Elmdale Ave., Akron, Ohio 1945
*Tift, Richard, The Oaks, Newton, Route 1, Albany, Georgia 1937
*Tilley, Francis Thomas, 26 Mohican Ave., Buffalo 8, New York 1944
*Tinker, A[lmerin] D[avid], R.F.D. 1, Chelsea, Michigan 1909
*Tipton, Dr. Samuel R[idley], 828 South 20th St., Birmingham 5, Alabama 1941
Todd, Mrs. Elizabeth D., 918 West Main St., Kalamazoo, Michigan 1939
Todd, George K[endall], USS LST 663, % Fleet Post Office, San Francisco, California 1943
Todd, Henry O[liver] Jr., Woodberry Road, Murfreesboro, Tennessee ...1938
Todd, Mabel Sellars (Mrs. A. P.), 1622 Kensington St., Houston 6, Texas 1940
**Todd, W[alter] E[dmond] Clyde, Carnegie Museum, Pittsburgh 13, Pennsylvania 1911
*Tomkins, Ivan Rexford, 1231 E. 50th St., Savannah, Georgia 1931
*Towle, Miss Helen Jessie, 5148 29 Ave. S., Minneapolis 6, Minnesota 1944
**Townsend, Miss Elsie White, Wayne University, Detroit 1, Mich. 1938
***Trautman, Milton B[ernhard], Stone Laboratory, Put-in-Bay, Ohio 1932
Trimm, Wayne, 165 Strong Ave., Syracuse, New York 1943
Tryon, C[larence] A[rcher] Jr., Zoology Department, Montana State College, Bozeman, Montana 1942
*Tubbs, Farley F., Game Division, Department of Conservation, Lansing 13, Michigan 1935
***Tucker, Mrs. Carll, Penwood, Mount Kisco, New York 1928
Tucker, Edward Robert, 245 N. Auburndale, Memphis, Tennessee 1942
*Turner, Miss Ruth D[ixon], Museum of Comparative Zoology, Cambridge 38, Massachusetts 1939
Tuttle, George Mott Jr., 4016 Cliff St., Niagara Falls, New York 1941

Tvedt, Lt. Harold B[loom], 4206 71st Ave., Landover Hills, Hyattsville, Maryland 1941
*Twomey, Arthur C[ornelius], Carnegie Museum, Pittsburgh 13. Pennsylvania 1936
*Tyler, Dr. Winsor M[arrett], 1482 Commonwealth Ave., Brighton 35, Massachusetts 1914
*Uhler, Francis Morey, Patuxent Research Refuge, Bowie, Maryland 1931
**Uhrig, Mrs. A. B., Box 28, Oconomowoc, Wisconsin 1926
Umbach, Miss Margaret, 2526 East Drive, Fort Wayne 3, Indiana 1941
*Upton, Clyde B., 120 Center Ave., Elm Grove, West Virginia 1945
*Vaiden, M[eredith] G[ordon], Rosedale, Mississippi 1937
Van Camp, Laurel F[rederick], Genoa, Ohio 1943
Van Coevering, Jack, 9816 Ingram, Rosedale Gardens, Plymouth, Michigan 1939
Vandervoort, Millard, 909 Security Bank Bldg., Battle Creek, Michigan..1945
Vandervort, Charles C[hampion], Laceyville, Pennsylvania 1937
Van Laar, Henry, U.S. Naval Hospital Staff, Great Lakes, Illinois 1944
*van Rossem, A[driaan] J[oseph], 2205 West Adams St., Los Angeles 7, California 1939
Van Strum, Miss Caroline, 3122 15th Ave., S., Minneapolis 7, Minnesota.1944
**Van Tyne, Mrs. Claude H., 1003 Spruce St., Boulder, Colorado 1939
***Van Tyne, Josselyn, Museum of Zoology, University of Michigan, Ann Arbor, Michigan 1922
*Vaughan, William C[oleman], 591 Ashland Ave., Buffalo, New York 1938
Vickers, Ernest Waters, Old Mill Museum, Youngstown, Ohio 1944
*Visscher, Paul, Biology Laboratory, Western Reserve University, Cleveland, Ohio 1924
*Voak, Mrs. Floyd S., 909 S. Custer Ave., Miles City, Montana 1945
*Vogt, William, % Mrs. F. V. Brown, 32 Cunningham Ave., Floral Park, New York 1935
*Vollmar, Mrs. Joseph E., 6138 Simpson Ave., St. Louis, Missouri 1941
*Wade, Douglas E., Natural History Bldg., Dartmouth College, Hanover, New Hampshire 1936
*Waggoner, John Sheaffer, 239 Storer Ave., Akron, Ohio 1945
Wagner, Esther E., 13 Locust Ave., Danbury, Connecticut 1937
Wagner, Helmuth O., Apartado 7901, Sucursal 3, Mexico, D. F., Mexico..1945
Wagner, Julia E. (Mrs. H. J.), 818 E. Boulder St., Colorado Springs, Colorado 1945
**Walcott, Hon. Frederick C., Investment Bldg., Washington, D.C. 1945
*Walker, Charles F[rederic], Stone Laboratory, Put-in-Bay, Ohio 1939
Walker, M[yrl] V[incent], Yosemite National Park, California 1943
*Walker, William M. Jr., 107 N. Park Circle, Nashville 5, Tennessee 1945
***Walkinshaw, Lawrence Harvey, 1703 Central Tower, Battle Creek, Michigan 1928
*Wallace, Miss Edith Adell, 421 West 8th Ave., Gary, Indiana 1945
Wallace, George J[ohn], Zoology Department, Michigan State College, East Lansing, Michigan 1937
Wallner, Dr. Alfred, 807 Juniper St., Washington 12, D.C. 1941
Walters, Miss Kathleen, 312 Crane, Royal Oak, Michigan 1944
Wampole, John Henry, Broken Bow, Nebraska 1944
Wandell, Willet N[orbert], Natural History Survey, Urbana, Illinois ..1944
Wangnild, Miss Lillian M[arie], 2818 Gaylord St., Denver 5, Colorado ..1943
Wanless, Harold R[ollin], 704 S. McCullough St., Urbana, Illinois 1940
*Watson, Clarence W., Box 833, Atlanta, Georgia 1943
Watson, Frank Graham, 5423 Leopold St., Houston 4, Texas 1937
Watson, James Dewey Jr., 7922 Luella Ave., Chicago, Illinois 1945

Watson, Robert J[ames], Box 75, Blacksburg, Virginia 1943
*Weaver, Richard L[ee], Audubon Nature Center, R.F.D. 4, Greenwich, Connecticut 1936
Weber, Edmund P[eter], 95 Ingram Ave., Pgh. 5, Ingram, Pennsylvania..1942
*Weber, Orlando F[ranklin] Jr., 910 Fifth Ave., New York City 21 1936
Webster, Lt. J[ackson] Dan, % J. L. Webster, 1803 Franklin St., San Francisco 9, California 1939
Webster, Victor S[tuart], College Station, Brookings, South Dakota 1944
Welch, Mrs. Lola Harriet, 610 Bowen St., Savanna, Illinois 1943
Welles, Mary Pyke (Mrs. George M.), Camden, Delaware 1938
**Wernicke, Maleta M. (Mrs. J. F.), Gull Point, Escambia Co., Florida ...1944
Weston, Robert, Salmon Pool Farm, Brewer, Maine 1944
*Wetmore, Alexander, U.S. National Museum, Washington 25, D.C. 1903
*Weydemeyer, Winton, Fortine, Montana 1930
*Weyl, Edward Stern, 6909 Henley St., Philadelphia 19, Pennsylvania 1927
**Wheatland, Miss Sarah B[igelow], 313-15 Raywood House, Vassar College, Poughkeepsie, New York 1942
White, Claude, 940 West 6th St., P.O. Box 1001, Plainfield, New Jersey..1944
White, Courtland Y., Box 31, Bennett Hall, University of Pennsylvania, Philadelphia, Pennsylvania 1942
*White, Francis Beach, Silk Farm Road, Route 2, Concord, New Hampshire 1926
*White, Miss Katherine A[ugusta], Route 2, Collinsville, Illinois 1940
White, Miss Marcia R., 5626 Dorchester Ave., Chicago 37, Illinois 1944
*Whitney, Nathaniel Ruggles Jr., 975 Willow Ave., Glendale, Ohio 1942
*Whittier, Mrs. Lida, 2830 E. 130th St., Cleveland 20, Ohio 1943
Widdicombe, Harry T., 439 Fulton St., S.E., Grand Rapids 3, Michigan ..1943
Widmann, Berthold, 4621 Wesley Ave., Los Angeles 37, California 1936
*Wiggin, Henry T[aylor], 151 Tappan St., Brookline, Massachusetts 1941
Wilcox, Harry Hammond Jr., 1236 Isabella St., Williamsport 33, Pennsylvania 1938
Wilcox, LeRoy, Speonk, Long Island, New York 1944
Wiles, Harold O[liver], 26 Boxwood Ave., Wilmington 177, Delaware ..1936
Wilkowski, William [Walter], 119 Bronson Court, Kalamazoo 12, Michigan 1943
Williams, George G., The Rice Institute, Houston, Texas 1945
*Williams, Laidlaw O[nderdonk], Route 1, Box 138, Carmel, California..1930
*Wilson, Archie F[rancis], 1322 Braeburn Rd., Flossmoor, Illinois 1937
*Wilson, Gordon, 1434 Chestnut St., Bowling Green, Kentucky 1920
Wilson, Harold Charles, Ephraim, Wisconsin 1938
Wilson, Myrtha M. (Mrs. Henry E.), Route 3, Box 118, Raleigh, North Carolina 1942
Wilson, Lt. Comdr. Rowland S[teele], % Otto Heaton, Apt. 1854, Deshler-Wallick Hotel, Columbus, Ohio 1941
Wilson, Ruth (Mrs. Carl), 11285 Lakepointe, Detroit 24, Michigan 1941
Wiltshire, Mrs. Grace T., Randolph-Macon Woman's College, Lynchburg, Virginia 1941
***Wineman, Andrew, 150 Michigan Ave., Detroit, Michigan 1934
***Wing, Harold F[rancis], Route 3, Jackson, Michigan 1941
*Wing, Leonard [William], Washington State College, Pullman, Washington 1924
Winterbottom, J[ohn] M[iall], African Education Office, P.O. Box 150, Livingstone, Northern Rhodesia 1939
Wistey, Mrs. A. L., South English, Iowa 1944

Wolfson, Albert, Department of Zoology, Northwestern University, Evanston, Illinois 1944
*Wood, Dr. Harold B[acon], 3016 N. Second St., Harrisburg, Pennsylvania.1932
*Wood, Merril, 811 N. Allen St., State College, Pennsylvania 1945
Woodard, Frederick A., 54 Emmett St., Battle Creek, Michigan 1945
Woodward, Arthur J[ason], 504 Kahkwa Blvd., Erie, Pennsylvania 1937
**Woodward, Miss Barbara, 24 West Main St., Le Roy, New York 1943
*Worley, John G[raves], 237 Charleston St., Cadiz, Ohio 1936
Wright, Miss Audrey Adele, 1312 Hepburn, Louisville, Kentucky 1941
Wright, Lt. Col. Dana [Monroe], State Game Farm, St. John, North Dakota 1943
Wright, Ernest B[icknell], 140 West Chestnut Ave., Chestnut Hill, Philadelphia, Pennsylvania 1941
*Wright, J[ohn] T[homas], Route 5, Box 618, Tucson, Arizona 1941
Wright, Philip L[incoln], Montana State University, Missoula, Montana.1940
Wright, Thomas Jr., 19 Mechanic St., Wakefield, Rhode Island 1939
*Yeager, Lee E[mmett], Fish and Wildlife Service, Merchandise Mart, Chicago 54, Illinois 1939
*Yeatter, R[alph] E[merson], Illinois Natural History Survey, Urbana, Illinois 1932
Young, J. Addison II, 93 Argyle Ave., New Rochelle, New York 1942
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Zempel, Capt. Arnold, 6623 Kingsbury Ave., University City 5, Missouri..1941
*Zimmerman, Dale, 480 North Almont St., Imlay City, Michigan 1943
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