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EVIDENCE OF TRANS-GULF MIGRATION

BY GEORGE H. LOWERY, JR.

PREFATORY NOTE.—It was my privilege to review in manuscript the present paper by Mr. Lowery which, with his paper in the *Wilson Bulletin* for June, 1945, I commend to all students of bird migration.

The phenomenon that we know as the migration of birds is a highly complex subject involving much more than the recording of the dates of arrival and departure of the winged travelers. Although much remains to be learned, there are certain ideas about migration that, on the basis of available information, have been accepted as facts for many years. Among these is the concept of trans-Gulf migration. Admittedly, data have not been extensive, but logical deductions from their study have fully justified this interpretation. Possibly acceptance has been due in part to the fact that on a world-wide basis, over-water travel by birds of equal or greater distances is not unusual. Because of this, many students of the migration of North American birds have been startled by the recent challenge to what they have rightly considered an accepted feature of the movement as applied to the Western Hemisphere.

Accepting the challenge, Mr. Lowery has not only obtained important new material in support of the original concept, but by an inspired analytical discussion of all features, particularly the climatological situation, has firmly re-established the belief that many, perhaps most, of the North American migrants that spend the winter season in South and Central America reach their destinations in spring and fall by direct flight across the Gulf of Mexico.—FREDERICK C. LINCOLN, *Biologist in Charge, Distribution and Migration of Birds, U. S. Fish and Wildlife Service.*

FOR many years all ornithologists agreed that vast numbers and many kinds of land birds migrate straight across the Gulf of Mexico each spring and fall. Recently, the existence of this trans-Gulf flyway was denied on theoretical grounds (Williams, 1945). Consequently,

further direct field investigation of the subject became desirable. The present paper is concerned chiefly with the preliminary results of such a study. It will adduce definite records in number proving that the presence of land birds over the Gulf is commonplace. It will show how these observations, supported by direct evidence of another sort, demonstrate a trans-Gulf flyway of major proportions. And, finally, it will point out fallacies in the arguments against trans-Gulf migration.

But first, in order that the issues may be clearly understood, we must briefly review the development of ideas concerning Gulf migration in general.

1. CONCEPTS OF GULF MIGRATION

The long-accepted opinion has been that the many species of North American birds wintering south of the United States migrate between their summer and winter homes along several routes. Wells W. Cooke, as early as 1904 and 1905, recognized that small land birds leave, and return to, the United States by four avenues of flight associated with the present problem: (1) Florida to Cuba; (2) Western Florida to Yucatán; (3) northern coast of the Gulf of Mexico southward; and (4) Texas to México by land. He felt certain that the overwhelming majority of birds use the second and third routes, which are trans-Gulf in character. In a summary of 66 species (1905: 9), he classed 49 as predominantly trans-Gulf migrants. On the other hand, he believed that 30 species of warblers alone were at least represented on the other two routes. Thus, he viewed migration across the Gulf and migration along its eastern and western edges not as conflicting concepts but as complementary parts of a broad semi-annual movement. The idea of migration around the Gulf is as old as the idea of trans-Gulf migration itself.

In the formal presentation of his theories, Cooke cited no direct evidence, although his writings elsewhere include obscure mention of an account (Frazar, 1881: 250-252) describing 23 species of land birds seen on the open Gulf. He based his case wholly on the vast amount of distributional data at his disposal in the files of the Biological Survey, which included information from eastern México and other critical areas that has never been published. These records revealed that many species passing annually from the Gulf States to South and Central America were all but unknown in eastern México and southern Florida. These abrupt gaps in distribution convinced Cooke that such species were trans-Gulf migrants. Another apparently significant feature of the data was the odd sequence of arrival dates along the Texas coast for certain birds. In spring these dates were not

progressively later from south to north, as one would expect, but *north to south*. For example, the average arrival of the Black and White Warbler in northeastern Texas was eight days earlier than its arrival at Corpus Christi, 300 miles to the south. Cooke suggested (1905: 2): "A probable explanation of such sets of records is that these early birds in northeastern Texas have reached the northeastern coast of Texas by a flight across the Gulf of Mexico, and this long journey performed in a single night has carried them north earlier than their fellows which reach southern Texas by a slow land journey from Mexico."

Since Cooke's day, a wealth of data on migration through the central Gulf Coast region has been assembled. Much of this is only now coming into print. Weston has spent 29 years studying the bird life of northwestern Florida, and his observations have been recorded in part in his periodic reports in 'Bird-Lore' and 'Audubon Magazine' (1924-1945) and in Howell's 'Florida Bird Life' (1932). Thomas D. Burleigh devoted eight years to an intensive field study of the bird life in the Gulf Coast region of southern Mississippi, and his observations have recently been published (1944). Of special interest in connection with Burleigh's work is the fact that during the eight years of his residence at Gulfport he lived in a heavily wooded area within 100 yards of the Gulf shore and was able therefore to make daily observations of the arrival and departure of migrating birds. My own studies began in 1929 when I returned to Louisiana after several year's residence on the coast of northwestern Florida. During the latter of these 17 years I had the assistance of a number of highly capable students and ornithologists, including James Henry Bruns, Thomas D. Burleigh, Thomas R. Howell, Robert J. Newman, Sam M. Ray, Robert E. Tucker, H. E. Wallace, and the late Austin W. Burdick. A considerable part of our work has been devoted to observations along various sections of the northern Gulf Coast, principally that of Louisiana.

None of these studies, from northwestern Florida to southwestern Louisiana, has revealed facts inconsistent with Cooke's basic concepts. However, as more and more field work was done, certain unexplained phenomena became increasingly apparent. During fine weather in spring almost no transient migrants could be found in the region, but during periods of storm tremendous precipitations of such migrants were encountered. Workers along the central Gulf Coast, where the shore lies at right angles to the trans-Gulf line of flight, knew from the testimony of their own eyes during times of visible migration that birds usually came in from the sea and that consequently any explana-

tion of the anomalies would probably be found in some consideration growing naturally out of the trans-Gulf theory.

The influence of weather conditions on the presence or absence of migrants on the northern Gulf Coast appeared so important that I undertook to correlate the occurrence of transients with factual meteorological data. I have discussed in detail the results of this study in a recent publication (1945: 92-121), but a brief résumé here is important to the thesis of this paper. In this region, the weather often changes suddenly as cold air masses move down from the north and come in contact with warm Gulf air masses. Prior to the arrival of these cold fronts, the surface winds are usually from the south and southeast and the air is humid. When a cold front reaches the coast and begins to underrun the warm Gulf air masses at that point, the wind direction changes abruptly to the north and the temperature drops rapidly. The actual contact of the cold, dry air masses with the warm, moist air is usually attended by thunderstorm activity. As the warm air ascends, it expands and condensation results. The junction of the two air masses forms what is known as the 'squall line,' in which the winds are intermittent and variable, and there is lightning, rain, and sometimes hail. Birds within the storm area are precipitated. However, as the squall line passes southward beyond the coast, northerly winds prevail across the whole Gulf Coast region now covered by the cold, dry air. It is then, and only then, that the Gulf Coast is deluged with thousands upon thousands of migrant land birds, which pile up in such immense pyramiding concentrations that every bush and tree in some areas is sometimes crowded with birds. I have already described this phenomenon in detail (*loc. cit.*), but I want to reiterate at this time that tremendous precipitations of migrants occur only when the wind shifts into the north. They do not occur in appreciable numbers when the winds are from the east and southeast prior to the arrival of the cold fronts. Obviously, the strong northerly winds represent a barrier to a *south-north* line of flight. Results of these studies point inescapably to the conclusion that birds noted under such conditions are trans-Gulf migrants that are arriving continuously across a broad front; for, regardless at what hour of the day a cold front reaches the coast and passes southward over the Gulf, migrants are invariably precipitated in great numbers. Thus, when confronted with a strong wind barrier before reaching shore, the birds suffer increased fatigue and therefore come down on the first available land. However, during fine weather they do not stop on the coastal islands and ridges, but instead pass inland some distance before alighting. In other words, under those conditions a considerable part of the central coastal plain is almost devoid of transient bird life.

As a result of these and other observations, a comprehensive modern theory of Gulf migration must both extend and modify the details of the original concept. Cooke realized that a few species of flycatchers, vireos, and warblers normally pass over the Gulf States and the Gulf of Mexico in one flight. But he failed to grasp the fact that virtually all the other species of transients, *i. e.*, migrants that do not breed in the region, behave in the same way unless confronted by a weather barrier. We now know that the principle of the coastal hiatus must be included as an integral part of the trans-Gulf theory. We know also that the arrival of trans-Gulf migrants on the northern Gulf Coast must be a more or less continuous process and that therefore Cooke's notion that the flight is accomplished overnight is a non-essential detail. Moreover, while Cooke had little to say about the migration of diurnal birds, the use of a coastwise route by such species has since been recognized by Gulf Coast ornithologists. Diurnal migrants that are well known to be in part coastwise include ducks, geese, herons, hawks, certain shorebirds, and the Cliff Swallow.

Meanwhile there had been a reawakening of ornithological interest on and near the eastern coast of Texas. In 1936, L. Irby Davis began the publication of a series of bimonthly reports on the birds of the Rio Grande Delta Region, which were supplanted in 1941 by George G. Williams's summaries covering the middle and northern Texas coasts and their environs. These reports, particularly the latter, have repeatedly revealed phenomena strikingly similar to those on the central Gulf Coast, *viz.*, the absence of transients in fair weather, the abundance of transients on the coast in cold-front weather, and the scarcity of transients inland under any circumstances. In Louisiana and Mississippi, such conditions can be adequately accounted for only by the principle of the coastal hiatus; but in Texas, another explanation seemed acceptable. It occurred to Williams that, perhaps, trans-Gulf migration was a myth, that all Gulf migration was confined to a narrow coastal pathway along which vast flights of birds passed day and night, too high to be seen unless forced down by bad weather. While my alternative explanation and Burleigh's 'The Bird Life of the Gulf Coast Region of Southern Mississippi' (1944) were still in press, Williams came forward with a formal presentation of his theory (1945: 98-111).

Williams built a persuasive case. He felt that recent field work on the Texas coast had invalidated most of the indirect evidence adduced by Cooke. And he pointed out that in 63 years there had been only two published accounts of birds seen from ships plying the open Gulf in spring (Frazer, 1881; Helmuth, 1920). He believed that there were

serious flaws in these records as evidence of trans-Gulf migration. They had been secured in stormy weather; they were not in the middle of the Gulf; and they included species not generally known to winter south of the Gulf. He said: "It seems, therefore, that if birds really did migrate across the Gulf itself, they would have appeared at some time on ships plying across the middle of the Gulf. But I can find no record of such appearances. All seeming records . . . when broken down and analyzed critically, reveal only the well-known fact that adverse winds may blow migrating birds to sea." Finally, in conclusion, he added: "There is no direct evidence to show that birds migrating from regions south of us in spring actually cross the Gulf of Mexico; but there is abundant evidence to show that these birds, both individuals and species, take the coastwise routes *around* the eastern and western edges of the Gulf."

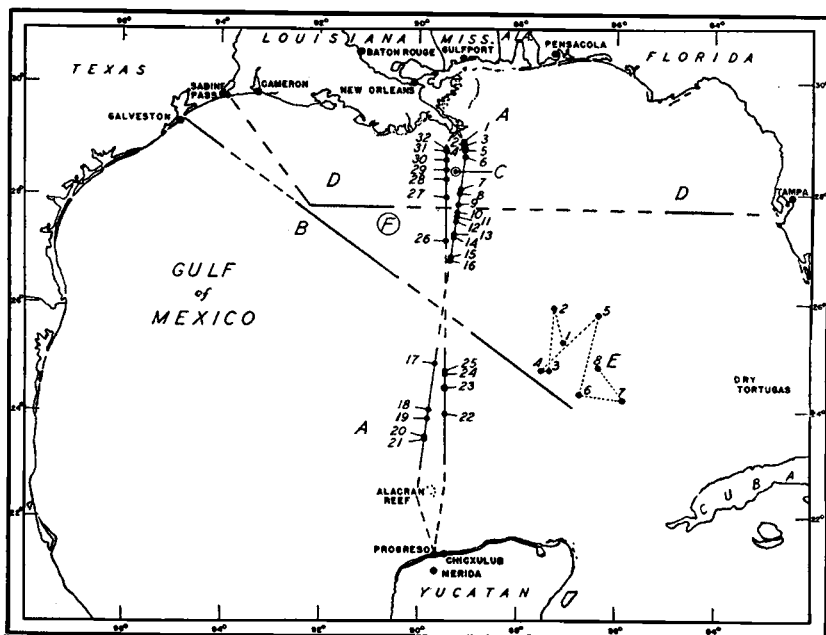
An analysis of Williams's arguments is given at the conclusion of this article. However, one inconsistency must be pointed out now. He agrees (*op. cit.*: 107-108) with all Gulf-Coast observers that migrants are rare or absent on the northern Gulf Coast in fair weather. He supposes that under such conditions birds are passing overhead continuously during the migrating season even though they are invisible. But, if the apparent absence of migrants along the Texas coast in fair weather does not imply their absence high over land, neither would a similar lack of birds at visible levels out on the Gulf prove their absence high over water. Even though an ornithologist were to cross the Gulf several times and see no birds, Williams still could not claim that such negative evidence was significant without exposing a similar weakness in his own theory.

However, Williams probably succeeded in establishing a reasonable doubt of trans-Gulf migration in the minds of some readers. For this reason I made plans to test the truth of the theory in the only place it could be tested—on the open Gulf, under sunny skies, along the 500-mile seaway from the mouth of the Mississippi River to Yucatán. This plan had been in prospect for a number of years, but because of circumstances it had been relegated to the postwar agenda. Fortunately, however, I was able to secure passage on a freighter bound for Progreso, Yucatán. The account of this trip will furnish indisputable evidence in support of trans-Gulf migration.

II. OBSERVATIONS OVER THE GULF OF MEXICO

A. ROUND TRIP VOYAGE BETWEEN LOUISIANA AND YUCATÁN ON THE
S. S. 'BERTHA BRØVIG'

I sailed from New Orleans at 9:30 P. M. on April 29, 1945, on a slow freighter, the S. S. 'Bertha Brøvig,' bound for Progreso, Yucatán. It had been my intention to record the number and approximate direction of flight of any birds seen crossing the moon while the ship was at sea. This, however, proved impracticable because of the slight roll and vibration of the ship. I was unable, at least on this occasion, to keep the telescope focused on the moon. (See Section III C beyond.) Consequently, observations at sea were confined to birds that either



TEXT-FIGURE 1.—Map showing the location of the principal observations discussed in this paper. (A) The round trip voyage on the S. S. 'Bertha Brøvig' en route between Louisiana and Yucatán, April 30–May 11, 1945. Numbers refer to the observations in the text. Broken line represents travel at night when no observations were made. (B) The route traversed by Lieutenant J. C. Howell in crossing the Gulf on May 3–6, 1945. Broken line represents approximate travel at night based on the known speed of the ship. (C) The approximate position of M. A. Frazar when his observations were made on April 2, 1881. (D) The approximate route traveled by W. T. Helmuth between Sabine Pass and a point in the Gulf and then to Tampa, Florida, March 29–April 1, 1918. Solid lines here represent his probable positions when he observed his birds. (E) Positions of the U. S. Coast Guard Cutter 'Blanco' when observations were made in August, 1945. (F) Approximate position of S. S. 'West Quechee' on August 25, 1926, when ship passed through the center of a tropical hurricane. All positions were plotted on U. S. C. and G. S. Sailing Chart 1007 from which a tracing was made and reduced to this size.

passed the ship close enough for recognition or happened to come aboard.

Herewith is an exact transcription of my notes on the land birds seen and the precise position in the Gulf where each was recorded. The approximate number of statute miles from the nearest land is placed in brackets following each observation. Numbers preceding each observation are the reference points in Text-figure 1. The latitude and longitude of each observation were plotted on U. S. Coast and Geodetic Survey Sailing Chart No. 1007, and from this a tracing was made. Central Standard Time is employed throughout.

VOYAGE TO YUCATÁN

April 30, 1945. Clear; moderate ENE wind, shifting to E in afternoon.

- (1) 4:45 A.M. One mile off South Pass. Two Yellow Warblers (*Dendroica petechia*) and a thrush (*Hylocichla* sp.) seen approaching from the south; they passed alongside of ship and continued northward in the direction of land.
- (2) 5:15 A.M. A small unidentified fringillid (female Indigo Bunting, *Passerina cyanea* ?) circled ship 3 miles off South Pass.
- (3) 5:36 A.M. Barn Swallow (*Hirundo rustica*) passed ship and continued northward.
- (4) 5:48 A.M. Barn Swallow (female) seen.
- (5) 5:50 A.M. Eastern Kingbird (*Tyrannus tyrannus*) came aboard ship and perched on a rope for fifteen minutes. Land out of sight. [8-9 miles off South Pass.]
- (6) 6:45 A.M. An unidentified warbler and a Barn Swallow appeared from the south and continued northward after passing over ship. 28° 40' N., 89° 05' W. [21 miles from the coast of Louisiana.]
- (7) 10:10 A.M. Barn Swallow appeared from the south, passed ship, and continued northward. 28° 05' N, 89° 14' W. [61 miles from the coast of Louisiana.]
- (8) 10:45 A.M. Barn Swallow passed ship. 28° 00' N, 89° 15' W. [67 miles from the coast of Louisiana.]
- (9) 12:00 M. Several Barn Swallows circling ship. 27° 48' N, 89° 17' W. [82 miles from the coast of Louisiana.]
- (10) 12:40 P.M. Least Sandpiper (*Erolia minutilla*) circled ship several times. 27° 40' N, 89° 18' W. [90 miles from the coast of Louisiana.]
- (11) 12:55 P.M. Female Dickcissel (*Spiza americana*) and immature male Orchard Oriole (*Icterus spurius*) on deck feeding around hay strewed on top of hatch cover. 27° 36' N, 89° 18' W. [94 miles from the coast of Louisiana.] The ship's cargo included four jackasses in crates on the open deck. Several bales of hay were spread in front of these crates, and it is here that the Dickcissel and oriole spent their time. When approached, they flew to another part of the ship only to return to the hay immediately when no one was near. [Both birds were on board at 6:00 o'clock the following morning but could not be found when I returned to the deck after breakfast. The position of the ship at 6:00 A.M. on May 1 was 24° 54' N, 89° 40' W. Consequently these two birds rode the ship 189 miles in the wrong direction.]

- (12) 1:30 P.M. Two female Barn Swallows perched on rope alongside ship. Departed after a brief rest. 27° 30' N, 89° 19' W. [101 miles from the coast of Louisiana.]
- (13) 4:00 P.M. With difficulty I succeeded in capturing two female Barn Swallows (*Hirundo rustica erythrogaster*) by slipping up behind them as they perched half asleep on a rail. [The skins are now deposited in the L. S. U. M. Z.] Few minutes later four more Barn Swallows appeared on the ship; all seemed tired. 27° 15' N, 89° 20' W. [119 miles from the coast of Louisiana; 408 miles from the coast of Yucatán.]
- (14) 4:10 P.M. Adult male Black-poll Warbler (*Dendroica striata*) found with the Dickcissel and Orchard Oriole at the pile of hay. Rather tame but I was unable to catch it. [Position of ship not materially advanced over last observation.]
- (15) 5:55 P.M. Six Barn Swallows aboard. 26° 50' N, 89° 22' W. [149 miles from the coast of Louisiana; 378 miles from the coast of Yucatán.]
- (16) 6:00 P.M. Sixteen Barn Swallows aboard, all preparing to roost on a ladder suspended from the roof of a companionway; all very tame and easily approached to within a few feet. [Position of ship about the same as last observation.]

———— [Sometime during the middle of the afternoon two birds came aboard the ship's poop deck and were seen by one of the sailors, who did not tell me about them until the next day. From his vague description all I can say is that they were possibly some kind of rail, shore bird, or small heron. He said that they remained for only a few minutes.]

May 1, 1945. Clear, few clouds; gentle SE wind.

- (17) 6:00 A.M. Three Barn Swallows flying around the ship; they disappeared after a few minutes. Dickcissel and oriole still aboard. 24° 54' N, 89° 40' W. [248 miles from the coast of Louisiana; 282 miles from the coast of Yucatán.]
- (18) 11:10 A.M. Three Barn Swallows passed ship and continued northward without circling ship. 24° 02' N, 89° 47' W. [190 miles from the coast of Yucatán; 335 miles from the coast of Louisiana.]
- (19) 12:15 P.M. Mourning Dove (*Zenaidura macroura*) circled ship several times; did not alight on ship, and finally disappeared in a northward direction. 23° 50' N, 89° 47' W. [177 miles from the coast of Yucatán; 349 miles from the coast of Louisiana.]
- (20) 2:10 P.M. Two Barn Swallows flew past ship and continued northward. 23° 30' N, 89° 52' W. [154 miles from the coast of Yucatán; 372 miles from the coast of Louisiana.]
- (21) 2:15 P.M. Five Barn Swallows flew past the ship and continued northward. Position about the same as last observation.

May 2, 1945. Clear; gentle easterly wind.

5:00 A.M. Anchored one mile off Progreso harbor, waiting for docking pilot to come aboard. Three Barn Swallows approached from the direction of land, passed ship, and disappeared northward out of sight. [Captain Syvertsen told me later that he has seen three swallows do the same thing; his birds may have been the same ones that I saw.]

RETURN VOYAGE TO MISSISSIPPI RIVER

May 10, 1945. Clear; gentle SE wind.

- (22) 11:30 A.M. Cape May Warbler (*Dendroica tigrina*), a male, circled ship several times, paused momentarily on a rail a few feet from me, and then flew around to the front of the ship where it was lost from sight. 23° 57' N, 89° 27' W. [176 miles from the coast of Yucatán; 342 miles from coast of Louisiana.]
- (23) 2:15 P.M. Bobolink (*Dolichonyx oryzivorus*), a male, came aboard for a few minutes and then disappeared. 24° 26' N, 89° 27' W. [210 miles from the coast of Yucatán; 328 miles from the coast of Louisiana.]
- (24) 4:00 P.M. Bank Swallow (*Riparia riparia*) flew close by the ship and continued northward without hesitation. 24° 42' N, 89° 27' W. [224 miles from the coast of Yucatán; 312 miles from the coast of Louisiana.]
- (25) 4:15 P.M. Baird's (?) Sandpiper (*Erolia bairdii*) circled ship five or six times and was last seen flying northward. Several times the bird passed within a few feet of me, so close I did not need my binoculars. Since, however, the bird failed to alight on deck where it could be studied in a perched position, I have appended a question mark to the identification. [Position of the ship only slightly north of last observation.]

May 11, 1945. Clear; gentle SE wind.

- (26) 5:15 A.M. Yellow-throat (*Geothlypis trichas*), a female feeding around the winches by the main forward hatch. 27° 09' N, 89° 27' W. [121 miles from the coast of Louisiana. This bird remained aboard until we reached the mouth of the Mississippi River, shortly after 4:00 P.M.]
- (27) 10:00 A.M. Black-throated Green Warbler (*Dendroica virens virens*), a male in company with the Yellow-throat. When first noticed it was amidst the mechanism of the winches and not easily visible. Hence, it may have been on board for some time. After much difficulty we managed to corner the bird in a companionway and capture it. [The skin is now in the L. S. U. M. Z.] 27° 56' N, 89° 27' W. [66 miles from the coast of Louisiana.]
- (28) 11:30 A.M. A female Baltimore Oriole (?) (*Icterus galbula*) circled over the ship several times and once or twice acted as if it were about to alight. This, however, it did not do and it disappeared before I could get a completely satisfactory view of its markings. The identification of this bird is highly questionable and would not be recorded except for the fact that it represents a passerine bird at sea over the Gulf. 28° 15' N, 89° 27' W. [43 miles from the coast of Louisiana.]
- (29) 12:50 P.M. Gray Kingbird (*Tyrannus dominicensis*) flew back and forth past the bridge where I was standing, several times within 30 feet of me. I obtained a perfect view of the bird from above and below. It had no white terminal tail band; the upper parts were distinctly gray; and the large bill was noted clearly. The bird circled the bow of the ship and over the main hatch in front of the bridge and once seemed about to perch on a rope only a short distance away from me. After circling again it finally headed directly northward. As the bird left the vicinity of the ship, I asked the man at the wheel, who was watching the bird also, to check its direction of flight with the ship's compass. Had it continued flying in the same direction it would have made a landfall near South Pass. I have no

- doubt whatever regarding the correctness of this identification. 28° 25' N, 89° 27' W. [32 miles from the coast of Louisiana.]
- (30) 2:00 P.M. Great Blue Heron (*Ardea herodias*) passed ship from East to West. 28° 30' N, 89° 27' W. [19 miles from the coast of Louisiana.]
- (31) 2:45 P.M. Duck Hawk (*Falco peregrinus*) flew over ship and continued northward. [16 miles from the coast of Louisiana.]
- (32) 2:46 P.M. Redstart (*Setophaga ruticilla*), a male, appeared on ship and stayed until the ship was within a half mile of land. I observed it leave the ship and head for shore. [First noted when the ship was about 16 miles offshore, immediately after the Duck Hawk was seen.]

RÉSUMÉ OF THESE OBSERVATIONS.—The ship traveled exactly across the middle of the Gulf; I knew the precise position of the ship at all times and was able to record the latitude and longitude of each observation; the weather was clear with hardly a cloud in the sky at any time; the wind was gentle easterly and southeasterly throughout the voyage, except on the first morning when a moderate ENE wind prevailed; the trip was made (especially the return) after the peak of migration in this latitude, when only late migrants might be expected. Under these conditions 21 species of land birds were seen by me while the ship was at sea and at distances varying from one to 248 miles from the nearest land, the latter being almost equivalent to the middle of the Gulf. Of the 21 species of birds seen, 18 were observed under circumstances permitting positive identification. Ten came aboard the ship and 11 went past without stopping. Many did not even hesitate. At least 61 individuals were counted, 32 of which did not alight on the ship. All birds that were seen before they reached the ship approached from the south, with the exception of the Great Blue Heron, which passed across the bow of the boat from east to west. All of the birds seen leaving the ship, or passing it, flew as directly toward the mouth of the Mississippi River as if land had been in sight.

I wish to add that I do not believe that I saw all of the birds that came aboard or passed the ship during the voyage. The birds observed by the sailor on the poop deck on April 30 substantiate this belief. Moreover, in the course of walking back and forth the length of the ship, I frequently saw birds which I would have missed had I been, let us say, on the opposite end of the vessel. Also there were unavoidable intermissions in the observations.

The ship is of Norwegian registry and has an entirely Norwegian or Norwegian-American crew. The officers of the ship, and many of the crew, are well-educated men who demonstrated a sincere intellectual interest in the problem. In the course of the voyage I had ample opportunity to converse with many of the men aboard regarding other times when birds may have been noted on the ship while in the Gulf of

Mexico. This boat had been in service between New Orleans and Progreso for seven years with little change in crew, especially among the officers. Some of the men told me in no uncertain terms that seeing small land birds on deck was commonplace. Furthermore, they told me of occasions when "small birds were everywhere." I am inclined to believe that when they speak of seeing "many" birds this means a considerable number. Even though 16 Barn Swallows and several other birds were on deck at dusk on April 30, this number impressed none of the men as being "many" birds. Moreover, by far the majority of the birds I observed went entirely unnoticed by members of the crew near me at the time.

B. OBSERVATIONS BY JOSEPH C. HOWELL WHILE CROSSING THE GULF
FROM GALVESTON TO YUCATÁN CHANNEL

By fortunate coincidence, my friend Lieutenant Joseph C. Howell, the well known ornithologist, happened to cross the Gulf of Mexico by boat from Galveston, Texas, to the Yucatán Channel, on May 3-6, 1945. When Lieutenant Howell returned to the United States I conversed with him about his findings. He generously turned over all of his notes to me with permission to include them here. Howell's observations are of the utmost importance for two reasons. First, they were made near the middle of the Gulf¹ under different weather conditions from those I encountered on the Gulf. Secondly, his records for May 5 coincided in date with my astronomical observations of birds passing over Progreso in the direction of the coast of Louisiana and Mississippi, *i. e.*, beginning a trans-Gulf migration.

A transcription of Howell's notes follows:

Left Galveston at 14:32 o'clock [1:32 P.M., C. S. T.], May 3, 1945. Course 127° T. Speed 10 knots. The first migrant land birds were seen on May 4, 150 nautical miles SE of Galveston, Texas [*cf.* Text-figure 1]. Many of the species noted on May 4 were observed again on May 5, but some of those seen on the latter date could have been birds of the previous day that had stayed aboard during the night. A Bank Swallow and a male Indigo Bunting were the only species seen on May 5 and not on May 4.

Twenty-one species and a minimum of 65 individuals were seen during the two days. A Red-backed Sandpiper was the only bird observed that did not alight on the ship. A complete list of the species observed in the Gulf follows, with a conservative estimate of the number of individuals involved after due allowances are made for birds that possibly stayed aboard more than one day:

¹ Howell's distance from the nearest land (*viz.*, Louisiana) on May 4 varied from approximately 121 to 179 statute miles; on May 5, his distance from the nearest land (Yucatán) varied approximately from 271 to 169 miles.

Green Heron (<i>Butorides virescens</i>), 1	Yellow Warbler (<i>Dendroica petechia</i>), 5
Least Bittern (<i>Ixobrychus exilis</i>), 2	Magnolia Warbler (<i>Dendroica magnolia</i>), 1 ♂
Purple Gallinule (<i>Porphyryla martinica</i>), 15	Bay-breasted Warbler (<i>Dendroica casta-</i> <i>nea</i>), 1 ♀
Red-backed Sandpiper (<i>Erolia alpina</i>), 1	Louisiana Water-Thrush (<i>Seiurus mota-</i> <i>cilla</i>), 1
Yellow-billed Cuckoo (<i>Coccyzus ameri-</i> <i>canus</i>), 8	Kentucky Warbler (<i>Oporornis formosus</i>), 1
Nighthawk (<i>Chordeiles</i> sp.), 3	Redstart (<i>Setophaga ruticilla</i>), 2 ♂
Acadian (?) Flycatcher (<i>Empidonax</i> <i>virescens</i>), 1	Tanager (<i>Piranga</i> sp.), 1 ♀
Bank Swallow (<i>Riparia riparia</i>), 1	Orchard Oriole (<i>Icterus spurius</i>), 2 ♂ ♀
Barn Swallow (<i>Hirundo rustica</i>), 12	Baltimore Oriole (<i>Icterus galbula</i>), 1 ♂
Catbird (<i>Dumetella carolinensis</i>), 2	Indigo Bunting (<i>Passerina cyanea</i>), 1 ♂
Veery (<i>Hylocichla fuscescens</i>), 2	

All of the birds seemed to be weak. In flight they were feeble and clumsy and many alighted close enough to be caught by hand. One gallinule alighted on the gun deck during an early morning drill and skidded right amongst the gun crew. Twelve gallinules were caught by hand, and although they were awake, they appeared too exhausted to try successfully to escape. A Yellow Warbler, Louisiana Water-Thrush, Barn Swallow, Redstart, Bay-breasted Warbler, and Least Bittern were also caught by hand. Most of the birds appeared to be very sleepy. I caught one of the gallinules while it slept in a gun tub. All had their heads tucked beneath their wings. I noted a Green Heron, Yellow-billed Cuckoo, and Barn Swallow sleeping while I was within ten feet of them, but only the gallinules had their heads beneath their wings.

During the daylight the swallows flew over the decks and near the ship. The gallinules, bitterns, and Catbirds spent most of their time more or less secreted in the winches or among the crates of the deck cargo. The other species alighted on wires, boxes, or even on the open deck. Not a bird was heard to give its song, and all were silent except when disturbed.

At night a cuckoo perched on a railing, and the gallinules hid in the machinery of the winches, or in the deck cargo. A Redstart occupied an empty gear locker and a Baltimore Oriole slept on a coil of rope on the open deck.

Most of the birds came aboard during the daylight hours of May 4. No time of the day was favored over any other. Some of the warblers definitely stayed more than 24 hours, and probably some of the cuckoos, gallinules, swallows, and bitterns did likewise. Most of the birds stayed at least 12 hours. Two different gallinules were seen to alight in the water alongside the ship after being frightened from the deck. One of these was seen to take off again and the other remained afloat until the ship was out of sight. Only a single Barn Swallow was definitely thought to have died aboard from natural causes.

C. OBSERVATIONS BY FRAZAR AND HELMUTH

My notes have shown the late spring status of birds at visible levels over the Gulf during fair weather when the winds favor northward flight. Howell's observations have shown what happens when the skies are clear and the winds moderate but adverse. What, then, is the situation when the full fury of storm sweeps southward over the water? No ornithologist in recent years has had an opportunity to

furnish an eye-witness answer. To find out we must go back to the reports of Helmuth (1920) and Frazar (1882). Although the significance of their accounts as proof of trans-Gulf migration has been questioned by Williams (*loc. cit.*), they form important parts of the data on birds over the Gulf and must be re-evaluated in the light of recent findings, as I shall do beyond. But to appreciate their true meaning, one must read more than brief excerpts. Since they were published long ago and may be unavailable to many readers today, the pertinent passages are reproduced here in full:

FRAZAR'S ACCOUNT

April 2, 1881, found me in a small schooner, on the passage from Brazos de Santiago, Texas, to Mobile, Alabama. At about noon of that day the wind suddenly changed from east to north, and within an hour it was blowing a gale; we were now about thirty miles south of the mouths of the Mississippi River, which would bring the vessel on a line with the river and the peninsular [sic] of Yucatán. Up to the time the storm commenced the only land birds seen were three Yellow-rumped Warblers (*Dendroeca coronata*) that came aboard the day previous, keeping us company the most of the day; but within an hour after the storm broke they began to appear, and in a very short time birds of various species were to be seen in all directions, singly and in small flocks, and all flying toward the Mississippi River. These birds of course must have been far overhead and only came down near the surface of the water in endeavoring to escape from the force of the wind. By four o'clock it had come to be a serious matter with them, as the gale was too strong for them to make scarcely any progress. As long as they were in the trough of the sea the wind had little effect on them, but as soon as they reached the crest of a wave it would catch them up and in an instant they were blown hundreds of yards back or else into the water and drowned.

A great many flew on to the deck of the vessel to be washed about by the next wave that came over the side. Although I made no attempt to count the number of specimens that came aboard, I should estimate them at considerably over a hundred and a great many more struck the sides and tumbled back into the water. It was sad indeed to see them struggling along by the side of the vessel in trying to pass ahead of her, for as soon as they were clear of the bow, they were invariably blown back into the water and drowned. Most of those that came aboard were washed into the sea again, but the next day we found about a dozen dead bodies that had lodged underneath the galley. The following is a list of the species recognized, and if more time could have been given to observation I undoubtedly could have made out others.

1. Wood Thrush. About twenty seen.
2. Black-and-white Creeper. Abundant.
3. Prothonotary Warbler. Large numbers.
4. Worm-eating Warbler. Large numbers.
5. Yellow-rumped Warbler. A few.
6. Chestnut-sided Warbler. Quite a number.
7. Yellow Warbler. Quite a number.
8. Golden-crowned Thrush. A few.
9. Kentucky Warbler. Large numbers.
10. Mourning Warbler. Large numbers.
11. Maryland Yellow-throat. Very abundant.
12. Hooded Warbler. Large numbers.
13. Redstart. The most abundant.
14. Cliff Swallow. Saw one.
15. Scarlet Tanager. Quite a number.
16. Summer Redbird. A few.
17. Towhee. A few.
18. Indigo Bird. As plentiful as Redstarts.
19. Nonpariel. Quite abundant.

20. Flycatchers. Saw a large number of the smaller species, but recognized only *Sayornis fuscus* (Phoebe). 21. Pigeon Hawk. Saw one. 22. Carolina Dove. A few. 23. Turnstone. Only one seen.

One important conclusion which can be drawn from these observations seems to be that instead of following the land a large number of species migrate directly from Central America to the Mississippi valley across the Gulf of Mexico, and the scarcity of these species in southwestern Texas is thus explained.

HELMUTH'S ACCOUNT

March 28, 1918. Anchored off Sabine Pass, Texas. [Describes flights of geese observed.]

March 29, 1918. *Migrants and waifs at sea.* From Sabine Pass to a point southeast in the Gulf of Mexico, 100-150 miles offshore. A "norther," with terrific wind and rain. Three Great Blue Herons (probably Ward's), lit on the main and foremast, and stayed there all day, balancing themselves against our 42 degree roll by half extending and lowering their wings to meet the motion. Among other strange visitors at a distance of 125 miles from land were a Belted Kingfisher, several Tree Swallows, and many flocks of Warblers, which seemed better able to weather the storm than the large Herons. The only Warblers identified were Myrtles, Parulas, Redstarts, and a female Black-throated Blue. Three Robins came aboard in the evening.

March 30, 1918. Gulf of Mexico, en route to Tampa, Florida. Very heavy weather, with violent squalls, wind varying in direction. A Henslow's Sparrow stayed with us all day, very tame, and ate crumbled hard-tack and drank water from the boat-covers. Passed five Louisiana Herons, making heavy weather of it.

March 31, 1918. About 85-95 miles off the entrance of Tampa Bay. Several Myrtles, a Parula, a Black and White, and one Prothonotary Warbler flew aboard and spent the morning on the boat-deck, all very tame. Strangely enough, the Myrtles ate bread crumbs and crumbled hard-tack thrown to them by compassionate sailors!

There is no question that in each of the foregoing cases the weather witnessed was a typical cold-front storm. Viewed in the light of the now-proven fact that trans-Gulf crossings occur continuously in spring, the import of Frazar's and Helmuth's observations can be understood clearly. They are merely the counterpart at sea of the tremendous concentrations of birds at visible levels that cold-front storms produce on land.

By comparison, Williams's interpretations of these data seem strained. Although Helmuth was aboard a United States Naval vessel on patrol in the Gulf, Williams questions if Helmuth knew his true positions. On careful analysis it appears perfectly clear that Helmuth's account contains no inconsistencies and, therefore, his approximate route can be plotted as I have done in Text-figure 1. Williams further claims that Helmuth's birds were not trans-Gulf migrants by listing certain species believed not to winter south of the Gulf. They are: Louisiana Heron, Robin, and Henslow's Sparrow.

However, the facts in the case are that two Louisiana Herons banded in the Galveston Bay region, on August 28, 1929, by J. W. Stiles, were recovered, respectively, about October 18, 1930, at Progreso, Yucatán, and September 6, 1931, at Laguna San José, 12 kilometers from Macuspana, Tabasco. Furthermore, the Eastern Robin (*Turdus migratorius migratorius*) winters south to western Cuba (Bond, 1940), and to southern México and Yucatán, as is proved by the recovery of a banded bird (Thomas, 1936: 113), a specimen in the University of Michigan Museum of Zoology, taken at Chichén Itzá, February 2, 1940 (Van Tyne, *in litt.*), and, finally, by specimens collected in southern Veracruz (Wetmore, 1943; Duvall, 1945). Regarding the Henslow's Sparrow seen by Helmuth on March 30, it is entirely possible that the bird was a Grasshopper Sparrow instead. The latter winters south to Guatemala and Nicaragua (Hellmayr, 1938). Granted it was a Hen-

TABLE I. COMPARATIVE GEOGRAPHICAL STATUS OF CERTAIN BIRDS SEEN BY FRAZAR

<i>Species</i>	<i>Frazar's account</i>	<i>Florida Peninsula</i> ¹	<i>Brownsville Region</i> ²
Wood Thrush	20 seen	fairly common	rare
Prothonotary Warbler	large numbers	fairly common	very rare
Worm-eating Warbler	large numbers	regular but uncommon	rare
Chestnut-sided Warbler	quite a number	very rare (one record)	fairly common
Kentucky Warbler	large numbers	very rare (three records)	rare
Mourning Warbler	large numbers	very rare (two records)	rare
Indigo Bunting	as plentiful as Redstarts (latter listed as the most abundant)	uncommon	abundant

¹ Based on Howell (1932).² Based on Davis (*in litt.*).

slow's Sparrow, it is conceivable that at least a few winter south of the Gulf and have merely escaped detection.

Williams reasoned that because the flight observed by Frazar also contained a few birds not known south of the Gulf, none of the birds seen was engaged in a trans-Gulf migration. By the same line of reasoning, one might argue that the birds could not have come from Florida since the flight contained large numbers of birds extremely rare in that state, and, moreover, that they could not have come from Texas since the flight contained large numbers of birds extremely rare there (*cf.* Table 1). However, the fallacy of such an argument is obvious. The birds must have come from somewhere. The fact that some birds in a flight have originated from one source does not show that other birds in the flight could not have come from other sources. The idea that the bulk of Frazar's birds were trans-Gulf migrants involves at most only the assumption that strays from the mainland may mingle in a trans-Gulf flight. Williams's theory, on the other

hand, seems to require that birds were carried out to sea from three directions by a wind that was blowing from only one.

D. AUTUMNAL RECORDS

Fall migration in the lower Mississippi Valley and in the central Gulf-Coast region is totally unlike the migration in spring. It is characterized by a steady stream of migrants, appreciable numbers of individuals daily, and the regular appearance, irrespective of weather conditions, of transient species that are seen in spring only during and after cold-front storms. Apparently the general meteorological situation during the period of southward migration is a major factor in producing these results; but no exact correlations have yet been made. Whether or not the effects noted extend out over the Gulf itself, making migration there more visible than in spring, is a point that requires further study in the field. But, at any rate, the use of the trans-Gulf route in fall, as in spring, is well authenticated and is notable for the appearance of birds in flocks even during mild weather.

One hundred and twenty-two years ago, Bullock (1824) wrote as follows:

A few days brought us off Campeche, but, owing to the shallowness of the water, we were obliged to cast anchor twenty-five miles from the town. Our captain, with some of the officers, went on shore on business, and to procure a supply of fresh provisions for the voyage. During their absence we were visited by great numbers of the smaller kinds of land birds, principally warblers and flycatchers, which reached the ship in an exhausted state, on their migration from the north side of the Gulph of Mexico to the coast of Yucatan. The cabin was never without these pretty creatures, which entered the windows in pursuit of the flies, that were in great plenty. Some of them became familiar, remained undisturbed for many hours, and took the small chopped meat and water placed for them, affording me a better opportunity of observing their habits than I could have obtained on shore. The boys caught me twenty-five different species on the deck and rigging; but the attempts to keep them alive were unsuccessful, and I preserved them on the spot. Many were of great beauty and variety, and some undescribed. Among those known were the purple heron, common snipe, pigmy sandpiper, the lesser spotted rail, American chatterer, orange and black warbler, and two kinds of swallows.

Griscom (1945: 100) has described his experiences in August, 1930, while crossing between New Orleans and the Yucatán Channel, as follows: "For the two days on the open ocean, land-birds were constantly in sight, and a few boarded the vessel. Reclining in a deck-chair, I heard a sudden loud 'chip' given directly beneath me, and glancing down, saw a male hooded warbler [*Wilsonia citrina*] looking up at me with great curiosity. Barn and cliff swallows passed the steamer and a hummingbird whizzed by, all making much better time than the boat could possibly do."

Lincoln (1939: 61) and Weightman (1926) make mention of migrating land birds seen from the steamer 'West Quechee' while in the vortex of a hurricane on August 25, 1926. The birds were so numerous that they filled the air and could be scooped up from the deck by the armful. Photographs illustrating the tremendous numbers present aboard the ship appeared in an obscure publication, the 'Fireman's Fund Record' (Anonymous, 1927). The photographs show birds crowded together, wing to wing, all over the rigging, railing, and superstructure of the boat. Among them are several species—hundreds of Purple Martins (*Progne subis*) and other swallows, numerous birds the size and shape of orioles, and others the size of warblers. The hurricane in question entered the Gulf of Mexico in the vicinity of the Yucatán Channel and passed northwestward above the northern coast of Yucatán. On reaching longitude 92° W., it turned abruptly northward by eastward and then moved slowly across the middle of the Gulf, enveloping the 'West Quechee' at a point about 300 miles east of Galveston, Texas, and approximately 125 miles south of the Louisiana coast.

From 1943 until shortly after the termination of the war, the U. S. Coast Guard Cutter, 'Blanco,' was engaged in gathering weather data in the Gulf of Mexico. Observation stations were always near the "middle of the Gulf," a fact which renders observations of land birds by the boat's crew of great significance to the thesis of this paper. Conversations during June, 1945, with Captain G. A. Ruhge, C. A. Spori, and Charles Nevitt, Jr., of the crew of the 'Blanco,' revealed that observations by them of land birds in migration across the Gulf were frequent and commonplace. Nevitt's testimony was especially significant in view of his biological background which includes an introductory college course in ornithology. Although many instances were described to me of occasions when birds of varying numbers and kinds were seen in the "middle of the Gulf," I asked them to supply me with specific records giving the dates of observation, positions of the boat, prevailing weather conditions, and the preserved wings of any birds which they could capture. The last proposition was made possible through the coöperation of the U. S. Fish and Wildlife Service in issuing necessary scientific collecting permits. The 'Blanco' was lately removed from duty in the Gulf and for this reason only one report was forthcoming from Captain Ruhge. His notes, as submitted to me, follow (the recorded position of each observation is plotted in Text-figure 1):

During the time of our patrol from August 14–30, 1945, we endeavored to obtain the information desired by you pertaining to the migration of land birds across the Gulf of Mexico with the following results:

[1] August 16, 1945. 5:00 P.M. Swallows observed (wing of this type obtained on August 26 [Barn Swallow, *g. v.*]). Position 25° 56' N, 87° 03' W.

[2] August 17, 1945. 6:00 A.M. Flocks of small birds, possibly warblers, flying south about 20 feet above the water. Much chirping was heard. Light (Beaufort Scale: 1-7 mph) SW wind. Position 25° 56' N, 87° 14' W.

[3] August 18, 1945. 10:15 A.M. Swallows observed. Wind SW, light. Position 24° 45' N, 87° 21' W.

7:30 P.M. Small flocks of warblers about 30 feet above water passing boat. Rain squalls with SSW wind. Position 24° 45' N, 87° 20' W. Also one black and white striped bird resembling a warbler [? Black and White Warbler, *Mniotilta varia*] landed for a few minutes and departed in SSE direction. At same position as above a Kingfisher [*Megaceryle alcyon*] was seen passing the ship, headed south.

[4] August 19, 1945. 7:30 A.M. Redstart [*Setophaga ruticilla*] landed on rail for a short time and departed in SSE direction. Light SSW wind and passing showers. Large dragonflies seen in quantity. More swallows seen about the ship throughout most of the day. Position 24° 45' N, 87° 30' W.

6:00 P.M. Undetermined species seen for a short time. It was slightly smaller than a sparrow; breast dull yellow (only under side observed). Position about same as last observation.

[5] August 23, 1945. Swallows, warblers, and dragonflies seen off and on during most of the day, all heading SSE or S. Noon position 25° 48' N, 86° 20' W. Light S wind.

[6] August 24, 1945. Many flocks of warblers heard passing over ship at night headed south. Position at 3:00 P.M. 24° 20' N, 86° 43' W.

[7] August 25, 1945. Swallows, warblers, and dragonflies observed at intervals during the day. Noon position 24° 12' N, 85° 50' W. Captured a warbler from a flock of thirty or forty; wing preserved [the specimen, now in the L. S. U. M. Z., is an immature example of the Yellow Warbler, *Dendroica petechia*].

[8] August 26, 1945. 3:00 P.M. Light NW wind. Captured a swallow that came aboard ship [the specimen, now in L. S. U. M. Z., is an example of the Barn Swallow, *Hirundo rustica*].

A glance at Text-figure 1, where the above observation stations are plotted, reveals clearly to what extent the records may be described as "mid-Gulf." At Station 7 the 'Blanco' was at its closest point to land—157 statute miles from Cuba, 195 from northeastern Yucatán, and 203 from Dry Tortugas. At Station 2 the boat was farthest from land, a distance of 305 statute miles from Yucatán and 312 statute miles from Dry Tortugas.

Weather conditions during the period of these observations were typical of the season in the Gulf area, as exemplified by the prevailing southerly winds, high temperatures, and local showers. Nearly all birds observed passing the boat were flying into the face of, or at an angle to, light southerly winds. Mention of birds aboard ship is in two instances associated with rain squalls and passing showers.

Possibly the most interesting single fact brought out by these notes is that "many flocks" of birds were heard passing over the boat in a southerly direction during the night of August 24. To my knowledge

this is the first instance recorded from the open Gulf of that well-known feature of nocturnal migration over land. However, the 'Blanco' provided highly favorable conditions for making such observations, for much of the time the boat was idle, moored to a sea anchor, thus eliminating the customary vibrations and sounds that accompany even large vessels in transit.

Previous mention has been made here to the effect that on the testimony of seamen who regularly cross the Gulf of Mexico, the appearance of small land birds is commonplace. Accordingly, I asked Mr. Kristian Akselsen, radioman of the 'Bertha Brøvig' which plies between New Orleans and Progreso, Yucatán, to keep a record of birds that appeared on his ship and to obtain wings of as many as he could succeed in catching. Since July, 1945, he has given me several written reports of which the following excerpt is typical: "During the last two trips [both in September], we had frequent visits by small birds on board, but all were very shy and none stayed very long." Indefinite as such reports are, they are nevertheless of some value. However, on October 9, 1945, I received from Akselsen a highly important account of an incident that took place early in October while his ship was at Progreso. In sending eight wings of birds to me, he wrote as follows: "These wings came from birds that were found on deck on the morning of October 5, while we were at Progreso. A stiff southeasterly wind had been blowing all during the night and day before, and all of the birds on the ship that were alive were plainly exhausted. There were many dead birds on deck, but they seemed to be of the two or three kinds which I am sending to you."

Since his "two or three kinds" include *six* species, there is little doubt that other species were present also. The wings sent are identifiable as follows: 2 Red-eyed Vireos (*Vireo olivaceus*), 1 Philadelphia Vireo (*Vireo philadelphicus*), 2 Magnolia Warblers (*Dendroica magnolia*), 1 Tennessee Warbler (*Vermivora peregrina*), 1 Water-Thrush (*Seiurus noveboracensis*), and 1 Connecticut Warbler¹ (*Oporornis agilis*).

After receiving this report from Akselsen, I met his ship on a subsequent call at New Orleans and conversed with him in detail regarding the incident and the surrounding circumstances. The boat was tied to a long pier projecting into the open Gulf and was blacked out except for two lanterns. Birds were first noted on the ship by the night-watchman, who awakened Akselsen at daybreak. At that time Akselsen estimated that no less than 40-50 birds were present, most of

¹ The identification of this wing proved extremely difficult. Neither A. Wetmore nor J. Van Tyne were able to furnish a positive identification. It seems nearest to *Oporornis agilis*, but the manus and under wing coverts are not quite as yellow as in specimens of that species which we have had for comparison. Possibly the wing came from an immature individual of that species.

which were dead or in very poor physical condition. It appears not unlikely that a segment of a very large flight of migrants arriving on the coast at that point met partial destruction by flying into the superstructure and copious rigging of the freighter as it lay between them and shore. Since the birds were arriving on the southern shore of the Gulf in the face of strong headwinds, the observation appears to represent the autumnal counterpart of spring concentrations precipitated on the northern Gulf Coast by cold-front storms.

III. THE MAGNITUDE OF TRANS-GULF MIGRATION

A. SIGNIFICANCE OF RECORDS OVER THE GULF

Let us now consider how the mass of data reproduced in Section II relates to the broad problem of trans-Gulf migration.

When we have read the complete record, one basic conclusion becomes self-evident—that non-pelagic birds appear frequently over the Gulf both in spring and fall. Though no deliberate field work was undertaken until recently, we already have definite records for 24 dates in March, April, May, August, and October, in weather ranging from calm to hurricane. Late in the summer of 1945, when southward migration was just getting under way, the personnel of the weather boat, 'Blanco,' noted passerine species on a total of eight dates out of eleven. Like most of the observers who have contributed to the long catalog of Gulf records, these men had other work to do. Had they been able to scan the sky continuously, they might well have been rewarded with results on all eleven dates. So far, I alone have made a voyage across the Gulf for the sole purpose of studying trans-Gulf migrants; and, although my trip was made after the peak of spring migration in that latitude, I recorded passerine species on every one of my four days at sea. The Frazar and Helmuth accounts are no longer isolated cases. The work of the past year has provided as many sets of Gulf observations as all the published investigations of the preceding 64 years put together. We can now appreciate that the former scarcity of records was due, not to a lack of non-pelagic birds, but to the lack of interested observers, on a route rarely traversed by ornithologists at the critical season.

Nevertheless, granted that small birds occur regularly over the Gulf, what reason have we to assume that they are actually crossing it? Is it, perhaps, possible that such birds are mere waifs that have drifted off their normal course and become lost at sea? Three facts stand in the way of the latter interpretation—the distribution of records, the presence of birds in mild weather, and the direction of flight. The

points of occurrence are not confined to coastal waters. As shown in Text-figure 1, they are strung out across the whole expanse of the Gulf. Indeed, on my own voyages between Louisiana and Yucatán, no 40 miles of the daylight distance was devoid of birds. Another sort of evidence is exemplified by the Coast Guard report of flocks of small birds at the middle of the Gulf when the force of the wind, as measured by instrument, did not exceed 7 mph. These flocks were flying counter to the direction of the wind more than 300 miles from the nearest land. Under the circumstances they could not possibly have been blown to the point of observation, and there seems to be no way to account for their location unless they were crossing the Gulf deliberately. Finally, with the single exception of a Great Blue Heron 19 miles from shore, every one of the numerous birds for which complete data are available was proceeding unerringly in the seasonal direction of migration. If migrants got lost on the Gulf often enough to explain the known records, if they did not continue on across the water in the direction observed but later reversed their course, then certainly at some time a few individuals at least would have been encountered flying the wrong way. But there is not a solitary instance of this kind on record. On the other hand, in an overwhelming majority of cases, considerations of one sort or another point to an intentional trans-Gulf flight.

We must pursue the inquiry still farther. Occasional crossings of the Gulf would not constitute migration in the accepted sense of the word, even if intentionally made. Migration implies a movement in which numbers of birds participate simultaneously. Do or do not the present data indicate whether trans-Gulf crossings come within the meaning of the term?

A total list compiled from the accounts in Section II comprises no less than 62 species. This is a formidable number—more kinds of birds than Cooke himself specifically associated with the trans-Gulf flyway. Particularly worthy of emphasis are the Myrtle Warblers encountered by Frazar on the day *before* the storm, the Mourning Dove 177 miles off the coast of Yucatán, and the Yellow-throat 100 miles below the mouth of the Mississippi when the breeze was blowing not *from* but *toward* the shore. These records and their surrounding circumstances prove that the winter-resident status of a species on the Gulf Coast provides no basis for assuming that individuals of that species do not traverse the Gulf of Mexico. A second interesting feature of the list is the inclusion of birds not ordinarily thought of as trans-Gulf migrants. In this class, the swallows, represented by three species, are especially numerous—a result that may be partly attributed to their habit of low flight and their resulting conspicuousness.

Much of this is incidental. Evidence of migration can be only partly predicated on variety of species. We cannot ignore the fact that many of the lists made on days when the birds were not faced with headwinds are notable for the low count of individuals. In cases where the observations were only casual, this would seem to require no particular explanation. However, my own records, based on a continuous search for birds during daylight, show only 11 individuals on the return trip from Progreso, an average of less than six individuals per day. Ornithologists who think of migration in terms of their own experience during the northern spring may say to themselves that this is not migration. And so it is not—intrinsically. But it is indicative of far more than meets the eye. The fact of the matter is that the situation out on the Gulf parallels almost exactly the situation with respect to transients in the coastal regions of the Gulf in spring. I say *almost* exactly because there is one difference. In calm spring weather one does encounter some transients offshore, but in lower Louisiana such conditions usually bring into view only species that breed in the region and such low-flying migrants as the swallows. One specific illustration will suffice to emphasize this point. Among the many transient migrants that have been seen over the Gulf in fair weather was a Black-throated Green Warbler that boarded my ship on the morning of May 11, 66 miles off the coast of Louisiana; yet on the mainland north to Baton Rouge I have never, during 13 years of intensive field work, found this species in spring except in the wake of polar-front storms.

To repeat, the bulk of spring migration in the Gulf coast regions is an unseen phenomenon, becoming visible only in bad weather. Gulf ornithologists agree that this is true whether the observer is working in Florida, Georgia, Mississippi, Louisiana, or Texas. All have been forced to a common conclusion—that most transient migration is performed at such high altitudes that it is virtually undetectable. If this is true over land, there is no reason to expect that it will be less true over water. Successful observation on the Gulf would seem to hinge on the same sort of circumstances that precipitate birds on the coast, and the results that have recently been achieved in fair weather can be nothing short of astonishing to anyone familiar with the situation on land.

The really perplexing thing, therefore, about trans-Gulf migration is not that it has produced so few records but that it has produced so many. Why should we find any transients at all over the Gulf during fair weather, when under similar conditions on the coast we do not find any? So many uncertainties still attach to the mechanics of

migration that any answer must be frankly speculative. But the actions of the birds themselves suggest a plausible hypothesis. Briefly, it is this—that spring observations of migrants on the Gulf are made possible mainly by the attraction of the ship, which depends in turn on the individual degree of fatigue of the birds flying high overhead. Let us examine the probable workings of this principle in greater detail.

The ability of small birds to cross stretches of water more vast than the Gulf of Mexico is amply attested by their appearance on islands in the open seas. There is little reason to doubt that the *average* bird under *average* conditions can pass from the peninsula of Yucatán to the coast of Louisiana in one flight without tiring unduly and yet continue on for some distance inland. In my opinion, the attitude of such birds to the ships passing below is one of complete disinterest, and they stream over unseen. However, in any aggregation as large as the trans-Gulf flights, there are surely many degrees of fitness. The sub-standard individuals must find the trans-Gulf crossing an ordeal of increasing severity. They, I think, furnish the bulk of the records in fair weather. The degree of fatigue, as well as the numbers affected, increases as the journey lengthens and is reflected in the bird's behavior. Except in the case of low-flying migrants like the swallows, even those individuals which pass the ship without stopping but come down close enough to be seen are probably in most cases beginning to feel the first hints of approaching fatigue. I do not mean that they are in actual distress but that they are beginning to experience physical and psychological reactions that would prompt their alighting if a suitable opportunity presented itself. As soon as they see that human beings are present, they decide not to stop. Later, as the strain increases, some of them abandon more reluctantly the impulse to pause and therefore begin to circle the ship. The stage where a bird actually boards a ship does not represent exhaustion in most cases, but it seems to indicate a state of discomfort where the bird's desire for rest is greater than its suspicion of man or the strange experience of alighting on a ship's deck.

Fatigue may be intensified by adverse winds to an astonishing degree. Let us study in the light of current aerodynamic theory (*cf.* Allen, 1939) the case of a bird capable of migrating at a speed of 30 mph. in still air. If there were no wind at all, such a bird could traverse the shortest north-south route across the Gulf in a little less than 18 hours. But suppose that it were traveling in a 20-mile tail wind. Then, it would move forward at the speed of the wind plus its original speed and would complete the crossing in a little over 10 hours.

Conversely, if it were proceeding against a 20-mile wind, its effective speed would be reduced to 10 mph. and it would need over 52 hours to cover the distance. Whether or not migrating birds attempt to compensate for the effect of wind by regulating their air speed, the result would be the same in terms of expended energy. The journey would take approximately five times as much effort in a 20-mile head wind as in a 20-mile tail wind.

However, wind direction and velocity often vary at different altitudes; the wind sometimes blows in opposite directions at levels only 1000 feet apart. Thus, migrants could seek favorable elevations and escape the consequences of continuous flight against adverse wind.

The effect of wind and distance on the number of birds seen is graphically illustrated by the notes in Section II. In spring, weather conditions being equal, more birds are always seen over the upper part of the Gulf. For example, on my trip to Yucatán, I saw 11 species comprising 37 individuals on April 30 when crossing the northern half of the Gulf, in contrast to only two species and 14 individuals on May 1 when my ship was in the southern half of the Gulf. On the return voyage, four species represented by single individuals were seen on May 10, whereas seven species and as many individuals were seen on May 11 when traversing the northern part of the route.

Howell's observations reveal that moderate to fresh adverse winds increase the number and variety of birds seen in a given period of time as well as their discernible state of weariness. His birds were apparently suffering greatly from fatigue, for not only did all of them come aboard the ship with one exception, but they were noted sleeping on the ship during the daytime. Only in the case of the Barn Swallows on April 30, did any of my birds show visible weariness. Obviously two sets of factors were in operation on the dates of our respective observations. Although the skies were generally clear during Howell's crossing of the Gulf, a moderate northerly wind was blowing in the central Gulf area on May 3-5 (*vide* U. S. Weather Bureau, New Orleans; also *cf.* Daily Weather Maps) as a consequence of a cold front which passed southeastward across the western part of the northern Gulf Coast around midnight on May 2-3. Since these northerly winds did not reach the extreme southern Gulf area in force, birds departing from southern México did so under generally auspicious conditions. However, on reaching the central part of the Gulf they encountered head winds, which were gentle to moderate and apparently sufficiently strong to hinder northward flight by materially reducing the birds' ground speed. The wind direction and velocity at a Weather Bureau observation station near the middle of the Gulf (25° N., 90°

W.) on May 4 was NNW., 8-12 mph. at 12:30 P. M.; NNW., 13-18 mph. at 6:30 A. M.; N., 13-18 mph. at 12:30 P. M.; N., 13-18 mph. at 6:30 P. M.

Frazar's birds exhibited, in part, the maximum degree of fatigue, for some of them were unable to make headway against the wind and were swept into the sea. Yet his birds had flown farther. In fact they were nearly across the Gulf and were about to make a landfall when they met a storm of "gale" intensity. Helmuth tells of "terrific wind and rain" at the time some of his birds came aboard his ship, but he speaks of no fatality and even states that "several Tree Swallows and many flocks of warblers were better able to weather the storm than the large herons."

Thus, the distance that a bird has traveled and the winds and other weather conditions it has encountered appear to be of tremendous import in determining the number of birds one might see while crossing the Gulf. If this were not the case, one should be able to count at least as many birds during fair weather on the coastal islands and ridges as are seen on the Gulf during auspicious weather. But on land there is one great difference. There may be just as many, or more, weary individuals, but there is no longer anything to attract them into the range of the observer. They probably drop down over such a wide area that the observer might scour the thickets all day without finding a single one.

So much for the principle of increasing fatigue. Let us further examine the records in Section II as part of an over-all picture of trans-Gulf migration. Certain existing records of birds over the Gulf correlate with observations on land during fair weather, and other observations also parallel exactly the situation on land during adverse weather. As previously pointed out, Frazar and Helmuth are the only two competent observers who have encountered cold-front storms on their trips at sea. Each observer noted great numbers of passerine birds; Frazar's notes suggest possibly as many as 400 or more individuals in the short interval of several hours. Since great concentrations of migrants are always noted on the central Gulf Coast after cold-front storms, the fact is apparent that Helmuth's and Frazar's observations are a counterpart at sea of a now well-known phenomenon on land. But they are no more than what we might expect from previous considerations regarding the scope of trans-Gulf migration. We have seen that in fair weather on the Gulf most birds are passing over at elevations too high to be detected and that the number and variety increase in direct ratio with increasingly adverse weather conditions. Now, in the final stage, we observe that a cold-front storm brings down

the entire overhead flight to visible levels. Frazar's and Helmuth's records can hardly be regarded as anything but a visible demonstration of the immensity of trans-Gulf migration.

B. COASTAL OBSERVATIONS OF THE ARRIVAL AND DEPARTURE OF TRANS-GULF MIGRANTS

Further evidence of the magnitude of trans-Gulf migration is to be found in the large flights of birds observed from time to time arriving and departing at the two ends of the trans-Gulf route. This type of evidence will be illustrated here by the accounts of two sets of observers, one in Yucatán, one on the northern Gulf Coast.

Recently, Van Tyne and Trautman (1945) published some highly significant observations made by them in Yucatán. They recorded witnessing the actual departure of an impressive number of birds from the northern coast of Yucatán. During February and March, 1936, numerous flocks of Turkey Vultures (*Cathartes aura*) were seen migrating in a northward direction over the coast. On April 1, 1936, all but a few individuals of some 60 Ruby-throated Hummingbirds (*Archilochus colubris*) noted near the front beach between Progreso and Chicxulub were observed to leave the land and disappear to the northward over the Gulf. Similar observations concerned a Sparrow Hawk (*Falco sparverius*), numerous Barn Swallows (*Hirundo rustica*), and the Least and Semipalmated Sandpipers (*Erolia minutilla* and *Ereunetes pusillus*), all of which were observed leaving the coast near Progreso and flying northward. Of special importance, however, is their note to the effect that "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." On the evening of March 30, between 9:00 and 11:00 P. M., "an unusual number" was said to have passed over.¹

For similar observations of arrival and departure of birds on the northern Gulf Coast I am privileged to publish here in full (*cf.* also, Weston, 1930) for the first time two highly significant observations by Francis M. Weston, of Pensacola, Florida. The evidence of trans-Gulf migration that these notes adduce is apparent and therefore requires no elaboration.

¹ In this connection I might add that lighthouses along the northern coast of Yucatán are said to attract and kill migrating birds during inclement weather. I conversed at length with the lightkeeper at Progreso and was told that sometimes great numbers of small birds are found dead at his light in autumn, this being the only time during migration seasons when rainy nights ordinarily occur at that place.

October 24-25, 1918. This full-moon night was spent by me and a companion in camp at Gulf Beach, an unfrequented (at that time) open beach backed by sand dunes, about 15 miles southwest of Pensacola, Florida. The sky was cloudless, there was no wind, and the gentle surf on the beach made no sound that could be heard at our camp site back among the dunes.

Beginning shortly after dark and continuing steadily until at least 3:30 A.M. (when I finally went to sleep), small birds of several species (to judge from the variety of sounds that they made) were passing overhead in groups of varying size. The tinkling medley of chirps of each group first became audible well to the northward of us, high in the air over the woods and swamps of the back country; then passed over our listening post; then were lost in the distance to the southward, far beyond the shore line and well out over the Gulf. Hardly would the sounds of one group become inaudible in the distance before another would be heard approaching from northward. The flight direction of every group was from north to south without variation or interruption, and none was heard to turn back or to pass in any other direction. There was no means of making an estimate for there could have been many silent members in each group. All that can be said with certainty is that, in the course of the night, many hundreds of birds traversed the tiny hemisphere of sky that lay within our radius of hearing.

The only sound then recognizable to me was the chirp of the Bobolink. I had long known this bird on the Atlantic coast, and had always regarded its distinctive chirp as one of the very few identifiable sounds made by passerine birds during migratory flight. The first group of migrants that passed over early in the evening was made up largely of Bobolinks, and others were heard off and on during the period of observation. The great majority of the chirps heard came from warblers and vireos of several species—this being only a guess at the time, but it is borne out now by my many years of observation of the birds of passage that are most abundant in this region in the second half of October.

Assuming a reasonable average flight speed of 20 mph, and assuming that passerine night migrants do not start their flights in darkness, we can infer that the first group of birds that crossed the beach line that night came from a point not less than 20 miles inland. The birds that passed at 3:30 A.M.—eight hours later—had already traveled 180 miles or more. Their next landfall, if they did not vary their line of flight, was the coast of Yucatán 584 miles away!

April 29, 1945. Pensacola, Florida. Santa Rosa Island: In the course of the forenoon, 3 loose flocks of from 15 to 25 Nighthawks (*Chordeiles minor*) had been seen flying northward overland, coming from the direction of the open Gulf and making slow progress against a fresh northerly wind. Finally, at about noon, I saw with the aid of binoculars a fourth flock actually coming in over the Gulf. When first seen, the flock was perhaps a quarter mile offshore, the birds in close formation and flying so low over the water that, from my position high up on the beach, they could hardly be seen against the background of waves. They held their course at the low elevation until they reached the beach, then spread out into a straggling flock, rose to a height of about 50 feet, and passed inland after the manner of the earlier flocks. This episode refutes the preconceived idea that the Nighthawk, one of the few species of land birds capable of feeding while in flight, reaches this region solely by overland flight around the Gulf of Mexico. FRANCIS M. WESTON.

We have reviewed three strong indications of the vast scope of trans-Gulf migration: (1) the similarity of transient migration over the Gulf

and transient migration over the adjacent land; (2) the tremendous numbers of birds recorded by Frazar and Helmuth during cold-front storms offshore; and (3) some of the observations of the number of low-flying migrants arriving and departing from both the northern and southern Gulf coasts during seasons of migration. While these considerations are of tremendous force, especially when taken together, they are conceivably subject individually to other interpretations and hence do not constitute positive proof. Can the intensity of trans-Gulf migration be subjected to a more decisive test? Can less circumstantial proof be secured? Fortunately, the answer is in the affirmative. Such a test was made on May 5 and 6, 1945, during my stay in Yucatán and should erase any lingering doubts as to the scope of trans-Gulf migration.

C. TELESCOPIC STUDIES OF MIGRATION AT PROGRESO, YUCATÁN

During the weeks preceding my trip to Yucatán, I had become intimately familiar with a method of obtaining valuable data on nocturnal migration. Painstaking telescopic studies were begun at Baton Rouge in late April of birds passing before the moon. In this undertaking I had the indispensable assistance of Dr. W. A. Rense, Professor of Physics and Astronomy at Louisiana State University, who devised mathematically precise reductions of the data, and of H. B. Boudreaux and Robert E. Tucker, who devoted many long hours to the actual observations. The results achieved and the details of technique, which follow in general lines laid down by Winkenwerder (1902), Stebbins (1906), and Carpenter (1906), are too extensive to be appended here and will be published separately after completion of additional work now in progress. A paper by Rense (1946) covering astronomical and mathematical aspects of the problem has already appeared.

Here, it is sufficient to tell what the method accomplishes. Virtually all birds passing between the telescope and the moon can be seen and counted. Their apparent paths can be plotted on diagrams of the moon and the true average direction of flight later computed by formula. Species can seldom be identified, but to an experienced observer there is no confusion whatever between an object that streaks by at low level and a bird that crosses before the moon's disc high above the earth. The space under observation has the shape of a slender, inverted cone, averaging only 30 feet in diameter at the 2000-foot elevation. Because of the upward widening of the cone, the dimensions of the section in which birds actually appear vary with the altitude of the birds, as well as with the changing phases and positions of

the moon. All of these factors can be determined astronomically. Obviously, the birds that can be seen in the space under observation provide only a tiny sample of the total number in the vicinity, and even a vast flight will be represented by a relatively small number of recorded individuals. The intensity of migration can better be visualized if the foregoing data are used to compute the flight density, *i. e.*, the theoretical number of birds per hour passing over a one-mile line on the earth's surface at right angles to the average direction of flight. This concept makes it possible to compare rates of migration at different points on a statistically equal footing. In computations of density it is mathematically accurate to assume that all birds are flying at a median altitude of flight density. The experience of Carpenter and Stebbins (*loci cit.*), supported by actual parallax measurements of the altitude of flight made at Baton Rouge, indicate that the median point does not exceed 2000 feet. This is the figure employed in the present calculations.

On the mornings of May 5 and 6, 1945, this tested method was put to work at Progreso. I used a 19.5-power B. and L. Spotting Scope on a tripod with an adjustable head, mounted on the deck of the 'Bertha Brøvig.' The ship's radioman, Kristian Akselsen, showed great interest in the problem and mounted the ship's telescope on a machine-gun turret above the bridge to make simultaneous observations and thereby become acquainted with the technique. The ship lay motionless at a pier about 100 yards from shore, but the diurnal path of the moon was such that the portion of the sky under observation was largely over land. The waning moon rose late, confining the work of both mornings to a short period before dawn.

The results are summarized in Table 2. Several of the observations made at Baton Rouge are included as a standard of comparison. *All of the migrating birds counted at Progreso were flying almost due north, out over the Gulf, in the direction of the coast of Louisiana and*

TABLE 2

Location	Date	Interval (hours) ¹	Central Standard Time	No. of Birds	Flight Density
Baton Rouge, La.	April 25	1.17	7:45- 8:55 P.M.	89	10,030
Baton Rouge, La.	April 25	.75	9:08- 9:53 P.M.	26	6,205
Baton Rouge, La.	April 25	.67	10:45-11:25 P.M.	9	2,975
Baton Rouge, La.	April 26	1.63	7:50- 9:28 P.M.	23	2,550
Baton Rouge, La.	April 26	2.50	10:35- 1:04 A.M.	32	2,635
Progreso, Yuc.	May 5	.75	2:45- 4:00 A.M.	12	3,710
Progreso, Yuc.	May 6	1.00	3:20- 4:20 A.M.	8	1,960
Baton Rouge, La.	May 18	1.00	8:30- 9:30 P.M.	3	1,302

¹ This represents the actual length of time the moon was under observation. "Times out" for making adjustments on the tripod, for recording the altitude and azimuth of the moon by instrument, or for periods when clouds were in front of the moon, etc., are thereby accounted for.

Mississippi. A glance at a map will show that the location of Progreso, far out at the northern extremity of the Yucatán Peninsula, excludes all probability that these birds might later have turned to avoid a Gulf crossing.

These data furnish only a hint of the important facts that may come to light as this line of investigation is continued. But already they permit conclusions of far reaching significance. The observations at Progreso were made over six hours after dusk. Therefore they probably represent birds that had been on the wing during most of the night, birds from the southern part of the Yucatán Peninsula or points even farther south. We now know that trans-Gulf migrants leave the coast of Yucatán at times other than the much cited 'late afternoon or early evening.' Since they doubtless leave then, too, as well as at other hours (Van Tyne and Trautman, *loc. cit.*), it becomes still easier to understand why birds appear on the northern shores of the Gulf at any hour when forced down by bad weather.

Most important of all, the densities at Yucatán show a close numerical relation to the densities at Baton Rouge. To be sure, there are difficulties. Flight densities vary not only with location but also with the hour of the evening, with different weather conditions, and with all the changes in attending factors that go with a different date. Moreover, because of the varying flight speeds of individual migrants, the composition of a given segment of flight changes from hour to hour. Hence, no single density at Baton Rouge is strictly comparable with the 3-4 A. M. observations at Progreso. However, taken as a whole, the table shows that during the period considered, the seasonal trend in observations is consistently downward. The densities at Progreso fit this trend as perfectly as though they, too, had actually been recorded at Baton Rouge. In other words, observations so far show migrants leaving Yucatán at rates sufficient to account for rates at which they have appeared in Louisiana. It is too early to say that trans-Gulf migration is the only source of nocturnal flights up the lower Mississippi valley, but at least we have a clear indication that it is a major source.

The flight-density concept has its soundest application as a means of correlating and comparing sets of observations, as has just been done. It is primarily a statistical quantity and does not necessarily express the number of birds actually present on a given one-mile front during a given hour. However, conditions along the whole middle section of the northern coast of Yucatán are remarkably uniform. It is a rather flat region unmarked by rivers and other physiographic features that birds might be presumed to follow in migration. There is a good

chance that telescopic data from any station in this area will provide a representative sample of the whole. There is no reason to assume that flight densities at Progreso, 40 miles east of the western 'corner' of the peninsula, are greater than at any other point along a 100-mile stretch of the coastline. Even allowing for a wide margin of error, we can safely conclude from these densities that, on May 5 and 6, 1945, birds were passing northward over the coast of Yucatán by the hundreds of thousands.

Therefore, the flight densities at Progreso lend factual support to the already inevitable conclusion that the birds seen out over the Gulf are merely the visible fraction of an immense flight passing high overhead. The long-standing view that trans-Gulf migration is of vast proportions is sustained.

D. BASIC FALLACIES IN THE ARGUMENTS AGAINST TRANS-GULF MIGRATION

Now that the flight of birds across the Gulf has been directly demonstrated, Williams's arguments against the theory of trans-Gulf migration automatically lose significance. Yet it may not be generally apparent just what was wrong with them.

To begin with—and this point is very fundamental—Williams apparently failed to recognize that trans-Gulf migration and coastwise migration are not mutually exclusive operations. To prove the one is not to disprove the other. To show that some birds migrate up the coasts of Texas and México is not to show that they all do. If so, it would disprove not only trans-Gulf migration but migration up the coast of Florida as well.

To be sure, this works both ways. Proving that birds migrate in numbers across the Gulf does not prove that others do not make the journey by the coastal routes. But that is exactly the point. No one has ever pretended that it does. From the first moment that Cooke proposed the theory of trans-Gulf migration, he recognized that several species of birds travel mainly by the coastal route while others do so in part. Subsequent ornithologists (Chapman, 1926 ed. *et seq.*; Wetmore, 1926; Lincoln, 1935 and 1939) did much to amplify this consideration. Thus it is strange that such birds are the very same ones that bulk large in Williams's direct evidence for coastwise migration—the diurnal flyers and the littoral feeders—herons, terns, shorebirds, geese, hawks, and certain swallows. Besides these, there are many land birds that winter in México for which a direct line of flight to the summer home would not cross the Gulf at all.

Because Texas, itself, is to all intents and purposes a part of the

northern Gulf Coast, conclusive observations tending to enlarge the proven scope of coastwise migration can never be sought there. When we see birds in the middle of the Gulf, we know that they could get there only by flying over three hundred miles of water and that they can get away from there only by flying over three hundred more. But when we observe birds on the coast, there is no certain way of knowing from which direction they have arrived. This is especially true on the coast of Texas where so much of the coastline lies parallel to the general north-south trend of migration.

Williams presented a table of 56 species of migrants which purported to show an overwhelming abundance of species and individuals along the sides of the Gulf and their corresponding rarity in the middle of the Gulf Coast region. Aside from omitting a number of critical species, Williams based his table on his unexcelled knowledge of the bird life of the northern Texas coast, where, naturally, he was able to show impressive representations. But for information on the other regions he had to rely on published reports. In regard to the central Gulf Coast region especially, there is a wealth of unpublished data which renders practically every one of Williams's designations of status hopelessly misleading. Indeed, this also appears to be true of every region except the one with which Williams had firsthand knowledge and on which he can authoritatively speak. For example, there are notable inconsistencies in his table with respect to the lower Texas coast and with information which L. Irby Davis has kindly supplied me (*in litt.*) regarding the status of migrant species in that region. For instance, Williams records the Golden-winged and Blue-winged Warblers as "regularly and frequently seen" on the lower Texas coast, but Davis considers these as rare migrants. Many others listed by Williams as "regularly and frequently seen" on the lower Texas coast merit from Davis the much more moderate ascription, "uncommon migrant."

These inconsistencies are merely illustrative of the fundamental fallacy which the table presents. To draw up such a table on the basis of all of the facts would be a gigantic undertaking that would dwarf many current works in ornithology of even broad scope. Such a table would have to include every species that winters south of the Gulf, wholly or in part, and it would have to be based on the hundreds of published and unpublished records of each bird. Furthermore, some system would have to be devised whereby proper cognizance would be taken of the varying amounts of field work in the different sections, since the number of records of any species is in direct proportion to the number of man-hours spent in the field.

Williams emphasized that on the Texas coast migrants are often abundant close to the shore, but that a short distance inland they are notoriously rare or absent. This, to him, represented evidence of coastwise migration. However, I feel confident I have already amply demonstrated both here and elsewhere that this same situation holds true along the entire 700-mile breadth of the northern Gulf Coast. The logical explanation lies in the principle of the coastal hiatus: birds approaching land from across the Gulf in the face of strong adverse winds come down on the first available land and hence pile up in tremendous concentrations on coastal islands, ridges, and cheniers. In other words, birds hard pressed to reach shore seek the shelter of their first landfall and do not attempt to cross the miles of extensive marsh lands that usually lie back of the coast. It is significant that this principle fits the situation on the central Gulf Coast as well as it does the Texas coast.

The theory of trans-Gulf migration is admittedly fraught with enigmas and, for this reason, there may have been some who hastened to abandon it when an alternative was presented, simply because the 500-mile over-water flight puts such a strain on our credulity. We are asked to believe that small birds are either capable of flying at many times the speed they have been observed to fly over land, or else that they can remain in the air for a considerable period without food or rest. However, the coastal migration theory offers a superficial alternative. By postulating that the birds fly entirely near land, we at least have a place for them to come down when they are exhausted. Doubtless there are some who up to now have subscribed to Williams's theory because of this possibility. However, the alternative that this viewpoint presents is not valid, even as a basis for speculation. Williams agrees that even he does not see many birds in fair weather, and examination of the reports of Davis (*loc. cit.*) from the Brownsville region of southern Texas reveals likewise that during periods of fair weather very few transients are seen. Consequently, we are being asked to believe that the birds stay out of sight up in the air as they pass along the Texas coast. Our credulity now suffers a greater shock than before. Instead of struggling with one 500-mile flight, the birds must fly continuously over twice that distance if they follow the general coastline. The coastal route is the long way around.

Still, this is precisely what Williams's theory of coastal migration postulates in its restricted sense (*i. e.*, on the premise that there is no trans-Gulf migration). The well-known and frequent concentrations of thousands of small transient land birds on coastal islands and ridges along the northern Gulf shore and near the mouth of the Mississippi

River must necessarily come from somewhere. Since Williams's thesis is that they do not come from across the Gulf, he simply extends his hypothesis that nearly all birds migrate up the coast of eastern México and Texas on one side, and Florida on the other. On reaching the northern Gulf Coast he has many of them turn abruptly eastward or westward, as the case may be, and fly something like 400 miles from either direction toward the Mississippi Delta, whence again they make another abrupt right-angle turn and proceed up one of the rivers flowing into the Gulf. Therefore, Williams's concept of coastwise migration requires that birds fly a much greater distance over land by a circuitous route than would be necessary if they crossed the Gulf directly.

Williams's paper deals only with spring migration. Therefore we do not know if he considered fall migration across the Gulf beyond refutation, or, on the other hand, if he thought 'disproving' trans-Gulf spring migration automatically disproved trans-Gulf fall migration.

Williams's *Season* reports in 'Audubon Magazine' discussing the status of the bird life on the Texas coast are great contributions to Gulf Coast ornithology. Consequently, it may be hoped that we can look to him ultimately for the irrefutable direct evidence that Cooke was correct when he proposed many years ago that many land birds migrate to and from eastern México by way of the Texas coast.

SUMMARY

Scores of records of 62 species of birds seen crossing the Gulf of Mexico during the period of migration are now available. The intentional nature of these crossings is demonstrated by the fact that all except one of these birds was proceeding in the seasonal direction of migration. Trans-Gulf flights of tremendous magnitude are indicated by the exact parallel between the phenomena of migration over the Gulf Coast regions and over the Gulf itself, by observations of flocks of low-flying migrants seen from land at the beginning or at the end of their trans-Gulf journey, and by the high flight densities over the coast of Yucatán in spring as revealed by telescopic studies. All evidence adduced by other workers to show that land birds migrate by coastal routes exclusively is compatible with the theory of trans-Gulf migration when it is properly understood.

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PHOEBES IN CENTRAL NEBRASKA

BY H. ELLIOTT McCLURE

Two species of phoebes, the Eastern Phoebe (*Sayornis phoebe*) and Say's Phoebe (*Sayornis saya saya*), occur in central Nebraska. In eastern Nebraska the Say's is rare, while in western counties the eastern species is seldom found.

In the summer of 1941, phoebes were noticed nesting upon the upper surfaces of stringers beneath irrigation and road bridges. Nests were observed at 76 bridges within 20 miles of Ord in 1942 and at 95 in 1943. They were checked at weekly intervals, fledgling phoebes were banded, and a record was kept concerning the numbers of young raised and the use of bridges by the two species.

Central Nebraska is almost at the westernmost limit of the range of