sible, I should say that over-abundance of some natural enemy was the cause. House cats may have been responsible. Hawks and owls certainly were not, for they have been very rare in this region for years. Black snakes and house snakes may have had a good deal to do with the matter for they are abundant hereabouts and they frequent such situations as are chosen by the Carolina Wren as nesting sites.

2. The House Wren and Carolina Wren may inhabit precisely the same region without friction; but the House Wren and Bewick's Wren, or the Bewick's Wren and Carolina Wren, or all these species, evidently do not. Ecologically speaking the vicinity of Bethany appears to be ideal for the Bewick's Wren, save for the presence of the other two nesting species of the family Troglodytidae.

BETHANY, W. VA.

THE FALL MIGRATION OF MOURNING DOVES

BY WILLIAM BREWSTER TABER, JR.

At the suggestion of Mr. Samuel E. Perkins III, I have undertaken the interpretation of migration data of the Mourning Dove, (*Zenaidura macroura*) as revealed by the bird banding method. At the outset I should like to point out that there will be developed theories which these data seem to warrant, and that although the data are apparently sufficiently voluminous to warrant the deduction and statement of these theories, it should be understood that until several more years have elapsed and many hundreds more of doves have been banded it cannot be definitely known that any one of these theories always fits the facts. The method of modern science may be divided into three parts; first, the accumulation of data; second, the statement of the significance of these data; and third, the proof of the theories illustrating this significance by experiment or by the further accumulation of data. It is with the first two parts of the scientific method that this paper deals. Whether or not several of the theories herein developed will be tenable after further evidence is accumulated it remains for the future to disclose.

It is pertinent here to say that the true scientist, ever a seeker of truth, cannot expect a statement of theory or fact to disclose its entire significance. Knowledge of any subject can never be consummated nor final, for as new truths are discovered and new methods of investigation devised, the light of scientific research casts ever changing shadows whose depths must be carefully plumbed, and discovers to the gaze of seekers new high lights of truth, thus throwing an entirely different

perspective upon the matter. One of our greatest naturalists has related that scarcely one of the theories he formed at first has withstood the tests of time.[1]

However, it is clear that the time has come when much of the knowledge of migration as disclosed by the bird banding method should be publicly stated and discussed. After eight consecutive years of extensive effort on the part of hundreds of banders surely much information has been obtained worthy of publication. It is to help fulfill this need that this paper has been written.

The subject of the *fall* migration of Mourning Doves has been taken simply because the banding method has only given returns for this particular migration. There are no data of the northward spring migration since the few returns for doves banded during the winter months in the south were made at or near the stations where the bands were placed. The abundance of data on the fall migration contrasted with the complete lack of data upon the spring is due to the hunting propensities of the people of the southern states. Although doves are classed as game birds in all localities they are hunted extensively only in the southern states. If it were not that they are game birds the return data would have been too meager to warrant any deductions.

In Figure 1 there is given a graphic representation of the migrating flights of doves, which includes all returns reported to the Bureau of Biological Survey by March 26, 1928. In order to show the trend of flight to different localities lines were drawn connecting the spots representing the banding stations in the north to the spots representing the localities in the south where each bird was retaken. When examining this map it should be borne in mind that not all of the flights represented are necessarily direct, that is in several cases one or more migration seasons may have intervened between the times of banding and recapture. Thus one dove banded at Kansas, Illinois, in May, 1924, was recaptured at Moultrie, Georgia, in January, 1926, after the lapse of two fall migration seasons. Such an occurrence, however, is the exception rather than the rule, for over sixty per cent of all the recaptures were made after only one fall migration season had elapsed. (See Table I). It must also be realized that the spots representing the banding stations do not show the nesting locations of many of these birds. Since a considerable number were trapped during the fall or spring migrations, many of them were caught while actually in

[1]Charles Darwin's Autobiography, "Little Masterpieces of Autobiography," Volume 2, page 58.

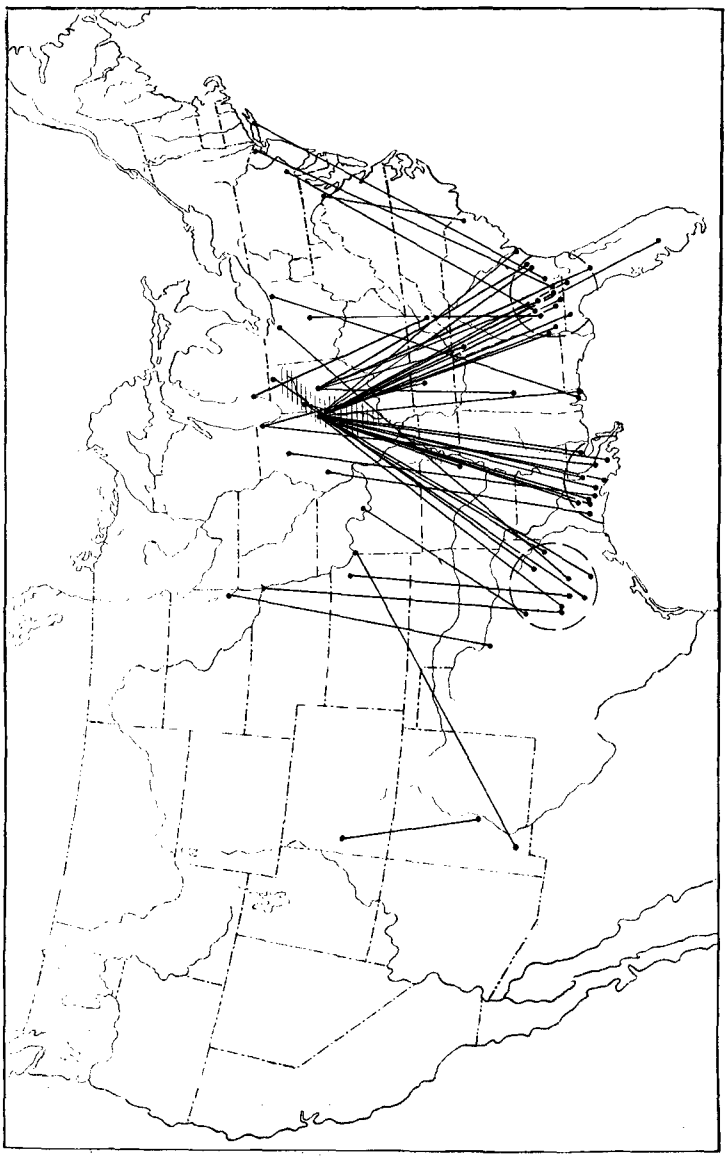

FIG. 1. Diagram to show the locations of banding and recovery of Mourning Doves.

the process of migration to or from their nesting locality, which in some cases, was undoubtedly considerable distances farther north.

Examination of the map at once shows that there are apparently three distinct areas in which doves concentrate for the winter. These areas are in the order of intensity of concentration, southern Georgia and northern Florida, southern Louisiana, and northeastern Texas. There may be three possible reasons for this *apparent* concentration, as follows:

1. That there is an actual concentration of doves in these localities.
2. That Mourning Dove hunting is more intense in these localities.
3. That dove hunting is more intense in these localities because of the concentration of doves there.

The third reason seems the more likely. Personally I have had no experience in the matter, never having been in the southern states. However, Mr. F. C. Lincoln has written me of his experiences concerning the wintering of doves in southern Georgia. He says, "Doves are extremely abundant at that season, particularly in the southern and southeastern parts of the state."

The map also shows that there is a boundary which determines the concentration areas to which doves migrate. This boundary is the Wabash River Valley, shown cross hatched. All birds trapped at points east or southeasterly of the Wabash River Valley migrate to the Georgia concentration area or its vicinity. Those nesting in or migrating through the Wabash River Valley migrate to any of the three concentration areas. Those trapped west of the Wabash River Valley migrate only to Louisiana or Texas. It would be absurd to state that never does a dove violate these rules, but nevertheless the data certainly indicate that in the majority of cases the Wabash River Valley serves as a boundary line for the fall migration.

Although the lines on this map connecting the points of trapping and the points of recapture have been drawn straight, it is an entirely unwarranted presupposition that the migration flight of any individual is in a straight line. There must be more or less wandering from one side to the other of the direct course to the point of destination. We have at present no information concerning the peregrinations of doves on their migratory flights. Nevertheless, it is evident from Figure 1 that mountain ranges form barriers which are not commonly crossed. Those birds trapped in Ohio, Indiana, and Illinois, and which were recaptured in southeastern Georgia either skirted the southern end of

the Unaka and Great Smoky Mountains or made their way through the valleys and the passes where the altitude is not great. The two doves recaptured in New Mexico also show the tendency to avoid high altitudes.

Table II gives data showing the relative times at which doves first arrive in the several concentration areas. Although it cannot be definitely said that the first migratory doves arrive at a particular concentration area upon a certain date, an average date of the earliest recaptures for a given number of doves in each area will indicate which areas are occupied first, and approximately how much earlier one area is occupied than another. The average date of recapture of the first eight doves in each area was Texas, October 16, Louisiana, November 15, and Georgia, December 6. As several of these eight birds recaptured in each area either originated in or passed through the Wabash River Valley, it is interesting to note the respective distances from Kansas, Illinois, a central point in the Wabash River Valley, to the three concentration areas. These straight line distances are approximately, to Texas, 750 miles, to Louisiana, 650 miles, to Georgia, 620 miles. It will be noted that although the distance flown to the Texas concentration area is greater than to the other two, the Texas concentration area is occupied the earliest. Three possible reasons can be given for this phenomenon:

1. The first migrants to leave the nesting locality fly to Texas.
2. The migrants to Texas fly more rapidly.
3. The earliest migrants fly to Texas and they also fly more rapidly.

In considering this matter it would be well to examine the game laws which determine the hunting seasons of these three areas and discern whether or not these data are vitiated by this artificial factor. At the time in which these data were secured, the open season for doves in that portion of Texas in which all the recaptures were made was from September 1 to December 15; in Louisiana, from November 1 to January 31; in Georgia and northern Florida from October 16 to January 31.[2] It should be noted that although the hunting season in Texas opened September 1, only two of the first eight recaptures occurred in September, while the majority occurred in October. In Louisiana all of the first eight recaptures occurred in the first month of open season. In Georgia and northern Florida not one of the first

[2]Migratory Bird Treaty Act.

eight recaptures occurred within the first month of open season. It is plain, therefore, that in Texas and Georgia the hunting season did not affect the times at which the first eight doves in each area were retaken, for the majority of recaptures were made after the season had been open for a considerable time. In Louisiana the hunting season may have influenced the time of recapture. If the open season had determined the dates upon which the earliest birds were recaptured, we would have found that these earliest recaptures were bunched into the first few days of the open season. In the Texas and Georgia areas this was certainly not so.

In order to be able to judge of how rapidly the migration southward progresses some idea of when migration commences at a northerly latitude must be ascertained. This date for Kansas, Illinois,

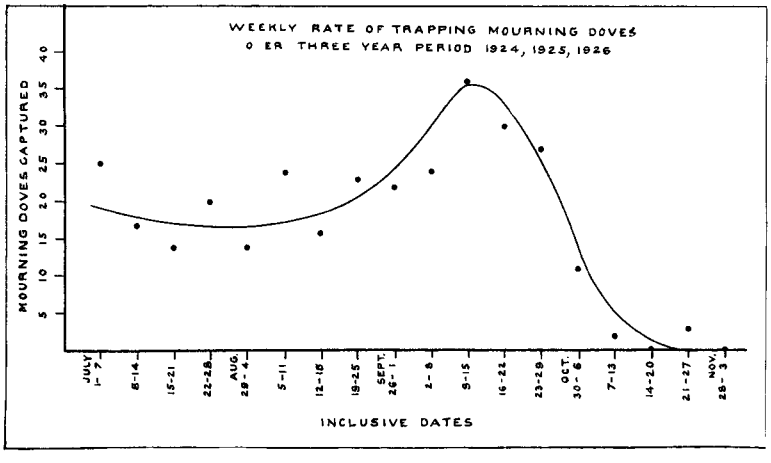

FIG. 2. Graph indicating the number of trapped and banded Mourning Doves in the fall season; which also serves as a measure of the intensity of migratory movement.

which is situated in the east central portion of the state, may be determined since here I have banded a sufficient number of doves over a period of three years to enable reliable deductions to be made. In Figure 2 there is graphically shown the totals of three years of dove trapping week by week beginning with July 1, and ending November 3.[3] All doves including repeats and returns have been counted. In all three years neither the number nor style nor location of traps was changed during any one season; and except for a few interruptions

[3]Data for this curve are shown in Table 3.

of two or three days extent the trapping was continuous. It can be seen from the average smooth curve line drawn among the points representing the total weekly catch over the three year period, that the intensity of trapping gradually decreases up until about August 1, then slowly increases until August 20, from that date increasing ever more rapidly until a sudden high peak is reached the second week in September. From then on the intensity of trapping rapidly decreases until by the early weeks of October scarcely any doves are caught. This intensity of trapping is an excellent measure of the intensity of migration. This is evident during the spring migration as well as during the fall migration. This curve shows that at Kansas by August 20, migration has sensibly begun, reaches its peak of intensity by the second week of September, and except for a few tardy birds is practically complete by October 1.

When attacking the problem of speed of migratory flight the banding method offers no positive evidence, for one can never be sure that any particular individual commences its migratory flight as soon as released from the banding station nor that it is recaptured immediately upon its arrival at its winter quarters. However, if all the available evidence is brought to bear upon the subject and the matter is approached from several different standpoints each method of approach giving approximately the same result, we may be reasonably certain that our results are not far from the truth.

Let us first consider the time of departure of the earliest migrants from Kansas, Illinois, and the times of arrival of the earliest doves at the three concentration areas. Table IV gives the data in concise form.

If now we investigate the speeds developed by individuals in their migratory flights there are two cases in which less than seventy days elapsed between the time of trapping and the date of recovery. Neither of these two repeated so the date of banding is the date on which they were free to migrate. Table V gives the complete data.

The average rate of travel 9.4 and 9.3 miles per day is the *minimum* rate of travel for each bird. It is quite possible that they actually traveled faster than this, but it is not likely that they greatly exceeded this speed for these are the two fastest rates of travel which the banding data afford.

Dove number 19008 gives additional evidence. Since this dove had been banded in June of the same year and was at Nashville, Tennessee, on September 28, it was on its migratory flight. If it had been free to continue its journey the additional 350 miles to southern Georgia and had traveled at the average rate of 10 miles per day, it

would have arrived November 2, and would have been among the earliest arrivals. Consequently it could not be expected that this rate of travel would have been much exceeded.

There is one more angle from which to look at the subject. Since it is based greatly upon conjecture it would have little weight of itself, but in connection with the circumstantial evidence already given it seems worthwhile mentioning. If it is assumed that the very last migrants of the season which pass through Kansas, Illinois, come from the northern extremity of the nesting range and that they begin their migration about August 20 and travel at an average rate of 12 miles per day, then since the last few scattered flocks of migrants have been observed to pass Kansas, Illinois, about November 1, or 70 days later, it would be expected that the northern extremity of the nesting range is about 850 miles farther north or at about 52° latitude. This, I believe, is the case.

To sum up all this evidence, which is purely circumstantial and none of it demonstrative, it seems quite certain that Mourning Doves migrate in the fall at an average rate of from about 6 to 13 miles per day. It also seems highly improbable that this rate is exceeded by much.

This slow rate of migration is in marked contrast to the strong rapid flight of Mourning Doves which often exceeds 35 or 40 miles an hour. Since only a part of a day of continuous flight would enable doves to traverse the greater part of the distance to their winter quarters, it must be that after a very few hours of migratory flight flocks will dally near one locality for several days or even weeks before resuming their southward course.

Cooke states that the average rate of migratory flight of all birds is approximately 23 miles per day.[4] His paper does not mention Mourning Doves. But then it is quite possible that at the date of that publication (1915) it was not known that Mourning Doves migrated. This seems to have been a point not accepted by all ornithologists.[5] At any rate the habits of doves are such that Cooke's methods of investigation could have yielded little information upon their migration, since they are more or less resident all the year around over at least most of their range and there are no distinguishing marks between the migrants and non-migrants.

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[4]Bird Migration, by Wells W. Cooke, Bul. 185, U. S. Dept. of Agriculture, page 45.

[5]Bird Banding in America, by F. C. Lincoln, Smithsonian Report, 1927, page 345.

Bird banding returns yield a little information about non-migrants. There are two returns of doves recaptured in the winter at or near the northern banding station in which they were originally caught. Number 319212 was banded by Mr. Perkins in the nest as a fledgling September 6, at Indianapolis. It was recaptured near Indianapolis the 29th of the following December. Dove number 283786 was trapped at Kansas, Illinois, in immature plumage October 6, and was killed by flying into a locomotive on the 31st of the following December at Hutsonville, Illinois, only thirty miles south. Here are two instances of individuals remaining at or near their summer quarters as winter residents. That they were both immature birds cannot, until additional data are secured, have any significance, for these two instances are insufficient evidence to warrant any deductions. We merely know that sometimes immature doves do not migrate.

Summary

In summarizing this paper the following points may be briefly stated:

Mourning Doves migrate.

In winter migrants from the north concentrate in three areas close to the Gulf of Mexico; namely, southeastern Georgia and northern Florida, southern Louisiana, and northeastern Texas.

The concentration of doves in these areas is greatest in the Georgia area, then Louisiana, then Texas.

The earliest migrants arrive first in the Texas area, then Louisiana, and finally in the Georgia area.

The earliest migrants arrive in noticeable numbers in the Texas area almost two months before the Georgia area is occupied in considerable numbers.

The Wabash River Valley is a boundary line determining to which area doves migrate.

Doves nesting east and southeast of the Wabash River Valley migrate only to Georgia.

Doves nesting in or migrating through the Wabash River Valley migrate to any of the areas.

Doves nesting west of the Wabash River Valley migrate to Louisiana or Texas.

The speed of doves on the fall migration flight varies from about 6 to 13 miles per day.

Migrants to the more distant Texas area fly more rapidly than migrants to the nearer Georgia area.

TABLE I

Foreign Mourning Dove returns up to March 26, 1928.

Banding Locality	Band No.	Date of Banding	Date of Recovery	Locality of Recovery
Colo., Grand Junct...	9793	Aug. 28, 1923	Sept. 5, 192(	N. Mex., Zia
D. C., Washington....	110743	July 25, 1924	Nov. 19, 1927	S. C., Conway
Ill., Clayton	440569	July 22, 1926	Nov. 6, 1926	La., Lake Charles
Ill., Kansas	287598	June 30, 1925	Sept. 22, 1927	Ala., Easonville
Ill., Kansas	287631	Aug. 11, 1025	Jan. 21, 1926	Ala., Perdido Beach
Ill., Kansas	440631	June 5, 1926	Dec. 9, 1926	Ark., Forrest City
Ill., Kansas	440646	June 25, 1926	Jan. 19, 1928	Fla., Jasper
Ill., Kansas	275206	Sept. 21, 1923	Nov. 29, 1923	Fla., Tallahassee
Ill., Kansas	315832	July 3, 1924	Dec. 6, 1925	Fla., Wauchula
Ill., Kansas	440672	July 12, 1926	Dec. 17, 1926	Ga., Baxley
Ill., Kansas	315801	June 16, 1924	Dec. 24, 1924	Ga., Brooks County
Ill., Kansas	283864	Apr. 22, 1925	Jan. 15, 1926	Ga., Donalsonville
Ill., Kansas	287635	Aug. 12, 1925	Nov. 24, 1927	Ga., Ft. Gaines
Ill., Kansas	314061	May 22, 1924	Jan. 29, 1926	Ga., Moultrie
Ill., Kansas	315837	July 5, 1924	Jan. 1, 1926	Ga., Savannah
Ill., Kansas	281741	Aug. 18, 1924	Feb. 9, 1925	Ga., Valdosta*
Ill., Kansas	281702	July 24, 1924	Dec. 22, 1924	La., Cataro
Ill., Kansas	287635	Aug. 12, 1925	Nov. 24, 1927	La., Iberia Beach
Ill., Kansas	283883	May 3, 1925	Jan. 13, 1926	La., Mandeville
Ill., Kansas	281715	Aug. 5, 1924	Nov. 27, 1924	La., Midland
Ill., Kansas	440603	June 1, 1926	Nov. 15, 1926	La., Milton
Ill., Kansas	287584	June 19, 1925	Nov. 15, 1926	La., Morgan City
Ill., Kansas	274615	Sept. 1, 1923	Nov. 8, 1923	La., New Roads
Ill., Kansas	442354	May 23, 1927	Nov. 8, 1927	La., Ridge
Ill., Kansas	287579	June 16, 1925	Oct. 31, 1925	Texas, Brenham
Ill., Kansas	287654	Sept. 14, 1925	Dec. 29, 1927	Texas, San Augustine Co.
Ill., Kansas	361938	Apr. 25, 1926	Oct. 20, 1927	Texas, Waco
Ill., Ohio.....	374892	June 2, 1926	Nov. 16, 1926	La., Vermillion Parish
Ill., Waukegan	359172	Apr. 29, 1927	Jan. 26, 1928	La., Belle Rose
Ill., Waukegan	19008	June 18, 1921	Sept. 28, 1921	Tenn., Nashville
Ind., Goshen	463609	June 12, 1926	Jan. 13, 1928	Texas, Chandler
Ind., Indianapolis	10119	June 19, 1922	Nov. 25, 1922	Ala., Marion
Ind., Indianapolis	283498	June 5, 1925	Nov. 26, 1925	Fla., Gainesville
Ind., Indianapolis	547002	June 15, 1927	Dec. 20, 1927	Ga., Baxley
Ind., Indianapolis	546928	June 23, 1927	Jan. 22, 1928	Ga., Curryville
Ind., Indianapolis	218942	May 25, 1924	Dec. 25, 1924	Ga., Doerun
Ind., West Lafayette	284059	Apr. 19, 1925	Oct. 14, 1925	Texas, Cameron
Iowa, Sioux City.....	288041	July 16, 1925	Sept. 24, 1927	Texas, Waco
Kans., Kansas City..	441014	June 20, 1927	Sept. 17, 1927	N. Mex., Luna Co.
Kans., Mayetta	339492	Aug. 3, 1926	Oct. 14, 1927	Texas, Falls Co.
Mich., South Haven	314026	June 10, 1924	Dec. 2, 1927	Tenn., Hubbard
Mo., Columbia	266941	June ...., 1924	Sept. 10, 1926	Texas, Fort Worth
N. J., Montclair.....	275327	May 26, 1925	Dec. 24, 1925	Ga., Howell
N. Y., Mastic.....	57969	July 22, 1923	Dec. 15, 1923	Ga., Homerville*
Ohio, Columbus	398616	July 7, 1926	Dec. 1, 1926	Ga., Dougherty Co.*
Ohio, Gates Mills.....	206104	Aug. 18, 1927	Oct. 29, 1927	Ala., Foley
Ohio, Tiffin	360371	Aug. 15, 1925	Nov. 28, 1925	Texas, Marquez
Pa., Newtown Squ're	42829	May 31, 1920	Jan. 28, 1921	Ga., Albany
S. D., Dell Rapids....	374075	June 3, 1926	Oct. 6, 1927	Texas, Wichita Falls

*Date of recovery approximate.

For a list of all dove returns, both domestic and foreign, up to January 1, 1927, *see* Returns from Banded Birds, 1920 to 1923, Dept. Bull. No. 1268, *and* Returns from Banded Birds, 1923 to 1926, Technical Bull. No. 32, U. S. Dept. of Agriculture.

TABLE II

Dates of recovery of first eight migratory Mourning Doves recaptured in each concentration area.

TEXAS AREA		LOUISIANA AREA		GEORGIA & NORTHERN FLORIDA AREA	
Number	Date of Recovery	Number	Date of Recovery	Number	Date of Recovery
266941	Sept. 10	440569	Nov. 6	287635	Nov. 24
288041	Sept. 24	274615	Nov. 8	283498	Nov. 26
374075	Oct. 6	442354	Nov. 8	275206	Nov. 29
339492	Oct. 14	440603	Nov. 15	398616	Dec. 1
284059	Oct. 14	287584	Nov. 15	315832	Dec. 6
361938	Oct. 20	374892	Nov. 16	57969	Dec. 15
287579	Oct. 31	287635	Nov. 24	440672	Dec. 17
360371	Nov. 28	281715	Nov. 27	547002	Dec. 20
Average	Oct. 15	Average	Nov. 15	Average	Dec. 6

TABLE III

Weekly rate of trapping Mourning Doves during summer and fall over a three year period, 1924, 1925, 1926, at Kansas Illinois.

Date	Number of Doves Trapped	Date	Number of Doves Trapped	Date	Number of Doves Trapped
July 1-7	25	Aug. 12-18	16	Sept. 23-29	27
July 8-14	17	Aug. 19-25	23	Sept. 30-Oct. 6	11
July 15-21	14	Aug. 26-Sep. 1	22	Oct. 7-13	2
July 22-28	20	Sept. 2-8	24	Oct. 14-20	0
July 29-Aug. 4	14	Sept. 9-15	36	Oct. 21-27	3
Aug. 5-11	24	Sept. 16-22	30	Oct. 28-Nov. 3	0

TABLE IV

Rate of migratory flight to the three concentration areas.

Area of concentration	Earliest date of departure Kansas, Ill.	Average date of 8 earliest recoveries at concentration areas	Days elapsed	Distance traveled in miles	Average miles per day
Texas	August 20	October 15	56	750	13.4
Louisiana	August 20	November 15	87	650	7.5
Georgia	August 20	December 6	108	620	5.7

TABLE V

Rate of migratory flight of individual doves.

Band No.	Banding station	Date of banding	Point of recapture	Date of recapture	Miles traveled	Days Elapsed	Avg. miles per day
275206	Kansas, Ill.	Sept. 21	Tallahassee, Fla.	Nov. 29	650	69	9.4
274615	Kansas, Ill.	Sept. 1	New Roads, La.	No. 8	630	68	9.3

Mountain ranges form barriers to the migratory flights of doves.

Some immature doves do not migrate the first winter.

If we stop to consider the relationship of this study to the study of bird migration in general, we find that it adds nothing of importance to what was already known.[6] We find that it tells us nothing new of the *modus operandi* of migratory flight, nor does it clarify our understanding of its causes. Migration is still as much of a mystery as ever. However, through the application of the bird banding method some detailed knowledge of the migration of a species, which from its own peculiar habits renders it impossible to study by any other method yet devised, has been secured.

KANSAS, ILLINOIS.

NESTING OF THE WHITE-WINGED JUNCO IN THE BLACK HILLS OF SOUTH DAKOTA

BY W. H. OVER AND C. M. CLEMENT*

During July and August of 1924, while collecting plants along the highway (No. 83) above Pactola in the Black Hills of South Dakota, Mr. Over observed numerous young and adults of the White-winged Junco (*Junco aikeni*). These birds were particularly abundant near a sawmill, and around a barn where horses were kept, feeding on wasted grain, etc. Upon inquiry he learned that they were reared earlier in the season in the immediate vicinity. Search also revealed several old nests, one on a horizontal 2x4 piece of timber bracing the wall and not six feet from the man who took the boards from the saw. Another nest rested on a timber under the floor and just beneath the saw. The band that ran the sawdust-carrier passed day after day within six inches of this nest. Several employees at the mill bore testimony to the fact that young birds were reared in each of these nests. Two other old nests were found, one in the mill, and another on a rafter plate of the roof of the blacksmith shop, nine feet above the ground and in almost the exact spot where in two succeeding seasons Mr. Clement found occupied nests of this species.

During the holiday season of 1924-25 Mr. Over spent a few days in the locality, and found many of these Juncos present and feeding daily around the buildings. They readily responded to an invitation to visit a hastily improvised feed box where crumbs and cracked nut-

[6]See Problems of Bird Migration, by A. Landsborough Thompson, Chap. XVI.

*This paper has been prepared by Mr. Over, but the material is taken largely from the field notes by Mr. Clement. Efforts made in 1928 by Mr. Clement to photograph the nests and birds were not successful.