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BANDING OF CHIMNEY SWIFTS (*Chaetura pelagica*), IN THE REGION OF CHATTANOOGA, TENNESSEE

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THE object of this paper is to supply all bird banders our complete data on the banding of 17,165 Chimney Swifts (*Chaetura pelagica*), in the region of Chattanooga, Tennessee. The work was begun in October, 1928. Two years later our observations and results were recorded in a short paper (Green 1930b). In this we described what we think is the most efficient swift trap possible, made some suggestions about receiving cages, and briefly discussed plans for future work. A month later we published a more extensive discussion of our objectives and pointed out some of our errors in technique in the hope of facilitating the work of other banders (Green 1930c). Since we then moved away from the Chattanooga region we thought it not useful to publish further until all of our results were in, which was 1940. After spending weeks on the analysis of our mass of data they were still not suitable for publication. It may not yet be intelligible to the casual reader; but we hope it will be interesting to at least the more ardent of the Chimney Swift banders.

We are very greatly indebted to several scores of men in the Chattanooga region, in St. Elmo, Soddy, and Jasper, for their timely and enthusiastic assistance in helping to make this paper possible. The author would like to mention especially the eager and agile members of the firemen's squad of St. Elmo who placed the trap on top of the fifty foot chimney of the M. E. Church (Fig. 2), his own students, and all who so kindly gave their permission to use their chimneys in this work. The Tivoli Theater (Fig. 3), was a most favorable place for banding work. The manager gave us his full coöperation. The chimney was gigantic, which created a problem. How could we set such a small trap on such a large chimney? Two of my keenly enthusiastic young men requested that the matter be left to them. So it was. The next morning when we arrived we saw a great massive door leaning against the wall of the theater. In their attempt to solve the problem of partially closing the great opening in the chimney, they explained, they had "borrowed" the sacristy gate from a neighboring church! The much greater problem of how to get such a weighty

covering to the top of the chimney they had not solved. As long as he lives the author will never forget their spirit of helpfulness. He helped carry the gate back.

Some recent papers by Messrs. Calhoun (Calhoun, 1938) and Coffey (Coffey, 1938) have made a review of the literature somewhat superfluous. Mr. Calhoun has laid special emphasis on "repeats and inter-city records" and Mr. Coffey, by the aid of a map, graphically presents the "station to station movements." While the writer believes that he has made a contribution to our knowledge of the swift migrations, in the present paper, he feels that not much more is to be gained in the future by random banding of Chimney Swifts. What is needed now is a *definitely planned* series of bandings. If a group of such indefatigable and enthusiastic banders as Calhoun, Coffey, Lowery, Laskey, H. S. Peters, and others, could get together and plan to have banding operations carried out on the same dates at say eight or ten well located stations ranging, let us say from Montreal to Baton Rouge, more facts could be discovered in one season than will likely be brought to light in decades of further random banding. My own banding work in the Chattanooga region was not coördinated with that of any other bander. Through the courtesy of the Pan American Union, Washington, D. C., I did secure a long list of the names of scientists, naturalists, teachers, etc., from the West Indies, Central, and South America, and sent about one hundred letters accompanied by a Spanish translation, to these men. Only two or three replied, and these seem never to have heard of the Chimney Swifts. Our effort to discover the winter home of the swifts was thwarted.

Some of my records indicate that swifts may stay around the same locality for days or weeks. One bander (Bartram, 1929) says that "No flock ever stayed more than one night in the chimney." Such questions as this, the rate of northward and southward migration, the amount of east and west movements enroute, etc., can only be solved by coördinated effort. Another type of work that needs to be extended is the banding of individual nesting pairs. Mr. R. V. Rapp of Vicksburg, Mich., (*Bird-Banding*, I, Oct. 1930: 191) reports banding a pair of swifts in his chimney on July 20, 1928. On August 19, 1929, he again captured the pair together in the same chimney! The next year, 1930, he took one of the pair again in the same chimney, together with four others. Might these four have been the offspring of the pair? The writer is unaware as to how many pairs have been banded during the last years; but he suspects that most banders have been giving attention to migrating flocks rather than to nesting pairs, and would suggest that the individual banders who are not coöperating in a broad but specific way with other banders will be able to make their greatest contribution to existing knowledge about Chimney Swifts if they

will give some of their attention to the banding of parent swifts and their young before they leave the nests.

The plan of this paper is to present as definite a picture as possible of the behavior of each flock of swifts banded. Following this is an analysis of the proportional recaptures of our swifts at our own stations during the years, 1930, 1931, and 1932.

The table below supplies information as to the band numbers used, how many were used on each banding date, and the location of each of our ten banding stations. (cf. Fig. 7.)

EXPLANATION OF THE CODE NUMBERS USED IN THE DISCUSSION

Code Nos.	*Band Numbers*	*No. of Bands Used*	*Dates*	*Place of Banding*
1.	B-072001 to B-073000	1,000	Oct. 16, 1928	Old grade school building, U. of Chattanooga campus
2.	C-006410 to C-006500	91	May 25, 1929	Office building, U. of Chattanooga campus
3.	C-023501 to C-025000	1,500	Sept. 21, 1929	do.
4.	C-032001 to C-032197	197	Oct. 8, 1929	Store building, Clemons Bros., Chattanooga, Tenn.
	C-036051 to C-037000	950		
5.	No banding, but 985 swifts were examined for bands		Oct. 19, 1929	Central High School, Chattanooga, Tenn.
6.	C-059501 to C-060000	500	Sept. 24, 1930	do.
	F-009001 to F-009380	380		
7.	F-008001 to F-009000	1,000	Sept. 28, 1930	School building, Soddy, Tenn.
	F-009381 to F-011000	1,620		
	F-000001 to F-000030	30		
8.	F-000031 to F-001802	1,772	Sept. 30, 1930	St. Elmo, Chattanooga, Tenn.
	C-062001 to C-062500	500		
9.	F-001803 to F-007000	5,198	Oct. 4–5,1930	Tivoli Theatre, Chattanooga, Tenn.
	F-013001 to F-014159	1,159		
10.	F-014160 to F-015427	1,268	Oct. 9, 1930	Jasper, Tenn.
	Total number banded	17,165		

To facilitate reference to our banding operations we shall use ten code numbers as indicated in the preceding table. Of the total of 17,165 swifts banded at our stations we have recaptured 732 in our own traps, seventy-two of these having repeated one or more times. Those recovered by others number 327, bringing the total up to 1,059. With the exceptions of the work at Soddy, Tennessee, and at Jasper, all of our work was done either in the city of Chattanooga or the immediate environs (See Fig. 7). Soddy is nineteen miles north of Chattanooga, and Jasper is across Walden's Ridge and the Sequachie Valley, twenty-seven miles to the westward. St. Elmo is a suburb about five miles southwest from the center of the city, at the foot of Lookout Mountain. The swifts recovered constitute about 6% of the number banded. We shall first present the results of our banding work station by station.

Station 1. Of the 1,000 swifts banded here (Fig. 1) eighty-one were recaptured by us and twelve recovered by others, a total of

ninety-three. At every subsequent banding we recaptured some of this lot of swifts. We took five of them at station 3, ten at 4, seven at 5, five at 6, seven at 7, eighteen at 8, twenty-two at 9, and two at 10. Also, five were taken in the fall of 1931 at Chattanooga by Dr. Butts.

Names and addresses of others who have recovered one or more of these swifts are as follows: N. Bales, Decatur, Tenn., April 20, 1929, (1); E. J. Pifher, Trout Lake, North Bay, Ont., June 21, 1929, (1); A. Chevrier, Markstay, Ont., June 24, 1929, (1); I. H. Johnston, W. Va., Sept. 2, 1929, (2); C. N. Saunders, Farmer, N. C., June 24, 1930, (1); Hattie W. Anderson, Hollis Center, Me., Aug. 1, 1930, (1); G. W. Bell, Mount Berry, Ga., Nov. 12, 1930, (1); and M. C. Baker and M. O. Merriam, Kingston, Ont., May 7, 1932, (1); Mrs. F. C. Laskey, Nashville, Tenn., Oct. 22, 1939, (1).

While these swifts ranged far north, as indicated by the capture at North Bay, Ont., June 21, 1929, and the one three days later at Markstay, Ont., as other workers have pointed out, they do not migrate in flocks to the same locations year after year. Precisely one year later, June 24, 1930, one was taken at Farmer, N. C. None were reported farther east than Hollis Center, Me. The records of other flocks also indicate a wide range as the swifts moved northward, though reports from west of the Mississippi River are absent so far as this flock is concerned. This is probably due to lack of interest in that region at that time.

There were fourteen swifts in this lot that were recaptured two or more times. Ten of these were retaken twice in our own traps. The most persistent repeater (in this paper, a repeat is a swift banded by us which returns subsequent to banding and is recaptured two or more times, either by us, by Dr. Butts or Louis Cook, who operated at Chattanooga in 1931 and 1932 respectively) was retaken at station 4 one year later, at station 7 another year later, nineteen miles north of Chattanooga, then two days later we got it at St. Elmo, station 8, at the foot of Lookout Mountain, and finally three years later, it was captured again by Dr. Butts in Chattanooga. The history of this bird together with five others out of the ten repeaters raises an interesting question. Two of these six were first retaken at station 4 one year after banding. Then two years after banding, all six were captured at Soddy, Tenn., station 7. Two days later, all six were taken at St. Elmo, at the foot of Lookout Mountain! Still more astounding is the fact that while these six swifts were all banded in the city of Chattanooga and two were retaken one year later in the city, at station 4, and all were together at Soddy and at St. Elmo, only about five miles from the center of Chattanooga, on September 30, 1930, when only four days later at station 9 in the center of the city we banded 6,357 swifts and released several thousand without banding them, only *one* of these six was among the lot, although we at this time recovered twenty-three other swifts which we had banded three

years before at station 1. What could be the bond that held these six swifts together. One of these six was reported from Kingston, Ont., May 7, 1932.

The swift recaptured by Mrs. Laskey was retaken eleven years and six days after it was banded, and it constitutes our best longevity record.

Station 2. Due to the time of the year, May, few birds were taken. The entire catch, ninety-one, was banded. Six were recaptured by us and three by others, all in the fall, except one about which information is not available. Two were taken at station 4, and one at station 5 in 1929, one at station 7 and two at station 9 a year later, one two years later in Chattanooga by Dr. Butts, and one three years later, October, 1932, by Louis Cook, in Chattanooga. Finally, one was reported sometime during 1930 by Fred Dearing, in Chattanooga. There were two repeats of no especial interest.

Station 3. At this station we banded 1,500 swifts September 21, 1929, and released 5,500 unbanded for lack of bands. We recaptured eighty-four of these and twelve have been reported by others. Four were retaken seventeen days later at station 4; nine, twenty-eight days later at station 5. The other seventy-one swifts recaptured by us were retaken within a period of fifteen days one year later, from September 24 to October 9, 1930. Eight were retaken at station 6 in the eastern part of the city, five at station 7 about twenty miles north of the city, seventeen at station 8 in St. Elmo, near the foot of Lookout Mountain, thirty-eight at station 9 in the heart of Chattanooga and three at station 10, at Jasper about twenty-seven miles to the westward. Dr. Butts banded at Chattangoga on October 11, 1931 and captured nine more of this flock. There was a total of ninety-five swifts, fifteen of them being recaptured twice. In spite of the wide ranging of the swifts as they reach the northern latitudes, the facts just related prove that at least one out of every sixteen swifts in this flock went back southward through the Chattanooga region, and suggests that a much larger per cent did the same.

Twelve of this flock have been reported by others as follows: C. B. Gardiner, Norwalk, Ohio, May 7, 1930, (1); A. M. Rueckel, Luxembourg, Wis., June 4, 1930, (1); C. W. Saunders, Farmer, N. C., June 24, 1930, (1); L. Messenger, Bridgetown, Nova Scotia, June 4, 1931, (1); Edna Sims, Manvel, Texas, May 1, 1931, (1); D. Helmick, Pickens, W. Va., May 4, 1931, (1); L. A. Test, W. Lafayette, Ind., Sept. 28, 1932, (1); A. R. Shearer, Mont Belvieu, Texas, April 29, 1934, (1); Mary Cota, Long Lake, Ont., June 7, 1934, (1); Paul E. Sutton, Maryland, N. Y., Mar. 28, 1938, (1); ———, Alexandria, Ont., May 28, 1938, (1); R. B. Brown, Jr., Mt. Vernon, Ohio, Sept. 30, 1939, (1).

These are most significant data, especially from the standpoint of the light which they throw on the subject of random distribution. One might expect that at least the same general region would be occupied by a given flock at the same time of the year. Yet it will

be seen that within a month of the same time we have reports from Norwalk, Ohio, Farmer, N. C., and Luxembourg, Wis. More striking is the separation of these birds a year later. For example, Edna Sims reports one at Manvel, Texas, on May 1, 1931, while just four days later D. Helmick reports one from Pickens, W. Va. After several years some are still more separated at the same season of the year. Note that while Shearer reports a swift from Mont Belvieu, Texas, April 29, 1934, Mary Cota reports another of this flock from Long Lake, Ont., June 7, 1934. It seems strange that birds that are together at one time in migration would at another time be scattered from Texas through the United States to Ontario and Nova Scotia.

The two swifts reported in 1938 were dead. Unfortunately, we do not have information as to how long they had been dead when reported. Otherwise, they would constitute interesting longevity records. The last swift reported from this flock is an important record, since it was recaptured more than ten years after we banded it.

There were a total of twelve repeats, one and two years after banding. None of this fifteen hundred has been recaptured more than twice. Eight of the thirteen repeats were retaken the second time at station 9. Three of these eight had been recaptured only four days before at station 8, at St. Elmo. Of the three swifts that were recaptured at Jasper, one had been trapped at station 9 only four days before.

Station 4. This station was on top of the Clemens Brothers furniture building in the business section of the City of Chattanooga. Here we captured 2,705 swifts on October 8, 1929, and banded 1,146, setting free 1,559 after examining them for bands. A total of 108 were recaptured, eighty-nine at our own stations and nineteen by others. Our eighty-nine were distributed among our stations as follows: Twelve were retaken at station 5 only eleven days later. The other seventy-seven were recaptured about the same time one year later. Six were retaken at station 6, sixteen at station 7, nine at station 8, thirty-nine at station 9, and seven at station 10. Another year later, October 11, 1931, five were recaptured by Dr. Butts, who banded at Chattanooga after I left. In October, 1932, Louis Cook recaptured three more at Chattanooga.

Others reporting swifts from this flock were as follows: Willie Turner, Rocky Face, Ga., June 5, 1930, (1); J. T. Emlen, Jr., West Chester, Pa., June 17, 1931, (1); R. Lawrence, Plummer, Ont., June 29, 1931, (1); T. D. Kidd, Knob Lick, Ky., May 5, 1932, (1); G. Kelker, Roscommon, Mich., June 13, 1932, (1); Bettie Yates, Gascon, Ky., May 22, 1933, (1); C. H. Jensen, Salmonhurst, N. B., June 1, 1933, (1); J. Farnsworth, Westerly, R. I., July 6, 1933, (1); Mrs. A. S. Wickware, Rideau Lakes, Ont., June 1, 1934, (1); I. H. Johnston, Charleston, W. Va., August 23, 1934, (1); C. LeFebre, South Lima, N. Y., June 21, 1934, (1).

It is interesting to note that five out of these eleven birds were reported dead, and that these are the ones reported four and five

years after banding. The percentage of swifts reported dead within one or two years after banding is extremely low. This would suggest that the swift is old at five years, though seven of our swifts were recaptured after six years. The eleven swifts were reported from eight different states, Ontario, and New Brunswick, representing a scattering comparable to that of previous flocks.

Considering that there were only seven repeats, their behavior is very interesting. One group of three appeared about one year after banding at station 6 and ten days later at station 9. Another group of three appeared about one year after banding, at station 7 and eight days later at station 9. In view of the fact that of all the 1,146 swifts banded at station 4, only one other bird repeated, the behavior of the two groups of three seems astonishing. So far, we have no clue to the explanation of the behavior of these two groups and the group of six discussed in connection with the data on station 1.

Station 5. Since no banding was done at this station at this time, the reader need only be reminded that, as stated in the tabulation of our banding operations, we examined 985 swifts for bands. This flock was typical of all ten considered in this paper in that it contained banded swifts from each of the earlier banding operations, roughly proportional to the numbers banded at each station. But since we are not now analysing our results from this point of view, we shall pass immediately to a consideration of our next banding operation, about one year later.

Station 6. At this station, we banded 880 swifts, September 24, 1930. A total of 168 were recaptured, 146 in our own traps, and thirty have been reported by others. Eight of these thirty represent our returns also. We recaptured twenty-five swifts four days after banding, at station 7, Soddy, and thirty-six only six days after banding, at station 8, St. Elmo, while ten days after banding eighty-two were retaken at station 9, in Chattanooga and five days later three were retaken at station 10, Jasper, Tenn. The next year, October 11, 1931, Dr. Butts recaptured twenty-two of this flock. One that we had retaken at station 9 was again recaptured in Chattanooga in October, 1932, by Louis Cook.

Others recapturing swifts from this flock are as follows: Mrs. C. F. Sheffield, Lyndhurst, Ont., June 21, 1931, (1); C. Patzwahl, Claverack, N. Y., Oct. 23, 1931, (1); A. R. Hammond, Kearneysville, W. Va., May 30, 1932, (1); L. S. Iverson, Sturgeon Bay, Wis., May 29, 1933, (1); Ben Coffey, Jr., Memphis, Tenn., Oct. 12, 1934, (1); I. H. Johnston, Charleston, W. Va., Aug. 23, 1934, (2); Capt. H. L. Fisher, Chattanooga, Tenn., Oct. 4, 1936, (1).

Our data disclose nothing very unusual about this flock. The first report from others was June 21, 1931, from Lyndhurst, Ont. Later reports from New York, Wisconsin, and West Virginia indicate that the flock became widely separated as usual. October

reports four and six years later from Memphis, Tənn., and Chattanooga, Tenn., respectively, would seem to suggest that southward migrating flocks are probably made up in random fashion. Captain Fisher's swift F-009313 caught on Missionary Ridge, an eastern suburb of Chattanooga, constitutes one of our best longevity records, having been recaptured six years and ten days after it was banded. Another good record was one banded at station 9 and recaptured six years and seven days later by Mr. Peters, at Atlanta, Ga. We have received a few reports of birds found dead a somewhat longer time—eight years—after banding; but they may have died several years before they were found.

There were fifteen repeats, all quite at random. Of the twenty-two swifts recaptured by Dr. Butts at Chattanooga about one year after banding, five were repeats. One of these we had retaken fifteen days after banding, at our station 10, Jasper, Tenn.

Station 7. Here at Soddy, Tenn., we banded 2,650 swifts, September 28, 1930. A total of 247 have been recaptured, 184 by us and 63 by others. Only two days after banding we recaptured twenty-six of these swifts at station 8, St. Elmo. Six days after banding we recovered eight at station 10, Jasper, Tenn. The next fall after this flock was banded, Dr. Butts recaptured forty-five of them at Chattanooga, and two years later, October, 1932, four more were retaken here by Louis Cook. These data agree with our data on former flocks in indicating a more or less random choice of a roosting station from day to day. The large number reported by Dr. Butts a year later, as in the case of each previous flock, indicates that at least many birds of each group band gather in the same region each fall as they pass southward.

The record of reports from others follows: J. F. Burk, Flintstone, Ga., Oct. 2, 1930, (1); R. Boone, Orchard, W. Va., May 28, 1931, (1); J. Hillard, Lawrenceburg, Ky., May 31, 1931, (1); D. St. Onge, St. Jacques, N. B., June 17, 1931, (1); J. Wower, Egansville, Ont., June 24, 1931, (1); A. W. Johnson, New Milford, Conn., Oct. 25, 1931, (1); E. S. Davis, Clayton, Ill., Sept. 7, 1932, (1); T. Leamon, Ooltewah, Tenn., May 10, 1932, (1); Mrs. F. Geib, New Milford, Ohio, May 27, 1932, (1); V. Evans, South Hampton, N. H., Aug. 1, 1932, (1); W. H. Cooper, Willimantic, Conn., June 6, 1933, (1); Bertha Palmer, Revere, Mo., (app.) Aug. 15, 1933, (1); W. H. Davis, Chase City, Va., May 16, 1934, (1); Ida Merriam, Kingston, Ont., May 12, 1935, (1); Emanual Euklund, Chatham, Mich., (app.) July 7, 1936, (1); Dr. J. A. Brassard, Charlesbourg, Que., May 24, 1937, (1).

Precisely eight months after banding, one of these birds was reported from Orchard, W. Va., while another was reported from Lawrenceburg, Ky. That is not a wide separation, but only twenty days after that one was reported from St. Jacques, N. B., and only seven days later another from Egansville, Ont. Three reports about one year later are interesting also. As already stated above, forty-five of this flock of swifts were taken by Dr. Butts at Chattanooga, October 11, 1931. That was one year and thirteen days after banding. These swifts were doubtless in general moving southward.

But a report comes one year and twenty-one days later from Clayton, Ill., and another only six days after that from New Milford, Conn. So while the recapture of forty-five at Chattanooga would indicate that most of this flock were probably in that region on October 11 a year after banding, yet two weeks later at least one of them was still lingering in Connecticut. If we consider the location of members of this flock at the same time of the year, but different years, we find a similar wide range. For example, one year, seven months and twelve days after banding a swift is reported from Ooltewah, Tenn., while four years, seven months and twelve days after banding, one of the same flock is reported from Kingston, Ont., and another, six years, seven months and twenty-six days after banding is reported (found dead) from Charlesbourg, Que.

It seems likely that each year during the summer the swifts are widely scattered. The members of this flock have been reported from nine different states, Ontario, Quebec, and New Brunswick. Unfortunately we have not recaptured a single swift after it has been reported to us from other states. So we can offer no useful data on the speed of southward migration movements.

Station 8. At this station (Fig. 3) on September 30, 1930, we banded 2,272 swifts. A total of 213 have been recaptured, of which 151 were retaken by us four days later at our station 9, the Tivoli Theater in the heart of Chattanooga, and sixty-three by others in twelve different states, and Quebec. In view of our previous experience as to the local movements of swifts, and that of other swift banders, we were surprised not to find any of this flock among the lot we banded at Jasper, Tenn., nine days later. The next year Dr. Butts recaptured thirty-three of this flock at Chattanooga, and another year later, October, 1922, three more were retaken here by Louis Cook, which is in line with the growing suspicion that chimney swifts are likely to follow the same general migration route southward year after year.

The record of reports from others is as follows: O. D. Kennedy, Paris, Ky., May 20, 1931, (1); L. A. Test, W. Lafayette, Ind., May 23, 1931, (1); Mrs. K. McLeod, Chelsea, Iowa, May 28, 1931, (1); F. Hopper, North Creek, N. Y., May, 1931,(1); A. K. Smiley, W. Chester, Pa., June 2, 1931, (1); H. R. McCulloch, New Castle, Pa., May 18, 1931, (1); L. Roberge, Drummondville, Que., June 25, 1931, (1); Phoebe Smith, Whitestone, L. I., N. Y., July, 1931, (1); C. F. Wirth, Flintstone, Ga., July 21, 1931, (1); ———, Spottsylvania, Va., Oct. 24, 1931, (1); J. J. Milder, Grand Haven, Mich., May 9, 1932, (1); Dr. P. Lewert, Wayne Co., Pa., June 1, 1932, (1); R. A. Johnston, Oneonta, N. Y., July 19, 1932, (1); Wm. F. Mohr, Dayton, Ohio, Aug. 14, 1932, (1); E. Wheeler, Chattanooga, Tenn., Aug. 16, 1932, (1); Pearl French, Alleghany. N. Y., June 6, 1932, (1); Ruth Wears, Apple Grove, W. Va., May 7, 1933, (1); Frank Henize, Georgetown, Ohio, May 18, 1933, (1); L. F. Savage, Greenock, Pa., June 19, 1933, (1); F. B. McDonald, Blowing Spring, Ga., Sept. 21, 1933, (1); ———, Round Bottom, Ohio, June 1, 1935, (1); ———, Woodstock, Va., June 10, 1935, (1); ———, Utica, N. Y., Aug. 10, 1935, (1); M. Bowling, Ashville, Ala., Oct. 18, 1935, (1); ———, Uniontown, Ohio, May 26, 1937, (1).

Just one year and twenty-four days after this flock was banded one was reported from Flintstone, Ga., while another was reported from Spottsylvania, Va. Two years after banding, within two days of the same date, another swift was reported from Flintstone, Ga., while another was reported from Dayton, Ohio. While seven to nine months after banding swifts were reported from Long Island, New York, Pennsylvania, Indiana, Iowa, etc.; one swift eight months and twenty-five days had reached Drummondville, Que. In spite of the wide scattering, as we have already stated, thirty-three of these birds were retaken one year after banding, at Chattanooga. Another was taken at Flintstone, Ga., just a few miles from Chattanooga the same year, another as stated above, two years later, and a third at Blowing Spring, in the same neighborhood, three years after banding.

Station 9. This was our most extensive banding operation. Here we captured over 8,000 swifts and banded 6,357 of them, on October 4 and 5, 1930. A total of 151 were recaptured, twenty-five of them being in our trap at Jasper, Tenn., four days later. That was the last banding we did. Of the 126 others, fifty were reported by Dr. Butts, at Chattanooga, October 11, 1931. Three of these fifty, together with twenty-one others, were recaptured in October, 1932, at Chattanooga by Louis Cook.

The record of the other fifty-two swifts follows: ———, Murfreesboro, Tenn., Oct. 4, 1930, (1); Edna Sims, Manvel, Texas, April 30, 1931, (1); H. Cornes, Marietta, Ohio, May 14, 1931, (1); C. O. Handley, Ashland, Va., May 7, 1931, (1); C. Edwards, Woleska, Ga., May 8, 1931, (1); G. S. Wolfram, Canal Winchester, Ohio, May 12, 1931 and May 15, 1932, (2); R. C. Richards, Wadsworth, Ohio, May 24, 1931, (1); Mrs. L. Reeds, Custer, Mich., May 30, 1931, (1); P. Reichheld, Fisherville, Ont., June 3, 1931, (1); R. Hines, Vanceburg, Ky., June 4, 1931, (1); Wm. E. Hart, Hillsboro, N. B., June 7, 1931, (1); L. Bidard, St. Hilaire Village, Que., June 9, 1931, (1); O. W. Kirsten, Milwaukee, Wis., June 12, 1931, (1); H. E. Crouch, Ledyard Center, Conn., June 12, 1931, (1); R. Dawson, W. Winfield, N. Y., June 18, 1931, (1); M. Shepherd, Peoples, Ky., July 1, 1931, (1); Mrs. Williams, Kire, Va., July 6, 1931, (1); John Kutter, Coledon, Ont., May 5, 1932, (1); Pat Rich, Ittabena, Miss., May 6, 1932, (1); I. H. Johnston, Charleston, W. Va., 1932, (1); Baker and Merriam, Kingston, Ont., May 7, 1932, (2); D. C. Buell, Rushville, Ind., May 12, 1932, (1); A. W. Cooper, Gilmer County, W. Va., May 21, 1932, (1); P. Carman, Liberty, Ky., June 8, 1932, (1); E. Patterson, Stowe, Mass., June 25, 1932, (1); Mrs. J. Brown, Redbank, Tenn., July 3, 1932, (1); C. Jones, Pelfrey, Ky., July 5, 1932, (1); J. Karafs, Lansing, Mich., July 12, 1932, (1); J. E. Leef, Grassy Meadows, W. Va., July 16, 1932, (1); H. W. Imerson, Delta, Ont., July 25, 1932, (1); L. Sutton, Ocala, Ky., Aug. 19, 1932, (1); Cody York, Conover, N. C., Sept. 14, 1932, (1); R. O. Merriam, Kingston, Ont., May 5, 1933, (1); Richard Shafer, Port Royal, Pa., April 29, 1934, (1); G. E. Rich, Avis, Pa., June 15, 1934, (1); I. H. Johnston, Charleston, W. Va., Sept. 23, 1934, (1); ———, York Mills, Ont., May 10, 1935, (1); ———, Ooltewah, Tenn., May 18, 1935, (1); ———, McArthur Mills, Ont., June 26, 1935, (1); Charles Klausing, Batavia, Ohio, June 14, 1935, (1); ———, Canfield, Ohio, July 18, 1935, (1); R. E. Ware, Clemson College, S. C., April 16, 1936, (1); Arthur Calland, Urbana, Ohio, June 1, 1936, (1); J. B. Wells, Salisbury, N. C., Oct. 2, 1936, (1); Sears Crowell, Oxford, Ohio, Oct. 9, 1936, (1); H. S.

Peters, Atlanta, Ga., Oct. 11, 1936, (1); W. A. Glahn, Hartford, Conn., Feb. 3, 1937, (1).

Of these fifty swifts reported from elsewhere, the first record received is a very interesting one. It reached Murfreesboro, Tenn., the very day it was banded, October 4, 1930! That means that this swift traveled a distance of 105 miles (somewhat less than one hundred as the crow flies) that day after being released. At Murfreesboro it is reported to have been taken after having entered a chimney and fallen down into the fireplace. There are several interesting points to be noted in the remainder of the data on this group. On April 30, 1931, one of these swifts was reported from Manvel, Texas, while only four days later, one was reported from Marietta, Ohio. May 7 and 8, two were reported from Ashland, Va., and Woleska, Ga., respectively. Likewise on June 3 and 4 we got one report from Fisherville, Ont., and another from Vanceburg, Ky. That the one from Fisherville, Ont., was not a stray that happened to wander that far north is evidenced by the fact that we got two other records on June 7 and 9 from Hillsboro, N. B., and St. Hillaire Village, Que., respectively. Just before and after these dates, reports came from Georgia, Ohio, Michigan, Kentucky, Wisconsin, New York, etc., so we may be sure that this flock was widely scattered during the summer of 1931. Yet in October, 1931, as stated before, Dr. Butts captured forty-nine of this group at Chattanooga, Tenn., on their southward migration.

During 1932 the flock seemed to be still more widely scattered at corresponding times of the year. While we get one report on May 5, from Coledon, Ont., on May 6 we get one from Ittabena Miss., and another on May 7 from Kingston, Ont. Before the end of June we get reports from Indiana, Kentucky, West Virginia, Virginia, and Massachusetts. More interesting are the reports during July, for we got, in the order received, reports from Tennessee, Kentucky, Michigan, West Virginia, and nine days later than any of the above, one from Delta, Ont., although some of the significance is lost because this last one was found dead.

The number of reports received during the years, 1934, 1935, 1936, and 1937, is of interest in relation to longevity. Three reports were received in 1934, five in 1935, five in 1936, but only one in 1937 and none thereafter. The last report was of a bird found dead. So we know that at least some of the swifts of this flock lived to be at least six years old. Only three of our swifts have been reported alive longer than seven years after banding. Two of these were recaptured by Mrs. Laskey, one nine years and the other eleven years and six days after banding. The third was recaptured over ten years after banding, by R. B. Brown. (See data under stations 1, 3 and 10.)

Station 10. Here at Jasper, Tenn., we banded 1,268 swifts. Since this was our last operation, none of this lot has been recaptured by us.

Twenty-one have been retaken by others. Ten of these were recaptured just one year and three days later at Chattanooga, Tenn., by Dr. Butts. The record of recaptures elsewhere is as follows: J. Claiborne, Lafayette, Tenn., May 11, 1931, (1); Mrs. Fred Jensen, Penn Yan, N. Y., June 5, 1931, (1); E. W. Libby, McClure Basin, Mich., June 9, 1931, (1); J. Hogue, Henryville, Ind., April 24, 1932, (1); A. M. Six, Elmira, Mich., June 20, 1932, (1); C. Wheeler, Fincastle, Va., Dec. 1, 1934, (1); T. L. Owen, Wisner, La., April 18, 1935, (1); ———, Elizabethtown, Ky., May 20, 1935, (1); Frank Lane, Bourne, Ky., May 1, 1935, (1); Sears Crowell, Oxford, Ohio, Oct. 9, 1936, (1); Mrs. F. C. Laskey, Nashville, Tenn., Sept. 13 and 18, 1939, (1).

Thus these eleven swifts taken elsewhere than Chattanooga have been reported from eight different states. Three were reported in 1931, two in 1932, none in 1933, one in 1934, two in 1935, two in 1936, and the last one in 1939. This gives us about the same picture as to distribution or scattering, and as to longevity, as our previous records, and completes the known history of the movements of the swifts of each of the ten flocks subsequent to the banding operations.

It now seems desirable to consider our results from another point of view, namely from the standpoint of the numbers of swifts that have returned to the Chattanooga region and have been recaptured. For this kind of consideration our work at station 9, October 4–5, 1930, on the Tivoli Theater, in the business district of Chattanooga, seems to be the most suitable, since here at this time we banded over 6,000 swifts, and actually examined 8,000 for bands. We shall include also a consideration of the recoveries at station 10, Jasper, Tenn., where we banded a few days later, October 9, 1930, our swifts recaptured by Dr. Butts, October 11, 1931, and those taken by Louis Cook in October, 1932. Both Dr. Butts and Mr. Cook operated at station 9, in Chattanooga.

The analysis of our data has been an almost interminable task, and we can only hope that we have made them intelligible. It seems to us that the reader will get the clearest picture of the situation if we present our data in the form of a tabulation which will indicate what would have been the mathematical expectancies if at each station we had banded just 1,000 swifts, and if in our work at stations 9 and 10, in 1930, together with that of Dr. Butts, and Mr. Cook, at station 9 in 1931 and 1932 respectively, we had recorded the number of recoveries for every 1,000 swifts examined.

TABLE SHOWING THE NUMBERS OF OUR BANDED SWIFTS RECAPTURED PER THOUSAND EXAMINED AT STATIONS 9 AND 10, FOR THE YEARS 1930, 1931, AND 1932, FOR EVERY THOUSAND PREVIOUSLY BANDED.

Station Numbers and Dates	*1 X/16 1928*	*2 V/25 1929*	*3 X/21 1929*	*4 X/8 1929*	*6 IX/24 1930*	*7 IX/28 1930*	*8 X/30 1930*	*9 X/4 1930*	*10 X/9 1930*	*Average from all bandings*
Station 9 X/4, 1930 W. R. Green	3.00	2.74	3.17	4.25	12.35	7.22	8.31			5.87
		average 3.38			average 9.29					5.22
Station 10 X/9, 1930 W. R. Green	1.58	0.00	1.58	4.81	2.68	2.38	0.00	3.09		2.01
		average 2.13			average 2.04					1.91
Station 9 X/11, 1931 W. K. Butts	2.00	0.40	2.40	1.39	10.00	6.78	5.81	3.15	3.15	3.90
		average 1.39			average 5.75					3.05
Station 9 X/?, 1932 L. Cook	0.00	2.18	0.00	4.00	2.27	3.02	2.52	7.86	0.00	2.54
		average 2.06			average 3.13					1.73
Average recaptures from each station	1.64	1.33	1.79	3.81	6.82	4.85	4.41	4.70	3.15	3.61
Average recaptures from each year's bandings	1.64	2.46			4.75					2.95

No banding was done at station 5, hence its omission. We banded just 1,000 swifts at station 1. At station 9 two years later, October 4 and 5, 1930, we examined 8,000 swifts for bands and found twenty-four that we had banded at station 1. Obviously that is exactly 3 per 1,000, as shown at the top of the first column under station 1. Reading across the table we see that the corresponding figure for station 2 is 2.74, for 3 it is 3.17, and for 4 it is 4.25, averaging 3.38. The banding at these three stations was in 1929, and 2,728 swifts were banded. Thus when we examined 8,000 swifts at station 9 in 1930, in each 1,000 examined we found three swifts from the 1,000 banded in 1928, and 3.38 swifts from each 1,000 banded in 1929. Since such large numbers are involved these figures would seem to indicate that practically as large a proportion of a given flock of swifts will be found in the same region two years after banding as one year after banding.

Let us now compare these results with those obtained from the examination of the 8,000 swifts for the 5,802 banded at stations 6, 7, and 8, within a period of only eleven days before the examination. (See map for the location of these three stations.) The

corresponding figures for these stations are 12.35, 7.22, and 8.31, averaging 9.29. This is almost exactly three times the average for the 1928 and the 1929 bandings, and is perhaps to be explained by the fact that the banding at these stations and the recoveries all occurred within so short a time, and in a rather restricted region. The recoveries from station 6 which is only three miles from station 9 were 12.35, those from station 7, nineteen miles away, were 7.22, while those from station 8, which is five miles distant, were 8.31. Thus the recoveries were roughly proportional to the distance of the outlying stations from station 9. As indicated in the last column of the table, the average recoveries from each banding station is 5.87, and the average recoveries by years is 5.22, found in each 1,000 examined, for every 1,000 previously banded.

Our work at station 10, four days later, October 9, 1930, considered in the same manner, discloses a strikingly similar picture, although this station was about twenty-seven miles across Walden's Ridge to the westward. It may not be expected that many of the swifts banded at stations 6, 7, 8, and 9, would have crossed the mountain to station 10 during the short time since they were banded,—some fifteen days, but most of them only four or five days before. None were from stations 2 and 8, but there were a considerable number from stations 6, 7, and 9. The ratio of recoveries at this station from the bandings at other stations two years before, one year before and a few days before, are 1.58 to 2.13 to 2.04, respectively. Evidently a very rapid random distribution took place after the banding at stations 6, 7, and 9. Since only ninety-one swifts were banded at station 2 we can readily understand that the chances of recapturing one of these at station 10 a year later would be slight; but no explanation is at hand for our failure to find any from station 8 where we banded 2,272 swifts.

The next tier of data in the table is derived from the work of Dr. Butts who banded at station 9 on October 11, 1931. The author is very greatly indebted to him and also to Mr. Louis Cook who operated the same station the following year, 1932. Interestingly enough, Dr. Butts recaptured at least a few swifts banded at each of our different stations, which makes his contribution extremely valuable. He secured a higher quota of swifts which were banded three years before (in 1928) than he did of those banded only two years before (in 1929), the ratio being 2 to 1.39. This is contrary to the mathematical expectancy. Moreover, he captured over four times as many, proportionally, of those banded in 1930 as he did of those banded in 1929. We can offer no explanation for this. More perplexing still is the high number from station 6, which is about three times as high as the mathematical expectancy. It would seem, since we banded over 6,000 swifts at station 9, and since Dr. Butts examined over 2,000 for bands, that his recap-

tures, 3.13, from this station would establish the normal expectancy. Evidently this is far from correct since his recaptures from stations 6, 7, and 8, where we banded over 5,000 swifts, range from nearly twice to over three times as high. Stranger still is the fact that he recaptured precisely the same proportion of the swifts banded at station 10, twenty-seven miles across the mountain to the westward, as he did from station 9 itself, namely, 3.15! This happens to be not far from his average recapture of banded swifts from all of our nine different stations, 3.90. This is slightly more than the average by years, 3.05.

The work of Mr. Cook was much less extensive but is of special significance because it was one year later, October, 1932, and carried out at station 9. This was four years after our first banding work. That he secured none of the swifts that we banded in 1928 is probably due to the relatively small number (*ca.* 500) he examined for bands. Although we cannot be absolutely certain that many members of the station 1 flock were still alive in October, 1932, data under station 1 show one yet alive in 1939. We do have records of more than a dozen swifts that lived more than four years, four of these having been reported alive just over six years after banding. One only was reported alive as long as eleven years after being banded. We may be sure that had he examined more swifts for bands some would have been found from station 3 where we banded 1,500, and from station 10 where we banded 1,268. He did recapture a good share of the 91 swifts we banded three years before, in 1929. This makes the third successive year that some of these few swifts have been retaken at staion 9, although they were originally banded at station 2. Since Mr. Cook recovered swifts from six of our flocks, when the data are averaged they are of much value. From the 1929 flocks his average was 2.06, and from our 1930 flocks, 3.13. If we compare the figures supplied by Dr. Butts on our station 6 flock with those of Mr. Cook we see that this flock seems to have diminished in the region, from 1931 to 1932, in the ratio of 10.00 to 2.27, which is difficult to explain. His recoveries from flocks 7 and 8 were less than half as many as secured by Dr. Butts the year before; but his recoveries from the large station 9 flock were more than double those of Dr. Butts. We can offer no explanation for these irregularities unless it be the relatively small number of swifts examined.

In general, as the reader will notice, there is a gradual decrease in the value of the numerals in the table from top to bottom, and from right to left. This is due to two main factors, one of which is rather more definite than the other. First let us consider the death rate. Perhaps more than a fourth of the swifts die each year of old age. Surely not many swifts live to be more than four years old, and it seems likely that a large proportion die between

two and three years of age. Out of 1,058 recoveries only five swifts were reported alive longer than six years after banding. Less than a dozen others have been reported alive after four years. So it seems quite possible that the annual diminution of a flock of banded swifts in a given region may be much more largely due to the natural death toll than to indefinite random scattering, although we are certain that this does occur. There is a continuous and more or less random intermingling and wide diffusion of the flocks.

The relative value of these two factors cannot at present be very accurately determined. The effect of the two together, however, is clearly disclosed by the facts shown in our tabulation. It shows that within a few days up to two weeks after 5,800 swifts were banded in 1930 at station 9, in Chattanooga, an examination of an equal number for bands showed the banded swifts still present in the region in the ratio of 9.29 per 1,000. The recoveries of our swifts by Dr. Butts at the same station one year later, 1931, showed a ratio of 5.75 per 1,000, and Mr. Cook in 1932, at the same station found the ratio lowered to 3.13 per 1,000. Now the fact that both Dr. Butts and Mr. Cook recaptured about the expected number of swifts from each of the four flocks we banded in 1930, totaling over 12,000, assures us that the series, 9.29, 5.75, 3.13, actually gives us a very true picture of the rate of the annual diminution of a large flock of banded swifts in a given region. We may infer that if an examination of swifts had been made at station 9 in 1933, three years after banding, the ratio would have been less than 2 per 1,000, and in 1934, it would in all probability approximate 0.00, for very few of them would even be alive after four years.

SUMMARY

1. *Effects of the death rate.* Assuming that we band 1,000 swifts on their southward migration, it appears that we can account for the diminishing numbers (see preceding paragraph) we can recapture at the same station each year thereafter on the basis of the known death rate alone, even though it be true that nearly all of the members of the entire flock should pass southward through the same region each year after banding. If this be true then conclusion No. 2 follows.

2. *Diffusion.* That we can recover only about 1% of the swifts banded at a given station just a few days after banding means not that the flock has at once largely dispersed to other distant regions, but that we had probably banded a very small percentage of the swifts in the vicinity, and that there is a daily general diffusion of the swifts in the immediate region. This is in line with the work of other banders. (H. S. Peters, 1937, Calhoun, 1938.)

3. *Migration routes.* The general direction of migration movements is northeast-southwest, more or less parallel with the Atlantic coast, as other banders have noted. It seems that in general a given flock will become more widely scattered as they move northward; but evidently they get together again at their winter quarters, and traverse about the same routes annually, since it not infrequently happens that as high a proportion of a given flock can be recaptured at a given station two years after banding as one, or for that matter, a few days after banding.

4. *Monogamy.* There is some good evidence that swifts pair for more than one season, and that family solidarity may account for the fact that several individuals may be found together more often than could likely be due to chance. These phenomena merit full investigation.

5. *Future work.* While the banding of flocks should continue, the writer is convinced that the work should be definitely planned and coördinated throughout the country. Banders should now give their attention to the banding of the nesting pairs, and their young, before they leave their nests.

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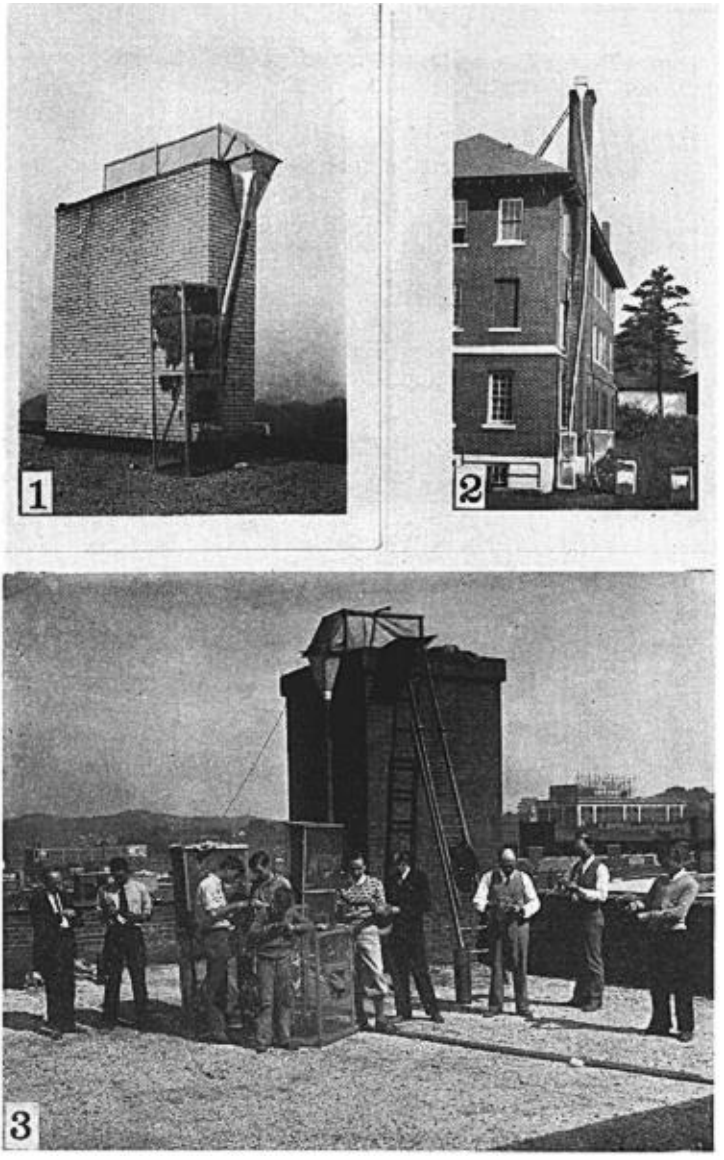

FIG. 1. Trap and receiving cage containing about 800 Chimney Swifts. On Central High School, Chattanooga, Tenn. Station 6.

FIG. 2. Showing the same trap with a nearly fifty-foot stovepipe leading to the ground. On the M. E. Church, St. Elmo, Tenn. Here on Sept. 30, 1930, 2,272 swifts fluttered down this long tunnel to the receiving cages below and were banded. Station 8.

FIG. 3. A group of enthusiastic banders at work on top of the Tivoli Theater, Chattanooga, Tenn. The total catch here was about 8,000, of which 6,357 were banded on Oct. 4 and 5, 1930. Station 9.

FIG. 4. Robert Sparks Walker, Chattanooga's nature poet, right, and the author, coöperating. We found that two thus working together can band about four times as many swifts per hour as one working alone.

FIG. 5. Showing how inexpensive pliers can be modified into an efficient banding tool. Bird banders will find them indispensible. (Kennard, 1930)

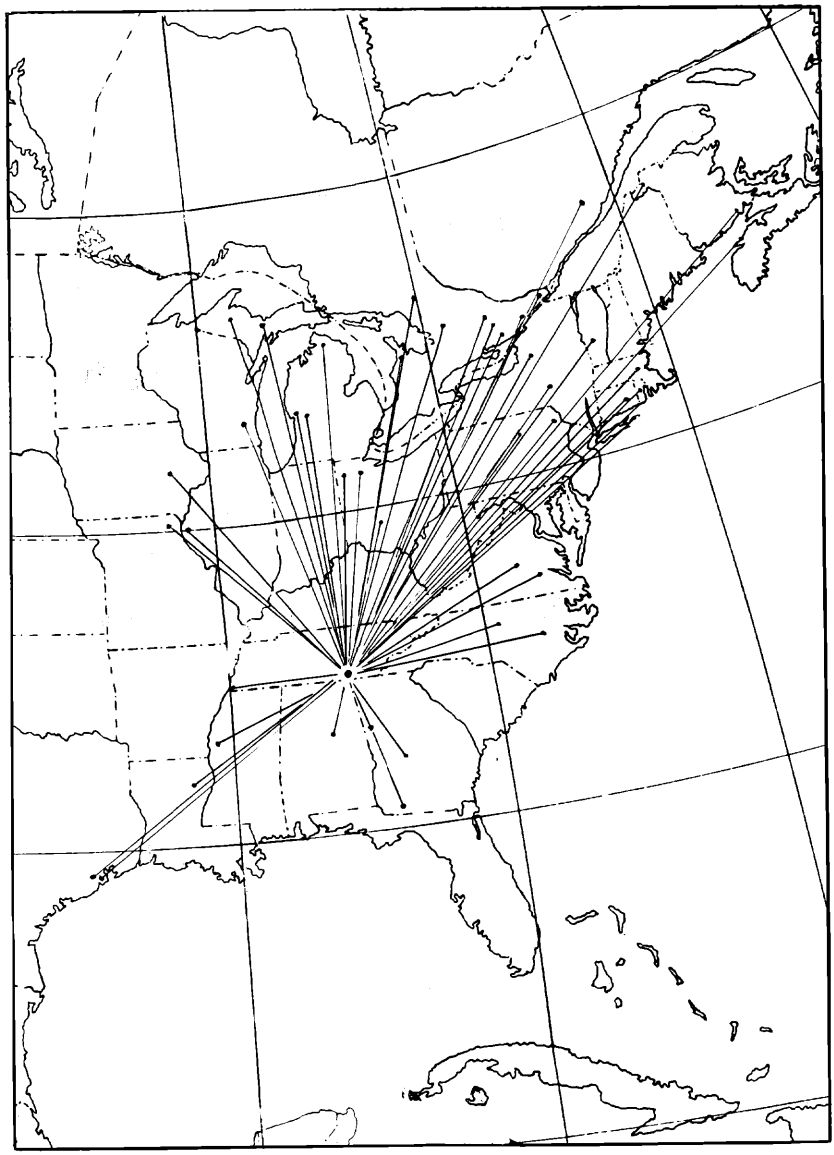

FIG. 6. Map showing where 47 of the swifts have been recaptured. While we have records of 1,058 recoveries, these 47 sufficiently indicate the general area over which our flocks have spread.

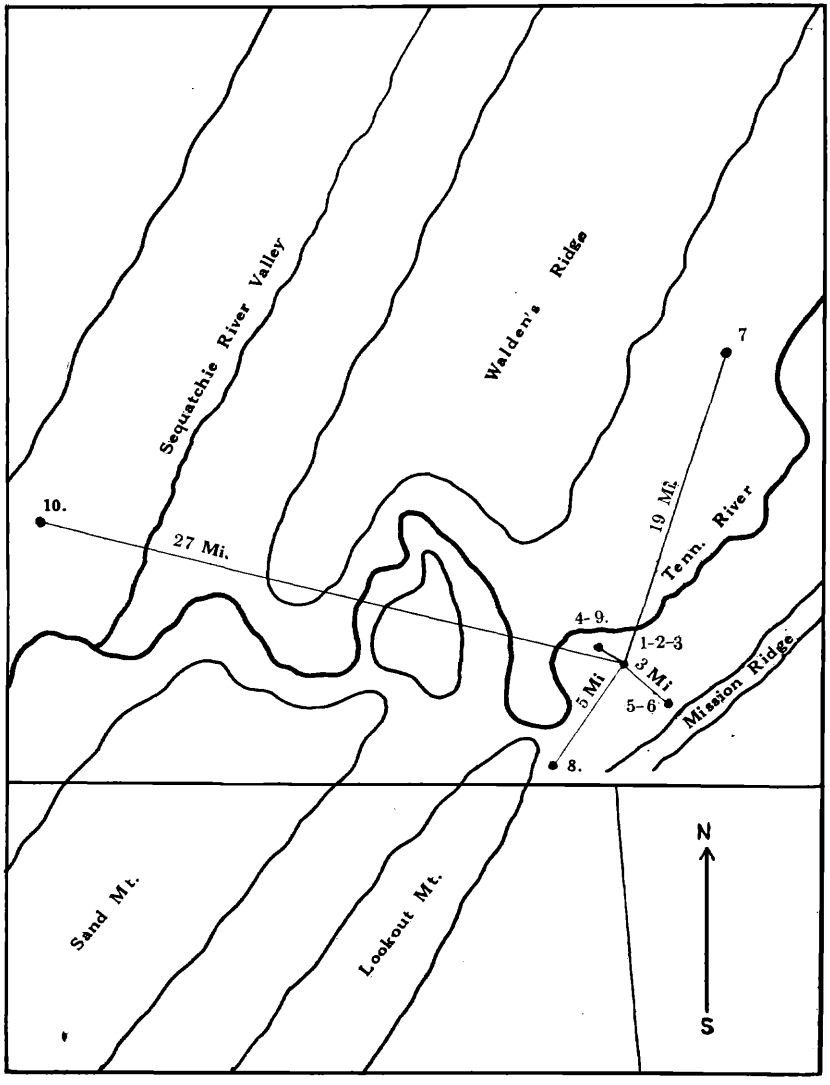

FIG. 7. Diagram of the Chattanooga region, showing the location of our ten stations. Stations 1, 2 and 3, were near together on the campus of the University of Chattanooga. Stations 4 and 9 were near each other in the business district, and 4 and 5 were both on the campus of the Central High School. The distances of the outlying stations from the University campus are indicated in miles. Number 7 is Soddy, Tenn., No. 8, St. Elmo (near the state line), and No. 10 is Jasper.