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STUDIES OF A TREE SWALLOW COLONY

(Third Paper)

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The study of a Tree Swallow (*Iridoprocne bicolor*) colony has continued at my home in Princeton since my two previous papers were published (Chapman 1935 and 1939). This study has now covered a period of 22 years and I am summarizing in this paper some of the observations made and the data collected.

The area occupied by the nest boxes from 1938 to 1953 was approximately 10 acres (4 hectares), varying somewhat from year to year. The number of nest boxes available each year is shown in Table I.¹

A curve showing the number of breeding pairs is given in figure 1. In 1934 and 1935 nine additional boxes were located around the main colony varying from $\frac{1}{4}$ to $\frac{3}{4}$ miles away; in 1936 there were four such boxes. The solid line in figure 1 includes these extra boxes and the dotted line in figure 1 shows the number of breeding pairs with these boxes omitted. It will be seen from figure 1, that the cold southern winter of 1939-40 when many Tree Swallows were reported killed in the south (Christy 1940, Weber 1940) had no influence on the number of nesting pairs in the Princeton colony in 1940.

The first Tree Swallows arrive in the nesting area usually around April 1 and the first eggs are laid between May 19 and 25 which gives a pre-egg period of about 50 days. Most of the swallows have completed their nesting and have left the colony by July 1. Only when nests have been broken up and the birds lay a second clutch of eggs, are there any swallows in the nesting area after the first few days in July.

I have not been at the colony during May and most of June except during week ends; hence no attempt has been made to collect data on the incubation period or the time that the eggs hatch. Data on the incubation period and the time the nestlings are in the nest are given by Austin and Low (1932: 40-43).

RETURNS OF BIRDS BANDED AS ADULTS

Table II gives data for 22 years covering the banding and the return to the colony of swallows banded as adults the previous year. Table III gives data on the returns of birds breeding the previous year in the colony.

¹Data for the years 1931-1937 is given in *Bird-Banding*, 10: 71

TABLE I—SUMMARY OF TREE SWALLOW DATA

	1938	1939	1940	1941	1942	1943	1944	1945	1946	1949	1950	1951	1952	1953
1. Number of boxes available for Tree Swallows, House Wrens and Bluebirds	37	36	41	43	44	42	39	45	46	46	46	46	45	45
2. Number of boxes occupied by Tree Swallows	20	20	18	17	25	25	24	20	15	26	29	21	25	30 ¹¹
3. Number of boxes occupied by Bluebirds	3	5	1	1	2	3	2	1	2	2	1	2	1	2
4. Number of boxes occupied by breeding House Wrens while Swallows were nesting ¹	0	1	0	0	2	5	6	4	5	3	7	3	3	3
5. Percentage of boxes occupied by Tree Swallows, Bluebirds and House Wrens	62.0	72.2	46.3	42.0	68.5	78.5	79.5	55.5	48.0	69.5	80.5	56.5	64.5	77.8
6. Percentage of breeding Swallows, <i>banded previous year</i> known to have returned ²	20.0	53.4	31.5	14.3	50.0	41.7	40.0	6.7 ⁵	21.5	27.8	46.7	0 ⁷	54.8	48.2
7. Number of nestling Swallows banded previous year which returned	1	0	1	1 ³	2	2	1 ⁴	0	0	— ⁹	2 ⁸	0	0	5 ⁸
8. Percentage of nestlings banded previous year which returned	1.2	0	2.4	—	3.3	2.3	—	0	0	—	2.7	0	0	5.05
9. Number of eggs laid	106	104	94	84	125	131	—	104	67	129	140	107	128 ¹⁰	158
10. Percentage of eggs hatched	86.0	92.5	44.7	84.5	88.8	73.3	—	—	—	62.0	71.5	62.5	79.0	80.3
11. Percentage of nestlings which died in nest boxes	52.8	13.5	64.2	15.5	20.7	41.7	—	—	—	8.8	— ⁷	44.7	3.95	10.2
12. Number of nestlings leaving nest boxes	43	83	15	60	88	56	40	12+5 ⁶	41	73	4	37	97	114
13. Reproductive efficiency	40.5	79.7	15.9	71.5	70.3	42.7	—	16.3	61.2	56.5	2.9 ⁷	34.6	75.8	72.0
14. Eggs per clutch—average of colony	5.30	5.20	—	4.95	5.00	5.25	—	—	—	4.95	4.82	5.10	5.12	5.10

For banding years 1931-1937, see *Bird-Banding* 10: 71

Blank spaces indicate data incomplete

For footnotes, see page 47.

Footnotes to Table I

- ¹Usually several ♂ House Wrens without mates in the colony area (Table VII)
- ²See Table III for return of Swallows *breeding* previous year
- ³Banded in 1939; not trapped in 1940
- ⁴A 1942 nestling
- ⁵See notes in text regarding season of 1945
- ⁶12 in first nestings, 5 in second
- ⁷See remarks in text regarding visit of raccoon
- ⁸One disappeared and did not nest
- ⁹No nestlings banded in 1947 and 1948
- ¹⁰Excludes second nesting in Box 14 (see text)
- ¹¹♀ in Box 4 disappeared after laying 4 eggs. A second ♀ laid a new clutch of 5 eggs. Both sets are included, making 31 nestings.

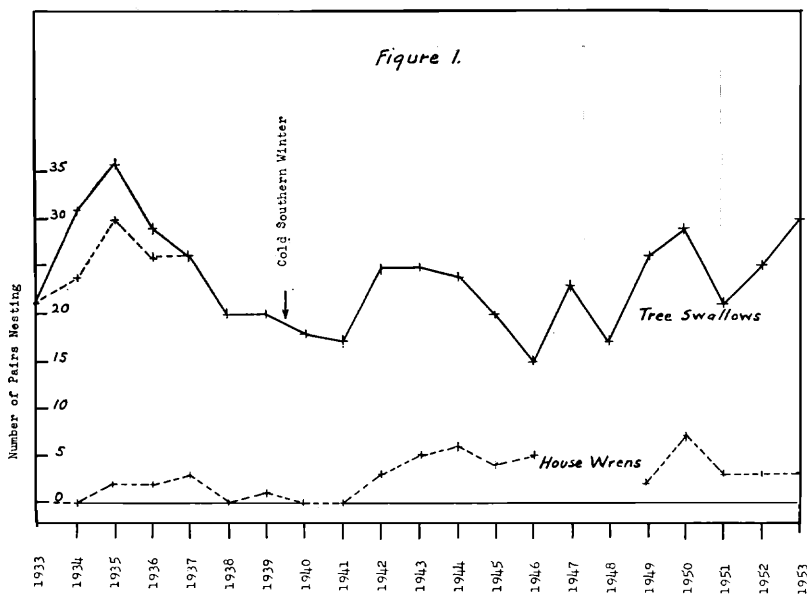


TABLE II
 RETURNS OF ADULTS BANDED PREVIOUS YEAR
 (Banding Years 1931-1952; Breeding Years 1932-1953 inclusive)

Banding Year	Breeding Adults Banded in Colony	Nestlings Banded and Fledged	Adults Banded Previous Year Which Returned ¹	Nestling Returns	% Adults Returns Banded Previous Year
1931	2	7	—	—	—
1932	21	48	2	1	100.0%
1933	28	61	11	1	52.3%
1934	37	148	11	4	39.3%
1935	26	125	22	3	59.5%
1936	12	64	7	2 ³	26.9%
1937	15	86	8	3	66.7%
1938	15	43	3	1	20.0%
1939	19	83	8	0	53.4%
1940	14	15	6	1	31.5%
1941	20	60	2	1	14.3%
1942	24	88	10	2	50.0%
1943	10	56	10	2	41.7%
1944	15	40	4	1	40.0%
1945	14	17	1	0	6.7%
1946	(15)	(41)	3	0	21.5%
Totals	272	941	108 ²	22 ²	
1947	14	0	6	0	40.0%
1948	18	0	6	—	42.9%
1949	30	73	5	—	27.8%
1950	28	4	14	2 ⁴	46.7%
1951	31	37	0	0	0%
1952	29	99	17	0	54.8%
1953	27	114	14	5 ⁴	48.2%

¹All did not return the next year. Five failed to make a Return-1. These five birds are recorded here as returning the next year, however, as they made a Return-2's.

²Excludes one non-breeding adult return.

³One found dead in nest box; hence 21 return breeders.

⁴One disappeared and did not breed.

Of the 272 adults banded in the colony for the fifteen-year period 1931-1945 (Table II), 108 returned to breed at least once in the colony. This gives an average percentage of adult returns of 39.6%.

The 272 adults banded in the colony were made up of 116 males and 156 females. The returns of birds banded as adults in the colony were made up of 51 males and 57 females (a total of 108 as stated in the notes under Table IV). Hence the return percentages by sexes were as follows:

$$\text{Males} \quad \frac{51}{116} = 43.0\%$$

$$\text{Females} \quad \frac{57}{156} = 36.5\%$$

TABLE III
RETURNS OF ADULTS BREEDING PREVIOUS YEAR
(Breeding Years, 1932-1946 inclusive)

	1	2	3	4	5	6
Breeding Year	Number of Breeding Birds	Return Breeders ¹	Colony Nestlings Breeding for First Time	Total Previously Banded Birds (Col. 2 & 3)	New Unbanded Breeders ²	Adults not Banded
1931	(8)	—	—	—	—	6
1932	26	2 ²	1	3	23	2
1933	42	12	1	13	29	1
1934	62	18	4	22	40	3
1935	72	37	3	40	32	3
1936	58	25	1	26	32	19
1937	52	22	3	25	27	7
1938	40	15	1	16	24	8
1939	40	17	0	17	23	3
1940	36	7	1	8	28	12
1941	34	8	1	9	25	2
1942	50	19	2	21	29	2
1943	50	26	2	28	22	9
1944	48	23	1	24	24	10
1945	40	6	0	6	34	21
1946	30	8	0	8	22	—
Totals	680	245 ⁴	21	266	414	108

¹Includes colony nestlings and birds banded by Dr. Kraus, *after* their first breeding year in the colony.

²Two adults banded in 1931.

³Includes birds banded by Dr. Kraus breeding for *first* time in the colony. May included colony breeders of previous years that were not trapped and banded.

⁴Returns = 245 + 2 trapped during 1948 and 1949 = 247 return breeders.

An analysis of the 680 swallows breeding in the colony during the years 1932-1946 inclusive (Table III) shows the average make-up of the colony as follows:

Return breeders of previous year	$\frac{245}{680} = 36.0\%$
New birds	$\frac{414}{680} = 60.9\%$
Birds banded as nestlings in the colony	$\frac{21}{680} = 3.1\%$ $\frac{21}{680} = 100.0\%$

Table III shows that during this fifteen-year period, 108 adults, mostly males, were not trapped. This is 15.9% of the breeding birds.

If we assume that one-third of these non-banded swallows returned as breeders the next year, the percentage of return breeders would be 41.3% instead of 36.0% and the percentage of new birds would be 55.6% instead of 60.9%.

Another summary of the returns of banded adults is given in Table IV. The designations of Return-1, Return-2, etc. (as explained in the footnote of Table IV) indicate the age of the bird from the time of its first nesting; hence the age of some of these Tree Swallows can be noted.

TABLE IV

15-Year Summary of Tree Swallow Returns

(Banding years 1931-1945, inclusive; Breeding years 1932-1949)	
Adult Return—1 ¹	122 ² (56 ♂ and 66 ♀)
Adult Return—2	65 (34 ♂ and 31 ♀)
Adult Return—3	30 (17 ♂ and 13 ♀)
Adult Return—4	18 (11 ♂ and 7 ♀)
Adult Return—5	7 (3 ♂ and 4 ♀)
Adult Return—6	3 (1 ♂ and 2 ♀)
Adult Return—7	1 ♀
Adult Return—8 (Breeding 9 times)	1 ♀
Total	247

Notes on Table IV

¹In the records of my banding station, a bird is recorded as a Return—1, if it returns the next year after banding. If it returns the second year after banding it is recorded as a Return—2, even if I fail to trap it the year following banding. Birds banded as adults and missing a year in nest trappings *but appearing in the colony in a later year were as follows:*

Failing to make a Return—1	4 ♂ and 1 ♀
Failing to make a Return—2	2 ♂
Failing to make a Return—3	4 ♂
Failing to make a Return—4	2 ♂

²122 swallows were trapped the year following their first nesting. The number of birds returning at least once to breed in the colony a second time was 127, made up of 122 Return—1's and five birds which failed to make a Return—1 but were trapped as breeders in the colony the second year after their first nesting. These 127 birds were made up of 108 banded as adults in the colony, 10 banded as nestlings in the colony and breeding a second time and 9 birds banded by Dr. Douglas L. Kraus or outside of the colony and breeding more than once in the colony.

The above table includes two birds banded as adults before 1945, trapped breeding after 1946, one in 1948 and one in 1949.

Probably some of the males listed above failing to make a Return—1, a Return—2, a Return—3 or a Return—4 were breeding in the colony in the year they were missed but were not trapped. Males can usually be trapped only when they enter the nest box to feed the young. Hence if a nest is broken up or deserted before the eggs hatch, the male is generally not trapped. Only a very few males have been trapped in April when they are first selecting a nest box.

Probably my designation, Return—4, for example, actually does indicate a bird which has bred five times, for the two males which failed to be recorded as a Return—4, no doubt were breeding in the colony but were not trapped for the reason stated above.

PERCENTAGES OF EGGS HATCHED, NESTLING MORTALITY AND
REPRODUCTIVE EFFICIENCY

Table I gives data on the percentage of eggs hatched, percentage of nestlings dying in the boxes and the reproductive efficiency for the years 1938 to 1953, with the exception of the years 1947 and 1948. Data for the years 1931-1937 are given in Chapman 1939:71. Omitting the year 1950, which is discussed later in the paper, the percentage of eggs hatched for thirteen breeding years varied from 44.7% to 92.5%; the nestling mortality varied from 4.0% to 64.2% and the reproductive efficiency varied from 15.9% to 79.7%.

Table V gives a summary of the above data for 12 years in which careful counts were made of eggs laid and hatched in the various nest boxes. This table shows that the average percentage of eggs hatched was 79.5, the average nestling mortality was 24.6, and the average reproductive efficiency was 60.0.

TABLE V

Summary of Results for 12 Years in which count was made of eggs laid and hatched.

Year	Nests	Eggs Laid	Eggs Hatched	Fledglings Leaving Nests
1933	21	118	108	61
1934	31	176	158	148
1935	36	175	155	125
1938	20	106	91	43
1939	20	104	96	83
1940	18	94	42	15
1941	17	84	71	60
1942	25	125	111	88
1943	25	131	96	56
1949	26	129	80	73
1951	21	107	67	37
1952	25	128	101	97
Totals	285	1,477	1,176	886

Average eggs per nest—5.2

Average no. of fledglings raised per pair—3.11

Average percentage of eggs hatched—79.5%

Average nestling mortality—24.6%

Average reproductive efficiency—60.0%

The above average percentage of eggs hatched (79.5%) compares favorably with the results of other Tree Swallow colonies and other hole-nesting species as given in the very complete table in Allen and Nice (1952:640). The average reproductive efficiency or nesting success of 60.0%, however, is low. The cause of this is discussed later under the Effects of Weather.

It is interesting to compare the above percentages with those published for Tree Swallows by Weydemeyer (1935), Kuerzi (1941), Low (1934), and Winn (1949).

Weydemeyer's summaries for eight years of breeding Tree Swallows on a ranch in northwestern Montana are:

Nests with eggs	52
Percentage of eggs hatched	98.5%
Nestling mortality	3.8%
Reproductive efficiency	94.7%

Weydemeyer reports that no nestlings died in the nest boxes. The 12 which failed to be fledged in the eight-year period were taken by Sparrow Hawks. Weydemeyer's swallows in a number of cases had second broods. The above data are for the first broods only.

Kuerzi with a much larger number of swallows breeding per acre than at Princeton, had a very favorable site on the bank of the Housatonic River in Connecticut. His average results for a 3-year period are:

Number of nests	68
Percentage of eggs hatched	72.1%
Nestling mortality	2.4%
Reproductive efficiency	70.5%

Low's results for a colony on Cape Cod for a period of 3 years are:

Number of nests	290
Percentage of eggs hatched	83.6%
Nestling mortality	41.0%
Reproductive efficiency	49.3%

Winn gives the following results for one season at Kent Island, New Brunswick:

Number of nests	22
Percentage of eggs hatched	94.6%
Reproductive efficiency	87.8%

During the fifteen-year period 1931-1945 there were 329 nestings and 941 nestlings were successfully fledged. This gives an average of 2.86 nestlings fledged per nest. For the combined years 1952 and 1953, which were exceedingly good breeding years, the number of nestlings fledged per nesting was 3.76.

WANDERING FEMALES AND WANDERING MALES

In my second paper (Chapman 1939), I reported seven cases of "wandering females" that were trapped in a subsequent season nesting several miles from their previous nests. During the seasons 1939-1953, eleven additional cases have been discovered of females nesting a second season from one to 20 miles from the previous nest. The fact that 36.5% of the banded females return to breed a second year as against 43% of the males, would appear to indicate that the number of females which wander off in this manner is not large.

Six of these wandering females were exchanged between the Chapman and Kraus¹ colonies, which were four miles apart. One female was found breeding $3\frac{1}{4}$ miles away, one was $1\frac{1}{2}$ miles away and one was one mile away. Unfortunately the color of these females was not always recorded when they were first trapped, but in three cases

¹See *Bird-Banding*, 6: 51

where a notation was made they were brown birds, i.e. breeding for the first time.

In 1951, one of my nesting females (46-8727), a bright blue bird nesting for the first time in the colony, deserted its nest with three unhatched eggs and one dead nestling around June 16, after three days of rainy weather. This bird was trapped by Mr. William Wharton on June 19th nesting in his colony in Groton, Mass., 20 miles away.

Also in 1951, I trapped a female (42-95835) on May 27 breeding in one of my nest boxes. This bird was banded by Mr. Wharton in 1947 and bred in his colony in 1947, 1948, 1949 and 1950 (Wharton 1952:30). This bird was at least 5 years old. It was not trapped in my colony in 1953.

As no breeding males have ever been exchanged between the Kraus and Chapman colonies, and as none of my breeding males had been recovered elsewhere up to 1938, I was inclined to believe that all the breeding males returned the next season to the same colony, frequently to the same or a nearby nest box. However, two cases have occurred to show that this is not the case. Male (41-47112) breeding in the colony in 1942 failed to return in 1943 and on June 1, 1944 was trapped breeding in a box one mile away. Male (47-8765) breeding in the colony in 1952 failed to return in 1953 and was found dead on June 10, 1953 15 miles S by W of Princeton.

Von Haartman (1949:22) who has done intensive research with the Pied Flycatcher (*Muscicapa hypoleuca*), another hole nesting species, on an area of 1.5 square miles (3.9 square kilometers) in Finland, gives some interesting data on the return of this bird to its nesting area. Banding data covering 7 years show that 70 males out of 189 banded as adults (37.0%) returned to the nesting area and nineteen females out of 177 banded as adults (10.7%) returned to the nesting area. The return of males varied in different years from 29.2% to 55.5% and the best return for females was 16.9%. While his average return of adults over the 7-year period, of 24.3% is considerably less than the 39.6% for my Tree Swallows, his data show that the females of the Pied Flycatcher are more given to changing breeding areas than the female Tree Swallows. In another paper by Von Haartman (Farner 1950:22), he considers some females breed every year in the same territory ("*ortstreue*") and others are "nomadic" and change their breeding place from year to year.

Trettau and Merkel (1943) in studying this same species in Silesia had much smaller returns—males 19.6% and females 21.7% (see Von Haartman 1949:42-43), with the males and females return nearly equal. However, in a later study of this species in Hessen, Trettau (1952) (see Nice 1953) had a return of 37.5% from 40 nesting females and a return of 35.1% from 37 males.

RECOVERIES OF SWALLOWS BANDED AS NESTLINGS

Between 1931 and 1952 inclusive, 1,195 nestlings were banded in the colony. Forty-four of these have been recovered as follows: 26

TABLE VI
BIRDS BANDED AS NESTLINGS RECOVERED OUTSIDE OF COLONY
(1931-1946)

Band No.	Sex	Date Banded	Place of Recovery	Distance from Colony	Date of Recovery
H69737	♀	6/12/33	Kraus Colony	4 miles SE	1934
H80137	♂	6/10/34	Kraus Colony	4 miles SE	1936*
L68636	♂	6/ 8/34	Kraus Colony	4 miles SE	1936*
L73116	♂	6/15/34	Kraus Colony	4 miles SE	1936*
L73132	♂	6/15/35	Kraus Colony	4 miles SE	1936
34-72134	♀	6/15/34	Kraus Colony	4 miles SE	6/18/37*
39-62252	♂	6/18/39	Kraus Colony	4 miles SE	6/12/41*
40-96585	♀	6/15/42	Kraus Colony	4 miles SE	6/15/46
F76375 ¹	—	6/22/32	Lodi, N. J.	160 miles SE	8/ 3/32
H80178 ¹	—	6/17/33	Uncasville, Conn.	70 miles S	8/14/33
H80148 ¹	—	6/12/33	New Ipswich, N. H.	21 miles N	6/34
L68611 ²	—	6/10/34	Hubbardston, Mass.	4 miles W	4/28/38
37-67743 ¹	♀	6/16/37	Princeton, Mass.	3 miles SE	6/ 7/38
42-77922 ³	—	6/27/43	S. Gardner, Mass.	9 miles NNW	5/20/45
39-62282 ¹	—	6/18/39	Gilbertsville, Mass.	18 miles SW	5/30/44

*Nested again at Kraus Colony the year following recovery

¹Dead

²Flew against store window "fighting with another bird"

³"Found"

breeding in the colony; 3 non-breeders in the colony; 8 breeding at the Kraus colony, 4 miles southeast and 7 elsewhere as listed in Table VI. This gives a total recovery percentage of 3.7% and a return to the colony of 2.4% of those banded.

Of the birds banded as nestlings *recovered* just before or during the breeding season, 69.0% were trapped in the colony. This percentage agrees well with Allen and Nice's (1952:654) percentage of 61% for the Purple Martin (*Progne subis*) recovered within one mile of the birthplace and with the other species given in Allen and Nice's table.

The distribution of the recoveries is as follows:

Returned to colony (16 ♂ : 13 ♀)	29
Recovered on first southward migration	2 ¹
At Kraus colony, 4 miles SE (5 ♂ : 3 ♀)	8
21 miles N (June)	1
9 miles NNW (May)	1
4 miles W (April)	1
18 miles SW (May)	1
3 miles SE (June)	1
<hr/>	<hr/>
Total	44

Among the nestlings returning to the colony were two from the same brood—one nesting in the nest box where she was hatched and the other in an adjacent nest box.

¹See *Bird-Banding*, 6:56

One of the most interesting recoveries of Tree Swallows banded in Princeton was a nestling banded by Douglas L. Kraus in 1942, which was recovered dead in East Lebanon, Maine, on June 18, 1945. Lebanon is 90 miles northeast of Princeton. It is quite evident from the date of recovery that this bird was breeding in Maine when it was killed. The northeast flight line taken by this swallow was in general parallel to the coast.

It is interesting to note that the only two Bluebirds (*Sialia s. sialis*) banded as nestlings in my colony and recovered elsewhere (Chapman 1942) also took a northeasterly course. One was recovered breeding at Groton, Mass. (20 miles northeast), the following June and the other was recovered in July in Maine, 300 miles northeast of Princeton when 5 years old.

Data are available on 44 birds banded as nestlings either in the Kraus or Chapman colonies which later nested in the Chapman colony or were banded in the Chapman colony and later nested in the Kraus colony. The breeding behavior of these birds is as follows:

Males breeding for first time when one year old	10
Males breeding for first time when two years old	14
Females breeding for first time when one year old	16
Females breeding for first time when two years old	4

No doubt a few of the two-year-old males were breeding when one year old and failed to be trapped, for, as pointed out later, males are not as readily trapped as females. However, the data appear to indicate that some males do not breed until two years old while most of the females breed when one year old.

Table III shows that during the period 1932-1946, 60.9% of the swallows breeding in the colony were new unbanded birds or birds banded at the Kraus colony and breeding in my colony for the first time. Many of these new birds must be one-year-old females or one-year- or two-year-old males. This high percentage of new birds together with the small number of returns of colony nestlings, indicate that many of the swallows banded as nestlings move off to other areas the next season.

It has been hoped that some fall recoveries would be obtained of swallows banded as nestlings in order to learn whether they dispersed in various directions in the fall and thus perhaps locate areas for nesting the next season. Boyd and Thomson (1937:280) give data on the fall dispersal of eleven fledglings of the European Barn Swallow (*Hirundo r. rustica*) ranging from one to 24 miles. Some went to the north (24 miles) some to the east (20 miles) and some to the southwest (23 miles). Similar fall movements for the same species are shown by Drost and Desselberger (1932). Allen and Nice (1952:650) mention the recovery of a fledgling Purple Martin 8 miles northeast, 3 weeks after it was banded. The only two recoveries of Princeton fledglings taken the same year that they were banded were to the south. (Table VI.)

In the middle of July 1952, two pairs of Tree Swallows were nesting in an open field (Boxes 14 and 36) after all the other swallows had left the colony. From the 18th to the 29th of July a group of immature Tree Swallows was observed flying around this field and appeared

greatly interested in the boxes occupied by the two nesting pairs. Many of the immature swallows flew up to the entrances of the boxes and looked in and several entered box no. 14 and other nearby empty nest boxes. They were evidently birds of the year dispersing from other breeding areas. As only a few pairs were known to be nesting in the vicinity of the colony, it is assumed that these young birds were hatched some distance away. By means of the shutter on box 14 and automatic shutters on other boxes, fourteen were trapped and banded over a period of 12 days. Two were taken in box 14 after the nestlings had flown.

As these swallows showed so much interest in the various nest boxes, it was hoped that some of them would return and breed the next year. However, none of them were found in the colony in 1953, although all but 5 of the breeding birds and 25 non-breeding swallows were trapped and banded.

A few other cases have been noted in past years of a single immature swallow appearing in the colony and in one case one entered a nest box in which nestlings were being fed. Low (1933:81) reports three cases of immature Tree Swallows entering nest boxes in this manner. One was an unbanded bird and the other two were from nest boxes a half-mile to the southwest which they had left about 10 days earlier.

EFFECTS OF WEATHER ON BREEDING TREE SWALLOWS

As a rule the percentage of eggs hatched each year has not varied widely, ranging between 73% and 92%, with exception of three years (1940, 1949 and 1951). The conditions causing the low percentage of eggs hatched in 1940 will be discussed in detail later in this section.

The nestling mortality on the other hand has varied widely from year to year as shown in Table I. The number of nestlings dying in the nest boxes is almost directly dependent upon the weather and consequently on the amount of insect food available when the young birds are being fed in the nests.

As pointed out in an earlier paper (Chapman 1935:45), the location of the Princeton colony is in a very unfavorable ecological region for breeding Tree Swallows and apparently the real attraction for the birds is the large number of nest boxes available. In cold and rainy weather, because of the large number of breeding Tree Swallows in an unfavorable area, the birds have great difficulty in finding a sufficient number of flying insects to feed themselves and their young and hence cold rainy spells have often resulted in heavy nestling mortality and low reproductive efficiency. In a few cases bad weather in early spring has resulted in a lower percentage of the eggs hatched. A discussion of the nestling mortality due to bad weather is given in my two former papers (Chapman 1935:40 and 1939:65) and will not be enlarged upon here. Koskimies (1950:45) points out that the combination of rain and cold weather is also most fatal to the European Swift (*Micropus apus*) and indicates (p. 40) that feeding ceases at a temperature of 12°C (53.6°F). He also mentions the almost complete disappearance of the swifts from the colonies in bad weather.

Extremely bad weather in 1940 in late May and early June and

again in late June had an adverse effect on both the incubation period and the feeding period and makes this year worth discussing briefly. In 1940 the swallows began laying about May 19 and by the 24th egg laying was well underway. From May 20 to 26, it was cold with rain or fog much of the time and the wind was northeast. On May 30 it was evident that some of the nests were temporarily deserted and several pairs of swallows had left the colony. It seems apparent that during this cold and rainy spell, the swallows had to spend so much time hunting for insects (a great deal of it away from the area) that incubation ceased in several of the nests. Droppings on top of several boxes contained seeds which apparently were bayberry (*Myrica Carolinensis*), indicating the scarceness of insect food.

During the cold drizzle of May 26, two pairs of swallows were observed flying back and forth between their own nest boxes and adjacent empty nest boxes. It appeared that each of these pairs was planning to nest again in one of the adjacent boxes. However, neither of these pairs nested again in new boxes. In one of the original nest boxes, a new nest was built and 6 eggs laid on top of one already containing 3 eggs. The other nest, which had been deserted for nearly a week with 5 eggs in it, was lined with white feathers and 4 new eggs added. On June 9 this nest contained 9 eggs, only 4 of which hatched.¹

The net result of this spell of bad weather in 1940 was as follows:

Pairs without eggs which disappeared	4
Pairs with eggs, which deserted	2
New nests built on top of old ones	2
Nest with eggs added after temporary desertion	3
Nest in which laying did not begin until after rainy spell	4
Nest in which incubation continued	7
	22

On May 19 there were 22 pairs in the colony; on June 9 there were only 16 pairs. Of the 7 nests in which incubation continued, two were later robbed of the eggs and in the remaining five only 52% of the eggs hatched.

Another cold and rainy spell occurred during June 23 to 26 when the nestlings were being fed. On June 25 the temperature was around 50°F nearly all day. Very few swallows were seen flying over the colony. On this day one nest was under observation for twenty minutes and neither adult entered the box during this time.

In 1940 the percentage of eggs hatched was 44.7—the lowest in the colony's history. The nestling mortality was 64.2%, one of the highest, and the reproductive efficiency was 15.9, the lowest with the exception of the year 1950 when all the boxes except one were cleaned out by a raccoon. Twelve nests (67%) of the 18 which originally contained eggs were total failures.

It is interesting to note that Allen and Nice (1952:637) report that 1940 was also a disastrous year for Purple Martins at the George Reserve where 12 pairs showed a nesting success of only 17.5% due

¹This female was 6 years old and eventually nested nine times in the colony.

largely to the same weather conditions experienced at Princeton.

On May 1, 1953 there was a hard driving rain all morning with an easterly wind and a temperature close to 32°F. and in the afternoon there was a light cold drizzle. On May 2 the wind was still easterly with a temperature close to 32°F. with a drizzle much of the day. No Tree Swallows were at the colony on either day.

At the home of C. Thomas Crocker, about one mile from the colony, about 100 swallows were observed on May 1 at 7 P.M.—some sitting on the electric light wires and others close together on the feeders and bird boxes. Many of these birds had their wings half spread. An investigation the next afternoon in the neighborhood where these swallows were seen the afternoon before, resulted in finding around 300 Tree Swallows, in a brushy pasture in which grew many bayberry bushes (*Myrica carolinensis*). Some groups were sitting on rocks, other groups were sitting on bushes and low trees and many were feeding on bayberries. Other groups were sitting on the wires along the road but only a few were flying around. On returning to my colony at 5:30 P.M., a few swallows were seen flying into the area during a cold rain and to enter some of the nest boxes. An inspection was made of 5 nest boxes. Three were found empty. In one, three swallows were found and in another, five. Of these 8 swallows, one was found later breeding in another box in the colony. The other seven were not seen again. These two boxes were empty at 7:30 P.M., the birds probably being disturbed by my banding. One of the swallows found in the nest box with four others was a bird (probably a male) banded on April 30, 1950 and not seen again until trapped on May 2, 1953.

It is impossible to account for the large number of swallows seen in the bayberry patch on May 2, as not more than one-third of these are believed to nest in the vicinity. As discussed later, May 1 appears too early for the arrival of the secondary flight of young swallows.

It was still cold and rainy on May 3 and there were no swallows in the colony nesting area but around fifty were still in the bayberry patch referred to above.

It is quite evident that Tree Swallows are able to take care of themselves during cold rainy spells by feeding on bayberries and hence when this food is available they do not suffer the mortality experienced by Purple Martins as discussed by Allen and Nice (1952:648) and by Forbush (1929:314) for the year 1903, and by other swallows caught north in bad weather in early spring.

Burleigh (1942:120) mentions that during the cold winter of 1939-40 in Mississippi, Tree Swallows were concentrated in enormous numbers where the thickets of myrtle bushes fringed the salt marshes.

However, Tree Swallows do not appear to be able to keep nestlings alive during bad weather by feeding them bayberries, although as pointed out above there is evidence that the adults fed to some extent on bayberries during bad weather when there were nestlings in the nest boxes. There are a great many bayberry bushes in the area adjacent to the colony.

As pointed out in an earlier paper (Chapman 1935:46) and by Kuerzi (1941:8) and others, Tree Swallows do not usually appear at the colony on cold and windy days in April and early May. If

they do appear it is only for a brief period early in the morning. My records for April 1, 1953 with the thermometer at 38°F, showed swallows present at 6 A.M. but all gone from the area at 10 A.M. Swallows were present on the mornings of April 3 to 8 but usually all had disappeared by noon. On April 14, there were nine inches of snow on the ground and no swallows were at the colony.

No information is available as to where the swallows go during the cold and cloudy days. Apparently the nesting urge diminishes by noon and the birds go to other areas where there is a greater concentration of aeroplankton. Quite probably they go to feed over lakes and ponds where the warmer air temperature due to the body of water would increase the number of flying insects, as pointed out by Koskimies (1950:45). It is evident from Glick (1939:94) that Tree Swallows can obtain little insect food at a temperature below 40 or 50°F.

It is interesting to note that Sheppard (1933:181) states that the Oriental Swallows (*Hirundo savignii*) disappear from the villages and towns in the territory around Jerusalem during periods of wet and stormy weather and go to the Jordan Valley where it is much warmer and insect life is abundant.

No adverse effects of hot days on the nestlings have been observed. On July 20, 1949 when the temperature in the shade under the nest box was 90°F. at 2 P.M. and a thermometer resting on the cover of the nest box containing 2 nestlings registered 110°F., the temperature inside of the box was 97°F. This box was painted gray and was 7/8" thick. On July 31 the temperature inside of the box at 3 P.M. was 104°F. The two nestlings were fledged successfully.

An analysis of the behavior of the 48 banded birds (32 ♀ and 16 ♂) involved in 32 complete nest failures showed the following:

females returning to colony to breed	3 (9.4%)
females not returning	29 ¹ (90.6%)
males returning to colony	5 (31.0%)
males not returning to colony	11 (69.0%)

Six of the males were observed at the nest boxes and not trapped and 10 were not observed or nest failure occurred before the males could be trapped.

OTHER CAUSES FOR REDUCED NESTING SUCCESS

Three other factors which have had an adverse influence on the nesting success of the Tree Swallows, have been House Wrens (*Troglodytes a. aedon*), Protocalliphora larvae [Apaulina] and ants.

From one to seven House Wrens have bred each year in the colony and in addition there are sometimes one or more unmated males each of which builds cock nests in one or more nest boxes. These wrens did not molest the Tree Swallows except in one case up to 1939 (see Chapman 1939:70). Table VII gives the number of Tree Swallow eggs apparently destroyed by House Wrens for an eight-year period.

In 1939, there was one pair of wrens breeding in the colony and one unmated male. On May 27 the eggs in two adjacent Tree Swallow

¹One female was trapped two years later, breeding at the Kraus colony, 4 miles away, classing her as a "wandering female."

nest boxes and in two adjacent Bluebird (*Sialia s. sialis*) nests were punctured and thrown out and on June 2, the eggs were thrown out from a third swallow's nest box. On June 2 a cock wren nest was found in one of these boxes. An unmated male wren was observed singing around these five nest boxes and on June 2 he was trapped and released at considerable distance from the colony. He did not return and there was no further destruction of eggs. It seems evident that this unmated male had been the cause of all this egg destruction. The three pairs of swallows immediately laid new clutches of eggs but the two pairs of Bluebirds deserted.

One bluebird egg was left unpunctured in one of the nest boxes and later a pair of Tree Swallows took possession and laid a clutch of five eggs in the deserted Bluebird's nest. The Bluebird's egg hatched along with the five swallow's eggs and the nestling developed at about the same rate as the swallows but it died when about half fledged.

Observations during subsequent years seem to indicate that the unmated male wrens are guilty of much but not all of the egg destruction. As is evident from Table VII, egg destruction is usually higher with an increase in the number of nesting wrens. The destruction of eggs by wrens seems to vary among individuals, some being especially destructive and others apparently not molesting the swallows at all. There have been a number of cases where young nestlings have been thrown out by the wrens and a male wren's nest started in the nest box the same day.

Protocalliphora larvae [Apaulina] have been found in most of the nest boxes each year and some boxes have been heavily infested (Chapman 1939:70). However, in recent years the number of larvae have been much less than in the early period of the colony and seldom have any been found attached to the nestlings in the past eight years.

In May 1938 a short article appeared in the *Technology Review* entitled "Do Flies Shun Blue?" This article pointed out that from observations made in France and elsewhere, the common house fly appeared to avoid rooms in which the walls were painted ultramarine or "implement" blue. This led to the idea that if the nest boxes were painted blue, the protocalliphora flies might not enter and hence the

TABLE VII
INTERFERENCE WITH NESTING BY HOUSE WRENS

Year	1941	1942	1943	1946	1949	1950	1952	1953
Pairs of Tree Swallows	17	25	25	15	26	29	25	30
Pairs of breeding House Wrens	0	2	5	5	3	7	3	3
Apparent number of male Wrens	1	3	5	8	6	7	4	6
Percentage of eggs apparently destroyed by Wrens	0	1.6	9.2	17.9	30.2	6.5	0	3.2
Percentage of nests broken up by Wrens	0	4.0	16.0	20.0	30.8	6.9	3.7	3.2
Percentage of Tree Swallow eggs hatched	84.5	88.8	73.3	—	62.0	71.5	79.0	80.3

trouble with the larvae could be obviated. Consequently a number of boxes were painted wagon blue before the 1939 breeding season. A careful count of larvae and pupae in 18 boxes was made and Table VIII gives the results of this experiment. It is obvious that the color of the box had no influence on the number of protocalliphora larvae, in fact the nest box painted blue inside and out had the highest count. Blue boxes were also experimented with at the Wharton Banding Station in Groton, Mass., and it was found there also that the blue color of the nest boxes had no influence (Mason 1944:242).

Ants and their eggs have occasionally been found in the nest boxes, sometimes while the nestlings were in the nests but more frequently after the nestlings have left. The year 1945 was an especially bad one and in several boxes which contained eggs or nestlings, hundreds of ants and ant "eggs" were found in the bottom of the boxes and throughout the hay making up the nest. The nestlings in all cases did not seem to be molested until the nest material was stirred up and then the ants attacked the nestlings. In each case the ants were destroyed and a new hay nest was made in the nest box. Dr. Charles H. Blake identified two species in two boxes as *Crematogaster lineolata*, and *Tapinoma sessile*, and a third as a *Myrmica sp.* in a third box. In 1951, three nestlings in one box were eaten by black ants of an undetermined species but larger than the brown ants found in 1945.

Mrs. Laskey (1940:186) mentions Bluebird nestlings in 3 boxes eaten by tiny ants (*Solenopsis sp.*) in Tennessee and Mrs. Thomas (1946:161) mentions ants occasionally found in Bluebird nest boxes in Arkansas.

TABLE VIII
PROTOCOLLIPHORA COUNTS (1939)

Box No.	Species	Color of Box	Larvae and Pupae
2	T.S.	Brown	12
3	T.S.	Brown	17
7	T.S.	Gray	3
8	T.S.	Brown	22
9	T.S.	Blue	0
14	Bluebird	Brown	0
16	T.S.	Blue	48
17	Bluebird	Blue ¹	121
18	T.S.	Gray	2
19	Bluebird	Blue	59
20	T.S.	Gray	42
22	Bluebird	Gray	61
33	T.S.	Gray	16
36	T.S.	Gray	35
38	T.S.	Gray	0
39	T.S.	Gray	0
47	T.S.	Gray	32
48	T.S.	Gray	54

¹Blue inside and out

TABLE IX
EGG DATA FOR NINE FEMALES

Breeding Year	F-96736	H-80104	40-96504	47-8704	43-48018	34-72143	41-47027	46-8717	46-8737
1	6 ⁴	6 ⁴	4 ¹	* ²	4 ¹	5 ⁴	6 ⁴	4 ¹	5 ³
2	5	5	5	5	*	5	6	7	5
3	6	4	5	4	5	6	2	6 ¹	5
4	6	*	7	5	5	6	6		
5	*	5	5	5	5	6	6		
6	—	2 & 4 ⁴	6	5 & 4 ⁰	—	5 & 4 ³	6		
7	—	—	*	7 ¹	—	6	—		
8			—			6			
9						4			

*No data available.

¹Brown bird; hence a nestling of previous year.²Dull blue bird.³Bright blue bird.⁴Color not recorded.⁵First laying of 2 eggs robbed.⁶This bird had 2 broods—5 eggs in first nesting and 4 in second.⁷Breeding in 1953.⁸Season of 1940 a wet cold season. 5 eggs laid and nest temporarily abandoned and then 4 more eggs laid, making 9 in all. 4 hatched.

A RACCOON'S VISIT TO THE COLONY

In 1950 a raccoon or more probably a family of raccoons entered the colony and destroyed 26 of the 29 Tree Swallow nests and in addition seven nests of House Wrens and one Bluebird nest. House Wrens destroyed two Tree Swallows' nests and the net result of the season was only one successful nesting with 4 nestlings leaving the nest box. The raccoon raid resulted in the taking of at least 6 adult female Tree Swallows, 85 nestlings and 13 eggs, besides the nestlings and eggs of the House Wrens and Bluebirds. Only three of the swallows breeding in the colony returned in 1951. These three were breeding again in the colony in 1953. Three nests were found empty on the morning of June 17 and on the morning of June 22, sixteen more nests were empty. Hence in five nights 54 good-sized nestlings were taken. On June 25, ten more nests were empty. In the case of the 6 adult females killed, the wings or wing feathers were found on the ground at the foot of the pole. No doubt other females were also eaten. The raccoon was not seen but the signs at and about the nest boxes left no doubt that one or more raccoons was the cause of this disaster.

The season of 1945 was also a disastrous one either due to a cat or a raccoon, with a nesting success of only 16.3%.

EGG DATA

The number of eggs laid and hatched was not recorded every year. Table V gives data for the eggs laid and hatched for 12 years with average data computed from the table. In a few cases where egg counts were not made early in the season, a record was made at the time of hatching of the number of nestlings and the unhatched eggs in each box, to obtain data on the number of eggs laid. This method may be open to question but it is not believed that Tree Swallows remove unhatched eggs from the nests.

Kuerzi (1941:25) gives the average eggs per set for 417 pairs over a three-year period as 5.2. This is exactly the same as the average for the 12-year period in the Princeton colony.

TABLE X
EGGS LAID BY BIRDS BANDED PREVIOUS YEAR AS NESTLINGS

	Breeding Year	Eggs	Color of Female
H80122	1934	5	—
L68640	1935	3	—
L73107	1935	4	—
41-47045	1942	6	Greenish
41-47134	1943	5	Brown
43-48116	1950	4	Brown
46-52916	1953	5	Dull Blue
47-8759	1953	6	Greenish-Brown

TABLE XI

EGGS PER NEST FOR 6 YEARS

	1939	1943	1949	1951	1952 ¹	1953
No. of nests with 2 eggs	0	0	1	0	0	0
3 eggs	2	2	1	2	3	3
4 eggs	1	4	7	2	2	3
5 eggs	9	9	9	9	11	13
6 eggs	7	7	7	8	7	9
7 eggs	1	2	0	0	2	2
8 eggs	0	1	0	0	0	0
9 eggs	0	0	1	0	0	0
No. of nests	20	25	26	21	25	30
Eggs laid	104	131	129	107	128	154

¹Second nesting of one pair not included.

Table IX gives the egg data for successive breeding years for nine females that returned to breed three or more times. Table X gives data for eggs laid in the first breeding year by swallows banded as nestlings.

NOTES ON BEHAVIOR

In 1953 observations were made on the time of arrival and the behavior of the one-year-old brown females. The first adults arrived in the colony on March 29 but the first brown female was not seen until April 24. A one-year-old male was trapped on April 23, and two others were trapped on May 11. Brown females were trapped at the nest boxes as follows:

April 30-May 10	4
May 11-16	7
May 19-31	10
June 6-21	5

An attempt was made to trap the brown females each day; hence the above data is representative of the arrivals of these females. These dates agree generally with the secondary flight noted by Kuerzi (1941:7) and also with Shelley's remarks regarding the arrival of brown females in New Hampshire (Shelley 1935:34).

The arrival of the brown females causes considerable trouble in the colony, as they frequently attempt to enter boxes which are already taken by mated pairs. Frequently fights take place between the mated female and the newly arrived intruding brown female. Practically all of the fights at the nest boxes appear to be between the two females. As far as could be observed the males take no part in these fights.

Each year a considerable number of the brown females disappear from the colony after being trapped and banded although a good number secure mates and nest. In 1953 a careful watch was made and as many as possible of these year-old females were trapped with automatic shutters and banded. Eleven out of twenty-five brown females

disappeared without attempting to nest. In addition to these twenty-five brown females, there were five classed as dull blue or dull greenish, all of which nested.

In 1953 two females were found together in the same nest box on May 12, a brown one on top of a dull green one. The brown female disappeared and the other swallow nested in this box.

In 1950 and again in 1953 an attempt was made to trap as many swallows as possible early in the season. Many of these birds were color-banded. The following tabulation shows the subsequent behavior of birds most of which were trapped before May 15.

	1950	1953
New ♀ ♀ moving to a second box before nesting	2	2
New ♂ moving to a second box before nesting	0	1
New ♀ ♀ trapped and disappeared	8 ¹	14
New ♂ ♂ trapped and disappeared	5 ²	0
New birds (sex unknown) trapped and disappeared	3	4
Nestlings of previous year which disappeared	2 ♀	1 ♂
Nestlings of previous year which nested	1	4
Returning ♀ disappearing after trapping	0	1
Returning ♀ ♀ moving to a second box before nesting	7	1
Returning ♂ moving to a second box before nesting	0	1
New ♀ ♀ nesting in box where first trapped	9	18
New ♂ ♂ nesting in box where first trapped	4	7

In a few cases the determination of the sex of the birds which disappeared may be in error.

¹In two cases attempts to nest were broken up by House Wrens.

²In one case attempt to nest was broken up by House Wrens.

The behavior of the breeding males varies considerably. Some go readily into the nest box as the incubating females leave and "stand watch" looking out of the hole during the absence of the female. Frequently these males call as they approach the box and the female flies out. Other males do not enter the box in this manner but sit on a nearby perch. Most males enter the box to feed the young. Usually they hesitate a second before entering but the female enters at once. As the females are generally banded while incubating, this behavior of the males noted above allows the watcher to distinguish the males from the females, and the males can thus be trapped with a pull string and the female is not usually trapped a second time. A few males enter the nest box only after long intervals and then usually they have a great many insects in their beaks. In one case where a count was made, a male had 67 green aphids and small flies. In a few cases males do not enter the box to feed the young and hence cannot be trapped. No case has come under observation where the male incubated the eggs.

Some males sing and try to encourage the female to enter the nest box when they have been disturbed by banding operations. Two males have been trapped during incubation when they flew into the box with a feather.

In two cases, once in 1935 and again in 1938, a male was trapped several times in two adjacent nest boxes. As only one male was seen in either case, apparently these were definite cases of polygyny.

PAIR FORMATION

In 1953, I was present at the colony when the Tree Swallows arrived and full notes were kept for each day in April and much of May on the behavior of the birds at some of the nest boxes. Many of the swallows were color-banded.

From these observations it is quite apparent that few, if any, of the swallows arrive at the colony as mated pairs. Pair formation appears to be such a confusing affair, with birds visiting back and forth between different boxes, that no worthwhile conclusions can be drawn.

It was decided to concentrate attention at one nest box and box no. 7 was selected for this purpose. The data collected at this nest box from April 1 to June 10 can be briefly summarized as follows. Most of the trapping at this box was done by means of an automatic shutter.

♂ ♂ trapped and later found breeding in another box	2
1952 ♂ nestling trapped and disappeared	1
Bright blue ♀ trapped and disappeared	1
Brown ♀ ♀ trapped and disappeared	2
Dull blue ♀ trapped and found nesting in another box	1
Trapped and disappeared (sex unknown)	4
Breeding ♂ trapped June 17 (1st seen April 27)	1
Breeding brown ♀ trapped May 11	1

The nest was started on May 23 and had five eggs on May 31.

How much of the behavior at this nest box was normal pair formation and how much of it was caused by trapping and banding activities it is impossible to say.

THE PAIR BOND

One of the facts which I wished to obtain from this study was whether there is a definite pair bond between any of the swallows from year to year. As the following data show, there are numerous cases of swallows remating for two or more seasons and also numerous cases of "divorce." Many believe that when two birds remate at the same nest box in a second season, it is merely because the male and female return to the same nest site and hence meet there and consequently remate. However, the banding data show that there are a number of cases where birds have remated a second time and nested in a different but nearby nest box in a subsequent season.

In fourteen breeding seasons at the Princeton colony which I have selected for analysis, 67 pairs which were mated the previous year returned to breed again in the colony. The remating behavior of these 67 pairs is as follows:

Remating in the same nest box	22	31.8%
Remating in a nearby box	12	17.9%
Divorces	33	49.3%

The above summary includes the data on 4 pairs that were mated three times and one pair that was mated four times. Four of these five pairs changed the nest box once and one pair nested in the same box three times. Hence the above data are based on 56 pairs.

There was one pair which mated for two seasons and was divorced the third season. Another pair was mated in 1942 (Box 4), divorced in

1943 and remated in 1944 (Box 4).¹ I suspect that in 1943 the female returned too late and the male mated with a female which arrived earlier. In addition to the 33 divorces there was one case where the female of a pair which was mated in 1952, returned in 1953 and deserted after being trapped. One female (H-80101) nested in the same box for 5 years, two years with one mate, and 2 years with a second mate. The first and second pair bonds were broken as the males failed to return.

During the fall of 1938, nest box no. 17 was moved to a new location 50 ft. away and was replaced at its old location by a new box. The pair of swallows which nested in no. 17 in 1938 remated in 1939 in no. 17 at its new location, evidently preferring the old box rather than a particular location.

The behavior of two pairs of swallows which definitely appear to have pair bonds deserves special discussion. One pair (46-8733 ♂ banded in 1951 and 47-8704 ♀ banded in 1947), nested in box 14 in 1951, the male being a new bird that year and the female a Return-4, hence at least 5 years old. This female had nested the three previous seasons in box 25 and her first season in no. 4. The mate of box no. 4 is not known but for each nesting in no. 25 she had a different mate, none of which returned the following season. In 1951 she moved to box no. 14. This pair which nested in no. 14 in 1951 nested again in the same box in 1952. In 1953 a pair of Bluebirds had possession of box no. 14 when this pair of swallows arrived. Although the swallows tried hard to secure this nest box, they were driven off by the Bluebirds. Finally on April 29, I put up another box, 54 feet from no. 14 which was immediately taken by this pair. In 1952 this pair had two broods in box no. 14—the only case of a pair of Tree Swallows having two broods in the 22 years of the colony's history.

The other interesting case of pair-bond is 34-72143 ♀ and 36-18650 ♂. Data on this 9-year-old female are given in Table XII. She mated with 36-18650 for three and possibly four years. This pair nested in box no. 11 in 1940 and nested in a nearby box in 1941 and 1942. The male was not trapped in 1943 although the female was again back at the same box.

It is interesting to note that this male, previous to the mating discussed above, had 36-18636 ♀ for his mate in 1938 and 1939, yet they nested in different (nearby) boxes in 1938 and 1939. His mate of 1939 did not return in 1940 and he moved to a third box (no. 11) and mated with 34-72143 ♀ who had lost her mate of two years in 1940.

A pair (F-81853 ♂ and H-80104 ♀) was mentioned in my 1939 paper. This pair mated in box no. 1 in 1933, 1934 and 1935. In 1936 they moved to an adjacent nest box (no. 2) and were mated again. The male did not return in 1937 but the female was back in no. 2 in 1937 and 1938 with a new mate each year.

It would appear from the cases given above that a pair bond may exist between certain pairs of Tree Swallows and remating at times may be more than merely arriving again at last year's nest box and hence remating.

¹This remating is not included in the above data, this pair being listed as divorced.

TABLE XII
HISTORY OF FEMALE 34-72143—A NINE-YEAR-OLD SWALLOW

		Nest Box	Eggs	Mate	Age of Mate
Banded in	1935	9	5	34-72140	1
Return	1936	52	5	not trapped	—
	1937	17	6	35-50782	2 ²
	1938	11	6	36-18523	2 ¹
	1939	11	6	36-18523	3
	1940	11	5 & 4 ¹	36-18650	3 ¹ 5
	1941	16	6	36-18650	4
	1942	16	6	36-18650	5
	1943	16	4	not trapped	—

¹A rainy season—see notes under Weather

²A 1935 nestling

³A 1936 nestling

⁴Trapped breeding the colony in 1938

⁵1939 mate did not return.

Laidlaw Williams (1952:26) in his study of the Brewer Blackbird (*Euphagus cyanocephalus*) gives cases of definite pair bond with this species, although this bird is polygynous. He points out that out of 70 primary matings, in 45 cases both members of the primary pair returned the following year. Of these 45 possibilities for remating, there were 42 rematings (93.3%) and only 3 divorces. Some of these pairs maintained the bond for several years—one pair for five years. The Brewer Blackbird in his study-colony was found to be non-migratory and pair formation takes place while the birds are in the flock. However, these birds did not remain mated during the non-breeding season and the male and female do not meet at the nest location of the previous year.

Kendeigh (1941:55) gives two cases in which pairs of House Wrens remated for three years. One pair nested for three years in the same box. The second pair nested in the same box for two seasons and in a box about 230 ft. away in the other season. This second pair remained together for the second nesting of each season.

Richdale (1947:115) in his study of the Yellow-eyed Penguin (*Megadyptes antipodes*) shows that the pair bond is strong in many birds of this species, as 82% of the mated pairs which returned remained intact for the second season.

Richdale also points out that certain of the burrow nesting petrels also remate and Lockley (1942) states that some of the Manx Shearwaters remate for one or more seasons. However, in the case of the petrels and shearwaters the birds meet again at the previous nest site like the Tree Swallows.

Richdale (1947:115) points out that birds of the above type do not fit into either Lack's (1940:270) class 4 (sexes that remain together for one breeding season) or class 5 (birds that pair for life) and

believes a new category should be established to include species which remain mated for some years but in which class divorces exist. Such a classification might include the Tree Swallows.

Since this paper was written, data for the 1954 breeding season have been obtained. Six pairs which were mated in 1953 returned in 1954. There were three cases of remating and three divorces. Of special interest is the fact that ♀ 47-8704 (8 years old) and ♂ 46-8733 returned and remated again in Box 14. This pair has thus been mated for four seasons, three times in the same nest box and once (1953) in an adjacent box. The female was trapped on April 24.

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GENERAL NOTES

Fighting and Mortality among Tufted Titmice (*Parus bicolor*) caught in Banding Traps near Leesburg, Virginia.—Early in the winter of 1953-1954, I had six all-purpose traps in operation at my banding station. During this period fourteen Tufted Titmice were banded. In addition, all three Titmice banded the previous winter returned. That Titmice may not get along well together when confined in the same enclosure was indicated by an observation on November 8, 1953. On making my rounds I found in one trap two Tufted Titmice locked in a furious struggle. Fighting took place on the ground, in the air and on the sides of the trap. One of the birds appeared to be getting the worst of it. On my intervention it flew to the side of the trap and remained there in a dazed condition. I noticed that one eye was partially closed. Both birds were unbanded. The unhurt bird was given band number 21-192634. The injured bird was given band number 21-192635.

On November 28, 1953, I found evidence of a very bitter struggle. A Tufted Titmouse flying about a trap was found to be 21-192638, a bird banded on November 14, 1953. After releasing this bird, I noticed a Tufted Titmouse lying prone in a corner of the trap. With its head almost buried in a shallow depression the bird, to all appearances, was dead. But in my hand it made a faint struggle to get away. It was 21-192627, banded on October 30, 1953. One eye was closed and nearly every feather had been plucked from its head. After a few hours in captivity the bird was able to fly away. It was not retaken, and my guess is that it died of its injuries.

During the Christmas season I left my traps open with grain in them. Visiting the traps on January 2nd, 1954, I found in one a dead Tufted Titmouse. This was 21-192640, banded on December 8, 1953. The bird had obviously been killed in a struggle similar to those I had previously witnessed. The entire head was bloody and devoid of feathers. There was a distinct hole through the cranium behind the eye.

On renewing banding activity on January 3rd, I discovered a new instance of Titmouse strife. A trap which had been empty at 1:00 P.M. contained four live Tufted Titmice and one dead one when revisited at 2:00 P.M. The freshly killed bird, 21-192639, had been banded on November 14, 1953, and had repeated frequently since then. Three of the four live birds in the trap escaped before I could examine them. The single bird I examined wore band number 21-192630. It was uninjured and to my knowledge had not been involved in any previous fights. The dead bird, as usual, had had its head plucked of feathers. An autopsy revealed that the bird was a female. The cranium was clotted with blood and had been punctured behind the eye. From the degree of cranial ossification it appeared that the bird was an immature. This was the last case of mortality or injury to come to light during the winter banding season.