

OBSERVATIONS ON THE BREEDING BIOLOGY OF THE TREE SWALLOW

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INTRODUCTION

The tree swallow, *Iridoprocne bicolor* (Vieillot), has an extensive breeding range in North America. Numerous studies have documented various aspects of the breeding biology of this bird, particularly in southern New England. However, little information of this nature has been published for the tree swallow in the more southern reaches of its breeding range.

This study presents breeding data of a swallow colony located on the Tincicum Marsh Wildlife Preserve in Philadelphia, Pennsylvania. This area is probably the only place in the southeastern corner of the state where these birds nest regularly, although nesting also occurs further south along the Atlantic coast.

DESCRIPTION OF STUDY AREA

The Tincicum Marsh Wildlife Preserve is located in the southwest corner of Philadelphia (Figure 1). It encompasses 250 acres of old field, fresh-water marsh, and open water. A tidal stream, the Darby Creek, and a tidal marsh, part of the Delaware River watershed, border the preserve to the west. An earthen dike separates the creek from the preserve.

The preserve is managed primarily for waterfowl which congregate there in large concentrations in the spring and fall. Water control devices are used for manipulation of the water level. In addition, the area is extensively used as nesting grounds by waterfowl and song birds alike. A more complete description of the area, its flora, fauna, and management can be found in Stoczek (1965). A 35-acre strip of marsh, not contiguous with the preserve proper but part of it, was included in the study area. It is located to the southeast of the preserve and is not shown in figure 1. Ecologically, this unit is similar to the larger freshwater marsh.

PROCEDURE

Prior to 1962 tree swallows had frequented the preserve and nested annually in small numbers limited by the availability of natural and, to a small degree, artificial nest sites. Thereafter, a greater effort was made to attract these birds by the placement of more nest boxes out on the entire marsh. These were put out each year prior to the arrival of the swallows.

The dimensions of the wooden nest boxes varied considerably but many were constructed to a basic design of six inches wide by six inches deep by nine inches high with a three-inch higher back for mounting. The entrance hole was, initially, 1½ inches in diameter placed six inches up from the bottom.

of the box. This was found to be too large, however, making the box more accessible to starlings. Consequently, a 1¼ inch diameter hole proved more suitable. The height of the entrance hole from the floor, again, varied considerably but appeared to make little difference to the swallows. One box with an entrance hole only one inch above the floor was successfully utilized. The boxes opened from the side, top, or front for observation. All were unpainted, treated with only a coat of boiled linseed oil.

Three and four hole nest boxes were also put out each year, eight in 1962, at least 11 (data incomplete) in 1963, six in 1964 and seven in 1965. In 1962, one wood duck box was also utilized.

All nest boxes were mounted three to five feet above the ground or water surface on metal or wooden posts or, as in a few instances, on trees. Most were randomly situated over water or immediately adjacent to it (see figure 1).

The number of nest boxes available for use by the swallows is shown in Table 1.

While breeding data for 1962, 63, 64 and 1965 will be referred to in this study, that of 1964 and 1965 will constitute the major portion. In 1962 the nest box contents were examined only once. Data on only three nests, each checked four times during the breeding season, were available in 1963. During 1964, the nests were examined every five to seven days, sometimes more often, while in 1965 they were checked as often as possible, usually every two or three days.

RESULTS

ARRIVAL ON THE BREEDING GROUNDS

The first arrivals at the marsh were usually individual birds with small flocks coming in during the first and second weeks thereafter. The average date of the first arrivals from 1962 to 1965 was March 16, varying as follows:

<i>Year</i>	<i>Arrival Date</i>
1962	March 10
1963	March 17
1964	March 9
1965	March 28

In 1961, the swallows were first seen between March 11 and 18. Bent (1942) gives an early date of spring arrival in Philadelphia as March 30.

A noticeable influx of brown-backed swallows took place much later in the breeding season of 1965. These birds were presumably young females (Kuerzi, 1941; Shelley, 1935), perhaps breeding for the first time. The first of these was seen on May 6. Upon arrival of the younger birds, squabbling with the breeding adults ensued, probably over nest box rights and/or mates (discussed further on). Some of the later arrivals eventually nested on the marsh. Kuerzi (op. cit.), studying the swallows in Connecticut, also observed mid and late May secondary flights of birds he termed non-breeders or birds nesting further north.

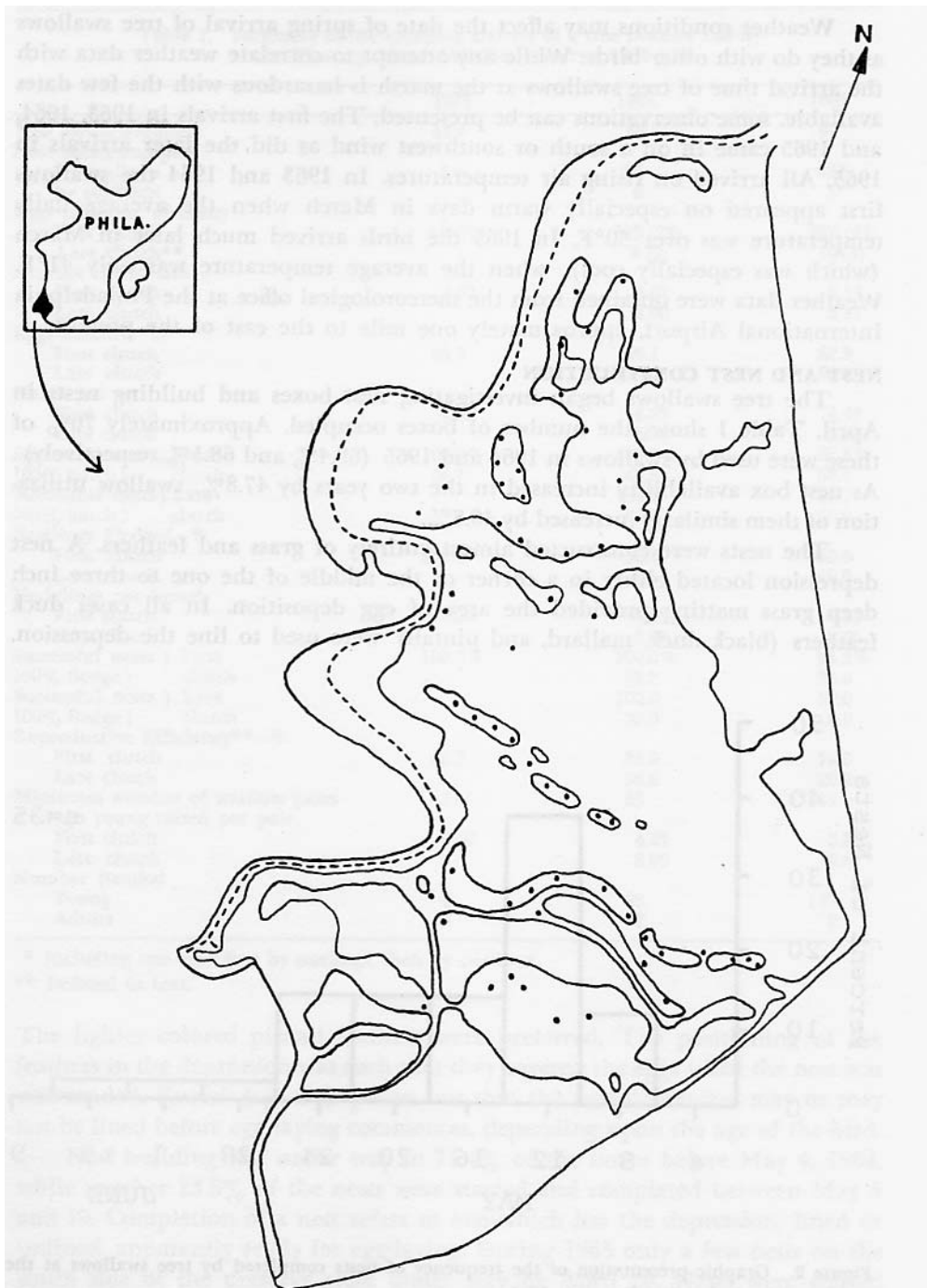


Figure 1. Map of the Tincum Marsh Wildlife Preserve showing the tree swallow nest box sites (dots). The dash line represents a mile long dike road. The insert shows the location of the preserve (darkened area) within the city of Philadelphia.

Weather conditions may affect the date of spring arrival of tree swallows as they do with other birds. While any attempt to correlate weather data with the arrival time of tree swallows at the marsh is hazardous with the few dates available, some observations can be presented. The first arrivals in 1963, 1964, and 1965 came in on a south or southwest wind as did the later arrivals in 1965. All arrived on rising air temperatures. In 1963 and 1964 the swallows first appeared on especially warm days in March when the average daily temperature was over 50°F. In 1965 the birds arrived much later in March (which was especially cool), when the average temperature was only 41°F. Weather data were obtained from the meteorological office at the Philadelphia International Airport, approximately one mile to the east of the preserve.

NEST AND NEST CONSTRUCTION

The tree swallows began investigating nest boxes and building nests in April. Table 1 shows the number of boxes occupied. Approximately 70% of these were used by swallows in 1964 and 1965 (69.4% and 68.1% respectively). As nest box availability increased in the two years by 47.8%, swallow utilization of them similarly increased by 46.8%.

The nests were constructed almost entirely of grass and feathers. A nest depression located either in a corner or the middle of the one to three inch deep grass matting provided the area of egg deposition. In all cases duck feathers (black duck, mallard, and pintail) were used to line the depression.

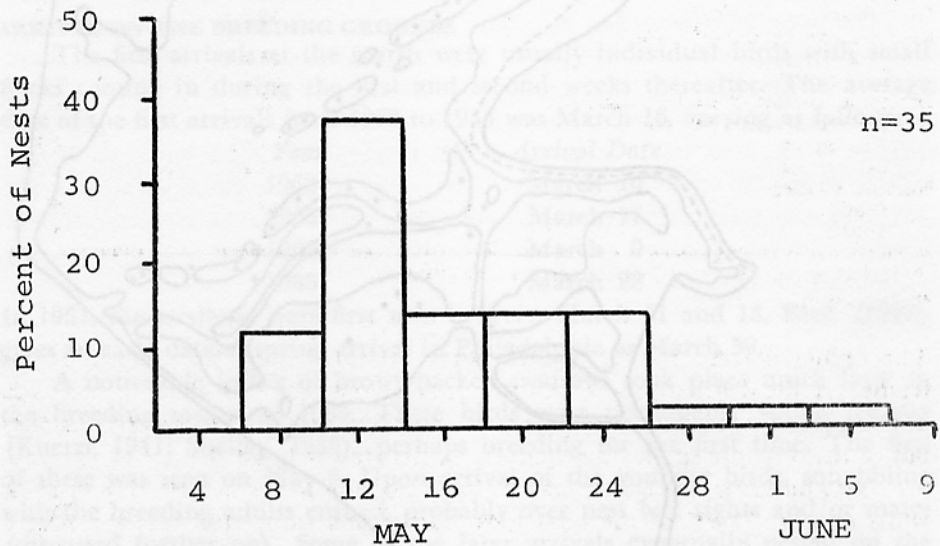


Figure 2. Graphic presentation of the frequency of nests completed by tree swallows at the Tincicum Marsh Wildlife Preserve, 1965.

Table 1. Summary of the breeding activity of a tree swallow colony at the Tinicum Marsh Wildlife Preserve, 1963-1965.

	1963	1964	1965
Nest boxes available	11+	36	69
Nest boxes occupied			
by swallows	3+	25	47*
by starlings		6	5*
Eggs laid (no. of nests)			
First clutch	14 (3)	129 (23)	226 (44)
Late clutch**		8 (2)	10 (3)
Average clutch size			
First clutch	4.67	5.61	5.14
Late clutch		4.00	3.33
Eggs hatched—%			
First clutch	85.7	86.1	82.3
Late clutch		75.0	50.0
Hatch per set			
First clutch	4.00	4.83	4.43
Late clutch		3.00	2.50
Successful nests) First	100.0%	100.0%	95.5%
100% hatch) clutch	66.7	43.5	50.0
Successful nests) Late		100.0	66.7
100% hatch) clutch		50.0	50.0
Nestlings Fledged—%			
First clutch	100.0	96.4	93.6
Late clutch		66.7	40.0
Fledglings per brood			
First clutch	4.00	4.65	4.35
Late clutch		2.00	2.00
Successful nests) First	100.0%	100.0%	95.2%
100% fledge) clutch		95.7	90.0
Successful nests) Late		100.0	50.0
100% fledge) clutch		50.0	0.0
Reproductive Efficiency**—%			
First clutch	85.7	83.0	78.0
Late clutch		50.0	20.0
Minimum number of swallow pairs	3+	23	44
Average young raised per pair			
First clutch	4.00	4.65	3.96
Late clutch		2.00	0.67
Number Banded			
Young	2	88	147
Adults	0	2	2

* Including one used first by starlings, then by swallows.

** Defined in text.

The lighter colored pintail feathers were preferred. The positioning of the feathers in the depression was such that they covered the eggs when the nest was unattended. Kuerzi (op. cit.) points out that the nest depression may or may not be lined before egg laying commences, depending upon the age of the bird.

Nest building was under way in 71.4% of the boxes before May 4, 1964, while another 23.8% of the nests were started and completed between May 5 and 10. Completion of a nest refers to one which has the depression, lined or unlined, apparently ready for egg-laying. During 1965 only a few nests on the south side of the preserve were under way by April 20. Nests were started before April 26, however, in 15.2% of the cases (n = 46) while 50% were in

progress or built by May 6, 78.3% by May 15, and 93.5% by May 20. Figure 2 summarizes the dates of nest completion during the 1965 breeding season. Almost 50% were finished by May 14. Only one nest was started after June 1. However, a few were being constructed as late as June 21 in one multi-hole box but were never completed. Austin and Low (1932) give the peak of tree swallow nest building in Cape Cod, Massachusetts, as the last week of April and the first week of May. This is similar to the data presented here.

Eight nests examined during the first two weeks of May, 1964, showed that five were completed in one week or less and three were built in more than one but less than two weeks time. Kuerzi (op. cit.) indicates the usual time for nest building as two weeks, sometimes close to three weeks, while Weyde-meyer (1934) shows an average of 29 days in Montana for building the first nest.

EGG LAYING

The first egg was laid on May 7 in 1964 and on May 6 in 1965. The average date of the first egg was May 16, 1965, for first nests. This is based on eight nests with known dates ranging from May 6 to 27. When additional nest data are utilized, the average date, through back-calculation, was May 18 based on 35 records. In 1964 the average date of the first egg was May 12 for 19 first nests. Austin and Low (op. cit.) and Kuerzi (op. cit.) give the dates of first eggs as May 7 and May 6 respectively.

All the first clutches were started between May 6 and 18 in 1964 (Figure 3), in contrast to 1965 when only 54.5% were started during this time (Figure 4).

The first eggs were laid at varying times after the initiation of nest building. In 19 first and late nests during 1965, one clutch was started in less than three days from the time of initial construction, six clutches in 3 to 7 days, eight clutches in 7 to 10 days, and four clutches in 10 to 14 days. There was, however, no apparent relationship between the number of days used in building the nest and the date of the first egg, except in one case. One late nest was built and the first egg laid in less than three days. This is similar to an observation by Kuerzi (op. cit.) of three to four days for completion of a nest for a second brood of tree swallows.

Before going any further, a distinction must be made between the first nest (clutch) and the late nest. A late nesting as used in this study refers to (1) a nesting much later than the norm for that breeding season, (2) a nesting for the second time after successful completion of a first clutch, or (3) a re-nesting after a first clutch failure. What little can be said regarding these different situations will be presented further on.

Any clutch started after June 1 was considered a late nesting in 1964. However, in 1965 a totally different situation arose. The breeding season was extended considerably (as will be shown). Consequently the late nests, determined by inspection of the distribution of the first egg dates (in 1964 and

Figure 3. Chronology of the breeding activity of the tree swallow colony at the Tinicum Marsh Wildlife Preserve, 1964. Solid bars indicate late nests.

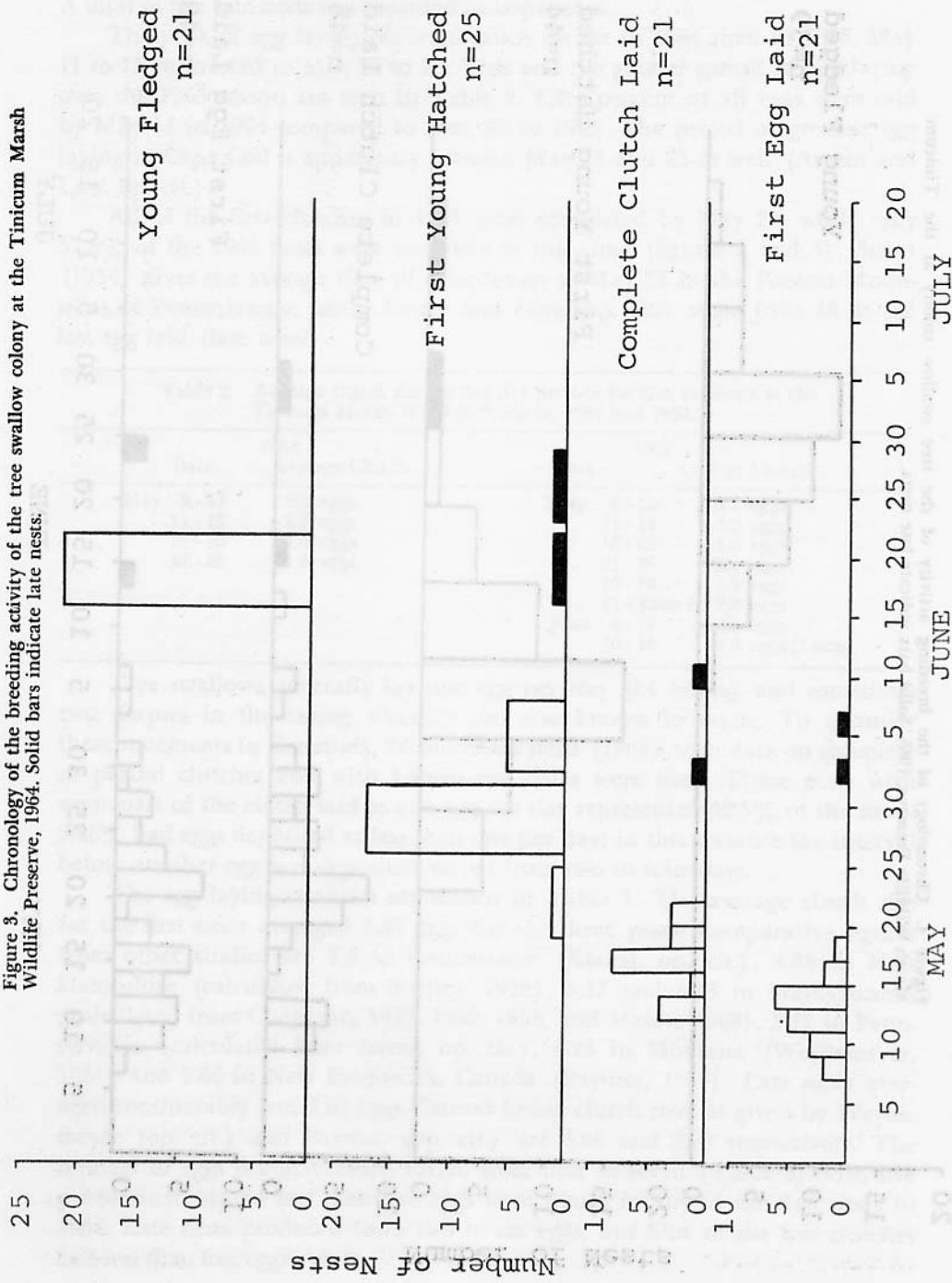
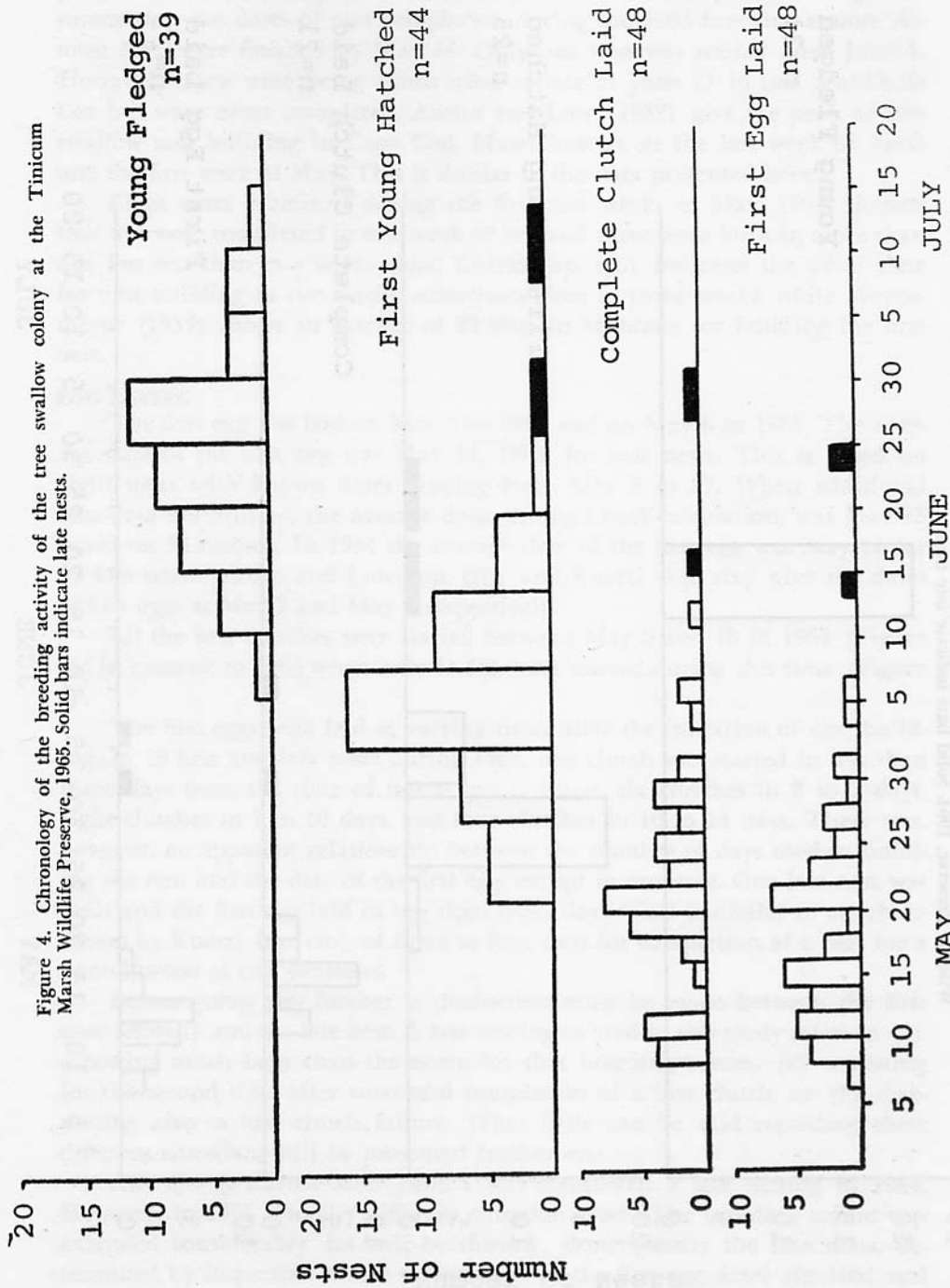


Figure 4. Chronology of the breeding activity of the tree swallow colony at the Tinicum Marsh Wildlife Preserve, 1965. Solid bars indicate late nests.



1965), were identified as those having been started much later in the season. A total of five late nests was recorded in both years.

The peak of egg laying occurred much earlier in 1964 than in 1965, May 11 to 15 contrasted to May 16 to 25. This and the greater spread of egg laying over the 1965 season are seen in Table 2. Fifty percent of all eggs were laid by May 14 in 1964 compared to May 20 in 1965. The period of greatest egg laying in Cape Cod is apparently between May 15 and 25 as well (Austin and Low, op. cit.).

All of the first clutches in 1964 were completed by May 22, while only 57.8% of the 1965 nests were complete at this time (figures 3 and 4). Street (1954) gives the average date of completion as May 28 in the Pocono Mountains of Pennsylvania, while Austin and Low (op. cit.) show June 18 as the last egg laid (late nest?).

Table 2. Average clutch size by five day periods for tree swallows at the Tinicum Marsh Wildlife Preserve, 1964 and 1965.

1964		1965	
Date	Average Clutch	Date	Average Clutch
May 6 - 10	2.4 eggs	May 6 - 10	2.1 eggs
11 - 15	3.2 eggs	11 - 15	2.7 eggs
16 - 20	2.6 eggs	16 - 20	3.2 eggs
21 - 25	1.0 eggs	21 - 25	3.2 eggs
		26 - 30	2.9 eggs
		31 - June 4	2.8 eggs
		June 5 - 9	2.7 eggs
		10 - 14	3.0 eggs (1 nest)

Tree swallows generally lay one egg per day (24 hours) and sometimes two. Lapses in the laying schedule are also known to occur. To quantify these statements in this study, 24 successful nests (1965) with data on complete or partial clutches and with known egg dates were used. Those nests with some part of the clutch laid as one egg per day represented 62.5% of the nests. 20.8% had eggs deposited as less than one per day; in this instance the interval before another egg was deposited varied from two to four days.

The egg laying statistics are shown in Table 1. The average clutch size for the first nests averaged 5.27 eggs for the three years. Comparative figures from other studies are 5.6 in Connecticut (Keurzi, op. cit.), 4.83 in New Hampshire (calculated from Shelley, 1935), 5.13 and 5.15 in Massachusetts (calculated from Chapman, 1935, 1939, 1955, and Mason, 1968), 5.12 in Pennsylvania (calculated from Street, op. cit.), 6.23 in Montana (Weydemeyer, 1935) and 5.86 in New Brunswick, Canada (Paynter, 1954). Late nests averaged considerably less, 3.67 eggs. Second brood clutch sizes as given by Weydemeyer (op. cit.) and Paynter (op. cit.) are 4.88 and 5.00 respectively. The number of eggs per first clutch varied from four to seven (Table 3) with five predominating. No less than five eggs were found in any of the first nests in 1964. Late nests produced from two to six eggs, but four of the five clutches had less than five eggs apiece.

Table 3. Clutch size of 70 first nests for a tree swallow colony at the Tinicum Marsh Wildlife Preserve, 1963-1965.

No. of Eggs	Percent of Nests
2	0.0
3	0.0
4	15.7
5	44.3
6	37.1
7	2.9

INCUBATION

The incubation period, as used here, refers to the interval between the laying of the last egg and the hatching of the first.

On the basis of 29 nests with reliable data in 1965, the average incubation period was calculated as 14.7 days with a range of 11 to 19 days (Table 4). Similarly, an average of 14.5 days, ranging from 11 to 18 days, was found for 19 nests in 1964. Other studies have shown incubation periods of 14.5 (Keurzi, op. cit.), 18 (Shelley, op. cit.), 14.5 (calculated from Austin and Low, op. cit.) and 15.83 days (Paynter, op. cit.) for the tree swallow.

Table 4. Frequency distribution of the duration of incubation period for 29 tree swallow nests, Tinicum Marsh Wildlife Preserve, 1965.

Duration, in days	Number of Nests
11	1
12	1
13	6
14	10
15	4
16	1
17	2
18	1
19	3
	—
	29

The most prevalent duration of incubation was 14 days (34.5% of the nests, Table 4). Compared to the previous studies mentioned, where a 14 to 16 day incubation period was given as most common, the data presented here show a frequency distribution skewed towards the longer incubation periods.

It appears that swallows with larger clutches take less time to hatch the young (Table 5). A four egg clutch has the longest mean incubation period; recall that when the colony was smaller in 1964, no four egg clutches were laid. While the seven egg clutch represents only two nests, the short incubation period here was noticeable in both years. Paynter (op. cit.) found a somewhat

similar trend but with an increase in incubation time for *both* the smallest (three egg) and the largest (seven egg) clutches.

Table 5. The relationship of mean duration of incubation and clutch size of first nests in a tree swallow colony at the Tinicum Marsh Wildlife Preserve. Number of nests are shown in parentheses.

Clutch Size	Mean Incubation period, Days	
	1964	1965
4	—	16.0 (6)
5	14.8 (6)	14.5 (12)
6	14.3 (11)	14.5 (10)
7	11.5 (1)	11.0 (1)

HATCHING

Hatching success can vary considerably, due to a complex of factors. Consequently, reports of annual successes of less than 5% (Chapman, 1955) to well over 95% (Weydemeyer, op. cit.) are found in the literature. For the most part, however, tree swallow hatching success is rather high, often in excess of 80%. Almost all first nests in this study produced some live young (Table 1), but only about half were entirely successful. An average of 83.7% of the eggs laid hatched. The highest hatch per clutch was found in 1964. Hatching success in late nests was considerably less in 1965, but generally these nests were as entirely successful as the first.

The majority of the first clutches (73.9%) started hatching from May 26 to June 1 in 1964 (Figure 3). Complete hatching of the broods occurred during the same period in 52.4% of the nests. During 1965, hatching extended over a longer period of time (Figure 4) with only 28.6% of the nests starting and 19.5% completely hatched before June 1. The peak of hatching (if it can be called that) in 1965 occurred between June 2 and 7. Chapman (1935) notes that most tree swallows on his study area in Princeton, Massachusetts, hatched from June 4 to 9.

In 1963, hatching occurred before May 30 in one nest and on June 12 and June 13 in the other two.

HATCHING MORTALITY

Egg mortality amounted to between 13 and 18% for first clutches. Late nests exhibited a higher rate, reaching 50% in 1965. Table 6 shows the probable cause of this egg loss. Approximately 10% of the eggs were thought to be infertile. Many of these infertile eggs (65%) disappeared after the brood had completely hatched. Deserted nests in 1965 represent only one first and one late clutch.

Table 6. Egg and nestling mortality in first and late nests of the tree swallow colony at the Tinicum Marsh Wildlife Preserve, 1964 and 1965.

Egg Mortality	Percent of Eggs Laid			
	1964		1965	
	First	Late	First	Late
Disappeared	4.7	12.5	0.9	0.0
Infertile (probably)	8.5	12.5	11.8	10.0
Broken	0.8	0.0	0.5	0.0
Deserted	0.0	0.0	2.3	40.0

Nestling Mortality	Percent of Eggs Hatched			
	1964		1965	
	First	Late	First	Late
Dead, cause unknown	4.5	33.3	2.2	20.0
Disappeared	0.0	0.0	0.5	0.0
Deserted	0.0	0.0	2.7	40.0
Predation	0.0	0.0	0.5	0.0
Crippled	0.0	0.0	0.5	00.0

Table 7. The relationship of egg mortality and clutch size of first nests in a tree swallow colony at the Tinicum Marsh Wildlife Preserve. Number of nests are shown in parentheses.

Clutch Size	Mortality, in %	
	1964	1965
	4	—
5	12.0 (10)	13.6 (19)
6	16.6 (12)	12.8 (13)
7	0.0 (1)	42.8 (1)

Egg mortality seems to be related to clutch size to the extent that the greatest survival is found in the five and six egg clutches, excluding the one seven-egg clutch in 1964 (Table 7). Contrary to this, Paynter (op. cit.) believes that the egg mortality for the tree swallow is probably independent of clutch size.

NESTLING PERIOD

The nestling period, the time from the hatching of the first egg to the last young fledged, was calculated from data on 10 nests in 1965. It averaged 19.7 days with a range of 17 to 23 days. Because of the nature of the 1964 data, no average could be computed for that year. However, between 18 and 23 days is a reasonable estimate for six nests. One nest of five young was recorded as having fledged in 14 days in 1964. In 1963 a nest with eggs hatching on June 12 had the entire brood out on June 13 and by June 21 all the young had left the nest. This would make the nestling period extremely short in this instance for a hole-nester (10 days or less) and more in line with open nesters (average 11.0 days, Nice 1957).

During 1965, seven additional nests had young that fledged early due to human disturbance. The nestling period in these cases averaged 18.3 days with a range of 16 to 20 days.

Average nestling periods have been documented for the tree swallow as

19.16 (Keurzi, op. cit.), 21.0 (calculated from Austin and Low, op. cit.) and 19.21 days (Paynter, op. cit.).

FLEDGING

Flying young were produced in 97.1% of the nests while 92.1% were completely successful (Table 1). The average number of fledglings per brood was, again, high in 1964 (4.65). However, in 1962 the average number of young per brood amounted to 4.80 for five nests. The late nests exhibited a smaller degree of success, producing less than half the number of young of the first nests. Various sources in the literature (previously listed) give average production ranging from 4.36 (calculated) to 5.90 young per brood for first nests and 4.13 young (calculated) in second broods.

All of the young of the first clutches fledged between June 16 and 22 in 1964 (Figure 3). In 1965, the fledglings in only 18.0% of the nests had left during this time, but 30.8% had fledged up to the end of this period (Figure 4). Here again, fledging was extended to July 16, much beyond the 1964 breeding season. In 1963, two of the three nests had young in the air by June 21.

Stone (1937) states that all tree swallow young are on the wing by the middle of July in the area of Cape May, New Jersey, while fledglings leave the nest between June 17 and July 18 in Princeton, Massachusetts (Austin and Low, op. cit.).

Two nests from which young fledged prematurely and two with normal departure were found to have the young birds returning to the nesting box three and four days later. One fledgling, leaving early, was found back in the box 12 days later. This is contrary to Keurzi's (op. cit.) and Austin and Low's (op. cit.) studies, where swallows were never seen re-entering a box after leaving, but in general agreement with Weydemeyer (1934) and Forbush (1929).

Table 8 suggests that the fewer the young that fledge per clutch the shorter the mean nestling period, up to a point. However, sample sizes are very small for the smaller broods. Combining the brood sizes of two, three, and four fledglings to compare them with five and six young fledged produces a similar situation, larger broods have longer mean nestling periods (though sample sizes are still inadequate). These observations concur with those of Paynter (op. cit.) and Austin and Low (op. cit.) but are in opposition to views of Keurzi (op. cit.) who found no correlation between brood size and the number of days the young are in the nest. Stated somewhat differently, as in Table 9, the relationship is still not clear except that the small brood size of three obviously fledged earlier than the larger broods. But however presented, the brood sizes or numbers of young fledged (which are not necessarily synonymous) of four, five, and six are, nevertheless, more similar among themselves than they are with smaller broods.

Table 8. Duration of nestling period as related to number of young fledged per clutch in a tree swallow colony at the Tinicum Marsh Wildlife Preserve, 1965. Number of nests are shown in parentheses.

No. of young fledged	Mean nestling period (in days)
2	17.0 (1)
3	18.0 (1)
4	20.5 (1)
5	20.5 (4)
6	19.8 (3)

Table 9. The relationship of the age at fledging and brood size for first nests in a tree swallow colony at the Tinicum Marsh Wildlife Preserve, 1965. Number of nests are shown in parentheses.

Brood Size	Mean Fledgling Age (incubation period + nestling period)
3	35.7 (3)
4	39.8 (4)
5	37.1 (9)
6	38.8 (5)

NESTLING MORTALITY

Nestling mortality for the three years was low for first clutches, amounting to an average of 5.2%. However, late nests suffered a 45.4% average mortality. Studies previously mentioned signify a low mortality rate as well, usually much less than 10% but with a few exceptions (e.g. 64.2%, Chapman, 1955).

Most of the losses were attributed to unknown causes (Table 6). Desertion of the young was more important in 1965, particularly in the late nests. It seems likely that most of the unknown deaths of the late broods in both years can probably be attributed to desertion as well.

An analysis of the age specific mortality of the nestlings in 1965 produced the expected decrease in mortality with age increase. Hence, 40.0% of the young that perished succumbed during the first week of life, 33.3% the second week and 26.7% the third week (prior to flying).

An important factor that could influence the survival of the nestlings was the presence of red mites (*Arthropoda, Arachnida, Acarina*) on the young birds and in the nesting boxes. This occurred during the latter part of the 1965 breeding season only. Infestation was extremely heavy at times with many of the nestlings virtually covered with mites; 29.3% of all the nestlings were infested and 31.8% of all the broods were likewise affected. The affected birds were in the advanced fledgling stage, the first record being June 19. No young were known to succumb to this infestation but the possibility does exist, particularly in light of the effect of other blood-sucking parasites on nestlings as mentioned by Shelley (1937), Weydemeyer (op. cit.) and Mason (1944).

REPRODUCTIVE EFFICIENCY

Tree swallows, as many other hole-nesting birds, are very successful parents. Reproductive efficiency, the relationship between the number of young fledged and the number of eggs laid, was high (Table 1). The three-year average for first nests was 79.4%. However, late nests showed a lesser degree of success, 33.3%. Comparative figures for first nests of 56.5% to 94.7% are cited in the literature previously mentioned.

Swallows with clutches of five and six eggs appear to be the most efficient in producing flying young (Table 10). In both years a mean reproductive success of about 83% for both clutch sizes combined suggested greater survival here than for either the four or seven egg clutches (two year average). However, the largest clutch size is only represented by two nests and is inconclusive evidence. Paynter (op. cit.) indicated a positive correlation between clutch size and fledging success excluding the smallest clutch (which was a complete success each year).

Table 10. The relation of reproductive efficiency and clutch size of first nests in a tree swallow colony at the Tinicum Marsh Wildlife Preserve. Number of nests are shown in parentheses.

Clutch Size	Number of young fledged (% of hatch)	
	1964	1965
4	—	72.5 (10)
5	88.0 (10)	82.1 (19)
6	78.7 (12)	82.1 (13)
7	100.0 (1)	42.9 (1)

A conservative estimate of the number of tree swallow breeding pairs on the marsh for each year is shown in Table 1. This does not include the late nesters, since their exact breeding status was not known. An increase in breeding birds in 1965 did not serve to increase the average annual production of young.

DEPARTURE FROM THE BREEDING GROUNDS

Most swallows left the marsh after fledging, although some stayed into the fall. Hence, rather than leaving en masse, the birds gradually diminished in numbers. The dates of departure from the marsh are given below:

Year	Time of Departure
1962	first two weeks of November
1963	first two weeks of October
1964	last two weeks of October
1965	last bird seen on October 28

It is of interest to note that one albino tree swallow was seen on the marsh in October of 1965 (exact date unknown). This bird was not part of the breeding colony.

BANDING

A total of 237 nestlings and four adults was banded by the author in the

three years (Table 1). The banding returns to date, though incomplete because more than one banding cooperator was active in the area, indicate that some of the young birds do return to the marsh to breed. Of 147 young banded in 1965, 14.3% returned to the preserve in 1966 and fewer (data incomplete) in 1967 and 1968.

INTERSPECIFIC RELATIONS

Since almost all of the nest boxes were located over water or on islands, the more probable predators would be avian. Predation, however, contributed only negligibly to nesting mortality (Table 6). Sparrow hawks, as well as other hawks and owls, were common on the marsh. One pair nested immediately next to the preserve, yet no evidence of predation on swallow nestlings by these hawks was observed. Weydemeyer (op. cit.), however, makes note of 12 tree swallow young taken by sparrow hawks.

Crows were a threat to exposed nests. In one instance in early May, a crow was observed destroying a swallow nest after the nest box lid had blown off. Within one week the persistent swallow had rebuilt the nest and laid three eggs of an eventual successful clutch of five.

Starlings were present on the area and occasionally built nests in the boxes (see Table 1). These nests were started somewhat earlier than those of the swallows. In one instance, as soon as the starling clutch was destroyed in one box, a swallow built a nest and successfully reared a brood of four. Even though only six nest boxes were used by starlings in 1964, 12 nests (two per box) were attempted and either completed or destroyed. In 1965, five boxes with 10 nests were used. Two persistent starlings (presumably the same bird in each case) started three nests in each of two boxes as each nest was in turn destroyed.

LATE NESTING

Late nesting as used in the general context previously explained is necessarily a collective term, primarily because of the paucity of data on recovered banded swallows. The recovery of banded birds could better establish breeding status, particularly whether the swallows were renesting or not.

Two late clutches laid in 1965 were started in nesting boxes that had previously (one week past) produced successful broods. The possibility of these being second clutches cannot be overlooked. Three other recorded late nests for 1964 and 1965 were all started in previously unoccupied nest boxes. Stone (1937) suggests that the tree swallow is two brooded in Cape May, N.J., approximately 70 miles to the southeast of the preserve.

At least one of the late clutches in 1965 was laid by a first year female. It was started about June 23 and fledged two birds. First year birds nested in two other boxes in 1965 as well, probably more. These first year eggs were laid on May 31 and May 28 and fledged four and five young respectively. This is an indication that young breeding stock are capable of producing viable young, a point further supported by the observations of Keurzi (op. cit.) and

Shelley (op. cit.). Young swallows also tend to lay their clutches later than older birds (Keurzi, op. cit.).

INTRASPECIFIC RELATIONS

Intraspecific strife in a tree swallow colony is commonly seen during the breeding season, usually at the nest box site. New female arrivals continually vie with older birds for nesting sites or for mated males (Shelley, op. cit.).

Two incidents in this study further attest to these confrontations. Six eggs in one nest were found to have disappeared or to have been thrown out of the nest box in the latter part of May. About May 31 another clutch was being laid in the same nest. Two weeks later this nest of five eggs was abandoned. What could have happened here was that an older bird, after laying a full clutch, was harassed by a young female and forced to abandon the nest. The late date of the second laying in addition to the eventual desertion of the nest would suggest the possibility of this bird being a first year breeder.

Another adult female laid five eggs in a multi-hole nest box. Apparently a brown female then took over and either added to or completely relaid the clutch (considering the apparent lengthy incubation period). She eventually raised five young from eight eggs, but this nest must nevertheless be considered a product of two females. Another nest, probably of two females, was found on June 8, 1962, to contain nine living young.

Fighting over nest box rights at the multi-hole boxes was more prevalent than at the single hole boxes primarily because more birds were in closer contact, either investigating or using each compartment. In four boxes in 1964 and 1965, where more than one swallow was attempting to use different compartments in the same box, the average first clutch size was only 4.5 eggs. However, the hatch of 83.3%, fledging survival of 100% and reproductive efficiency of 83.3% was no worse than that of the single hole boxes.

Every occupied multi-hole nest box was found to produce only one brood of young (at one time, that is), the other compartments either having unoccupied or "dump" nests. This is in line with Townsend (1905) who stated that it is rare to find more than one swallow family breeding in one house. Four dump nests were found in three nest boxes only, all of the multi-hole type. These consisted of one or two eggs deposited indiscriminately (apparently) by a bird with no intent of completing or incubating the clutch. Curiously, each dump nest was associated with a successful nest in the compartment immediately above it.

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