

FURTHER NOTES ON THE NESTING OF THE
TREE SWALLOWS¹

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THE one hundred bird-boxes in use at the Austin Ornithological Research Station in 1931 were so well patronized² that an additional four hundred were erected in 1932 for the purpose of acquiring for study additional data of broader scope and for determining how many Tree Swallows (*Iridoprocne bicolor*) the territory can support under existing conditions. In order to check the returns of 1931 residents to renest in the vicinity of the main station a few substations were established. The locations of these in respect to the Station and the number of boxes of each are as follows: fifty at substation A, five and one half miles north northwest; three at substation F, five miles due north; two at substation B, at the same distance due south; ten at substation C, two and one half miles south, and three one mile northwest at substation H. Substation W with its own ten boxes three miles southeast completes the list. The remainder of the five hundred wooden and fifteen tarpaper boxes were scattered over all the open spaces in the square mile which comprises the Station area.

RETURNS

The return of birds of previous years is to be considered from two angles: the return of young to the vicinity of their birth-places, and the rebreeding of adults in territory they used previously.

Two of the 157 young that left the boxes at the Station in 1931 were killed by automobiles before migrating. Of the remaining 155, seventeen (11 per cent) were recaptured this summer breeding at the Station and one was taken at substation A, five and one half miles north. Of eight nestlings banded in 1931 at substation W, three miles to the southeast, two nested at the station this year. The total return from 163 nestlings, then, was twenty (12 per cent). Two nestlings returned from each of three broods, but in no instance did more than two from a brood come back. This may indicate a high mortality during the first year of life.

¹Contribution No. 12 from the Austin Ornithological Research Station.

²Notes on the Breeding of the Tree Swallow by O. L. Austin, Jr., and S. H. Low. *Bird-Banding*, Vol. III, No. 2, April, 1932.

In 1931 seventy-four of the 120 adults breeding in the boxes were banded. One was killed so that 73 of them, in addition to 14 adults banded but not identified with boxes, making a total of 87 adults, were available to return. Twenty-two of the 73, (30 per cent) bred again in the boxes, two were recaptured in nets, and one was found dead beneath a telephone-line a mile and a half to the southeast. The return of known breeding swallows was twenty-five (34 per cent). In addition, two of the fourteen were known to breed this summer, so that the total returns from 87 adults were 27 (31 per cent). However, only 121 of the 230 adults breeding here in 1932 were captured, and 24 of these proved to be returns. If it is assumed that 121 is a fair sample of the adults and the ratio of 24 to 121 is indicative of the ratio of the number of returns to the 230, then the returns should have numbered about forty-five (52 per cent).

CHOICE OF NESTING TERRITORY AND BOX PREFERENCE

In discussing a bird's choice of a nesting territory and nest site (and incidentally its abundance), it is extremely important to consider the limiting factors. The two most important are the food supply and the available nesting sites. Which is the more important depends on the species and the locality in question. With the Tree Swallow it is assumed arbitrarily that a near-by pond, swamp, or marsh insures a good supply of food. Nesting sites are limited to natural cavities and bird-boxes. The former are so few, if not even non-existent, they may be eliminated from the discussion. An abundance of boxes alone, however, does not remove the nesting limitation, for there are two further restrictions, the type of box and the position of the box.

The preference for different kinds of boxes is shown at the main station, where there is an excellent food-supply and a superabundance of boxes. One manufactured tar-paper box and two wooden, Station-made types are in use. The former is the standard Packard bluebird-box. The 1931 type is of half-inch white pine, and the dimensions are bottom 5 x 5 inches, back 9 x 5 inches, front 7½ x 5 inches, and top, which slopes from the back down over the hole, 7¾ inches square. The 1932 type is similar to the Higgins box and is equipped with a Higgins shutter. The box is 9 inches deep, 6 inches long, 5½ inches wide. The flat top, which overhangs the front by 2 inches, is hinged at the back and has weather-strips along the under edges, so that it fits snugly over the box. The front

opens also, being hinged at the bottom. Both wooden types have $1\frac{1}{2}$ -inch holes and are stained a light brown. The majority of the boxes are on $5\frac{1}{2}$ -foot posts in open fields.

In treating of the box preferences of the swallows, the returning young and adults are treated separately. The young are returning to nest for the first time, and the locality of their nesting sites can best be discussed in relation to their birthplaces. Of the 14 young breeding at the Station only two nested within five hundred feet of their birthplace. The others were scattered at varying distances over the square mile of the Station, but only one chose the 1931 type of box. Two more came to the Station from substation W, and one young from the Station went $5\frac{1}{2}$ miles north to substation A.

The adults had, besides the 98 old boxes in their old location, an additional 334 new boxes and a dozen tar-paper ones. The last mentioned were erected on fence-posts along a railroad and alternated with wooden boxes. The wooden ones were taken, but the swallows scorned the tar-paper. Only one swallow, a male with a new mate, nested again in the same box it had occupied the previous year. Two adults chose new boxes adjoining their old ones, and three more returned to within one hundred feet of their old ones. The rest varied from two hundred feet to a mile from their previous sites, and it is interesting to note that of twenty-five returning adults, only one chose a box of the 1931 type. In 1931 sixty of the 98 old type boxes in use were occupied. This year the 98 were in the identically same positions, but were closely surrounded by three hundred odd new boxes in similar but in no more favorable positions. Only 13 in all of the 115 boxes which were occupied in 1932 were of the 1931 type. Therefore it is evident that the swallows have definite box preferences and prefer the 1932 type.

Substation A lacked a good food-supply but had fifty of the preferred boxes. At least thirty of these were in favorable positions, but only seven were occupied. Here the food is the limiting factor.

Substation C has a good food-supply. Ten identical boxes of the new type were put up on a small lot, five on posts and five on the building. Every one of the former were occupied, but not one of the later.

Substation W is an excellent example of the fruitless endeavors of laymen to attract birds. There are ten boxes, all close to a large pond. Seven are home-made affairs resembling dog-kennels, painted white and with the entrance at the base. Four are placed under the cornices of the house, and three high

on the trunks of pines. The other three are of the tar-paper type; two are on the barn and one on the side of a second-story dormer window. One of the barn boxes is partly concealed by vines and has never been occupied, but the other, at the peak of the barn roof, is used. Likewise the tar-paper box on the dormer window is occupied each year, but only occasionally is one of the "kennels" inhabited. The poor types and positions of the boxes discourage the swallows here.

The Station serves as a fine illustration of what happens when there is plenty of food and favorable nesting-boxes are erected. In 1930 some forty-odd tar-paper boxes were sprinkled around the woods, mostly in the shade in locust groves. A few were on pines and two on posts in the open. The latter two were used, as were two on pine trees on the outer edges of groves. The only two adults banded in 1930 returned in 1931, but instead of taking their old boxes, they moved out to new ones in the open.

With 98 wooden boxes, mostly in the open, the population jumped in 1931 from 4 pairs to 60 pairs. In 1932, with over four hundred boxes available in favorable sites, there were 113 pairs of breeding birds.

While the ideal location for a box cannot be determined from these observations, certain ecological preferences of the Tree Swallows are evident. When, however, boxes are available on posts in open fields away from trees, those on buildings or trees will not be occupied.

ACQUISITION OF ADULT NUPTIAL PLUMAGE

It has been exceedingly difficult to distinguish between the sexes of the adults. The dull, brown birds and those with a faint tinge of green appear to be one-year-old females. The male obtains its brilliant plumage the first year, but the female apparently does not acquire it until the second year. The female may be slightly duller, but frequently she is indistinguishable from the male except when both are held together in the hand. Hence, the sexes must frequently be determined by behavior. The female does most of the incubating and is the only bird taken on the eggs. Likewise it is the female which does most of the brooding and which stays on the nest at night during the first week. The female generally enters the box directly, while the male flutters about the hole or alights on the perch and looks around before entering.

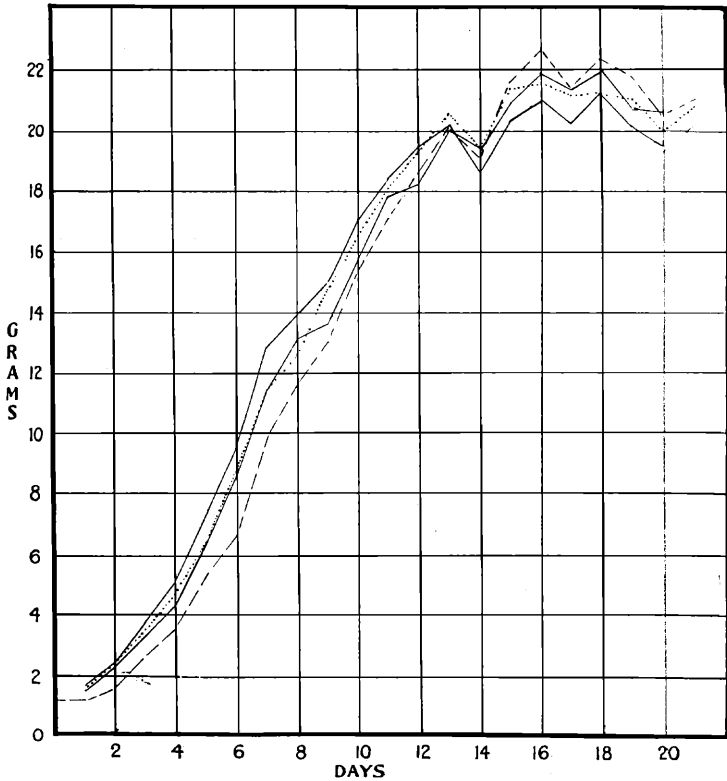


Figure 1. Daily Weights of Four Young in Box 129.

INDIVIDUAL NEST STUDIES

Late in June opportunity was found to give some individual attention to three nests. The first nest, Box 129, faced south in an open field. The eggs were laid sometime between June 11th, when the nest contained only grass and a single feather, and the 19th, when four eggs nestled in a cup of feathers. Two eggs hatched on June 30th before 8.35 A.M. (Daylight-Saving Time). The nest contained no shells, and the female was incubating. By 10.00 A.M. a third young had hatched out. At 1.40 P.M. the young were found to weigh 1.5, 1.5, and 1.6 grams each, and the egg 1.2 grams. By 3.50 P.M. the fourth had hatched and weighed 1.5 grams.

The others then weighed 1.6, 1.7, and 1.8 grams. The birds were weighed daily thereafter between 10 and 11 each morning until they flew.

On July 1st the male was trapped in the box and banded. That night the first accident befell the brood. Strong south winds blew the top cover open, and an early morning storm deluged the box. The mishap was discovered at 9 A.M. The female was sitting tightly on the nest, and the young were alive but quite wet. Observations made from 10.25 A.M. to 11.46 A.M. (from a blind erected several days previously in front of the box) showed the remarkable adaptation of the behavior of the adults to an emergency. During the 81 minutes the male fed 10 times. Each time he came to the box he called, and the female came out. The male then entered, fed, and left; immediately the female returned to brood. Eight times this happened, but twice she entered the box before the male left. The female was away from the nest just once during the period, for six minutes. Observations were again made from 1.55 P.M. to 2.50 P.M. During 29 of these 55 minutes the young were removed from the box and weighed. The male fed five times during the remaining 26 minutes.

July 3d the box was watched from 10.00 A.M. to 12.15 P.M. except for 20 minutes while the young were weighed. Assuming that each time an adult enters it feeds the young, then each parent fed 14 times, a total of 28 times, or once every four minutes. During the afternoon between 2 P.M. and 4.05 P.M. the male fed but 9 times to the female's 20 times.

On the morning of the 7th it was found that the shutter had become closed during the night, either by the wind or by the tripping of some animal over the string. The adults, therefore, had been unable to feed the young. The parents did not desert, and the only harm was a slight decrease in the daily gain of weight of the young.

The blind was next occupied on the 10th from 2.01 to 3.30 P.M. The male fed 6 times and removed fecal sacs twice; the female fed 15 times and removed sacs thrice. During this period an immature swallow tried to invade the box. Again in the afternoon during a brief watch two young swallows entered the box and were trapped. One was unbanded, and the other was a nestling from a box a half-mile to the southwest. The latter had flown about the first of July. Two days later another young bird from the same locality was caught in the box. Whether they entered in hopes of being fed, from curiosity, or in answer to a premature sexual impulse (cf. Brewster; *The Auk*, XV, pp. 194-195, April, 1898) we can only con-

jecture. The shutter again became closed the night of the 12th and was not opened until 9.30 the following morning. Consequently the birds were not fed and so suffered a decided drop in weight.

The morning of the 14th the box was observed for two hours. The first hour passed without a bird entering the box, although swallows fluttered frequently before the hole. Then came an hour of very intensive feeding. The male fed 23 times, the female 25 times, a total of 48, or once every 75 seconds. One sac was removed by the male. Another intrusion occurred, but the bird was not caught.

The next watch was from 1.37 to 3.00 P.M. on the clear, hot afternoon of the 18th. The young were then well grown and lively, and both parents were feeding from the outside of the box. A young swallow sat almost constantly in the hole, and so received all the food. The male fed 12 times, the female 14 times, a total of 26 in 66 minutes.

The first visit to the nest at 10 A.M. on July 20th revealed that two young had flown. A third flew after being weighed. The last one left during the afternoon. All had hatched June 30th, and all flew twenty days later.

During the same period another box, 408, was visited daily and its four young were weighed. This nest was close to the salt marsh and therefore had a better and handier food-supply. The nest suffered no accidents or interruptions except for a half-hour each noon when the young were weighed. The first egg was noted on June 11th, and on the next visit, June 16th, there were four. On June 28th at 9.40 A.M. one young had just hatched, and at 12.15 it weighed 1.5 grams while an egg also weighed 1.5. At 4.15 no more young had hatched, but all were out by noon the following day. The first young balanced the scales at 2.5 grams, and the others at 1.5, 1.6, and 1.9 grams. On July 18th one young escaped just after being weighed, and all had gone by 11 the next morning. The incubation period for this nest was 14 days and the period of the adolescence 20 days. Thus it seems that the many interruptions at box 129 did not delay the normal nesting period.

In conjunction with these, a third nest, 116, was watched. Two eggs were found on June 11th, and a third was laid that day or the next. Two of them soon appeared to be bad, and but one hatched, on June 27th. The chick weighed practically 2 grams the following noon and was weighed daily thereafter. A short watch was kept July 2d from 3 P.M. to 3.45 P.M. The female fed three times and the male twice. Excreta were

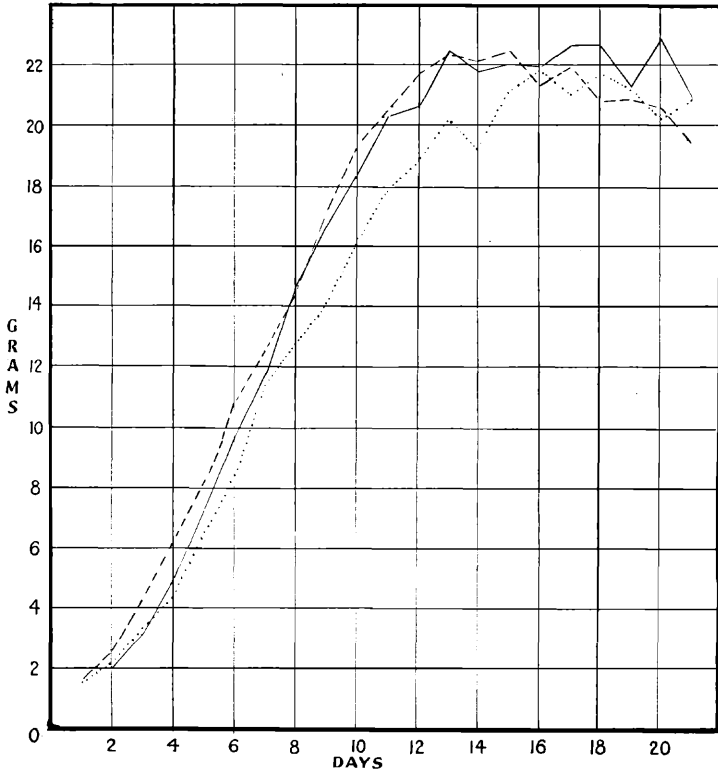


Figure 2

- — — Average Daily Weight of Four Young in Box 408.
- Average Daily Weight of Four Young in Box 129.
- Actual Daily Weight of One Young in Box 116.

removed once by the female. The male stayed in the hole after feeding until the female returned.

Observations were made at this box on July 3d from 2 P.M. to 4.05 P.M. while an assistant simultaneously watched box 129. The female fed 15 times; the male fed 8 times and remained on guard on top of the box twice. The single young was fed 21 times, while the four young in No. 129 received 28 meals between them. On the eleventh, following a short but heavy rain, further notes were taken from 3.15 to 5.15 P.M. The female spent most of the time sitting on the top of the box but

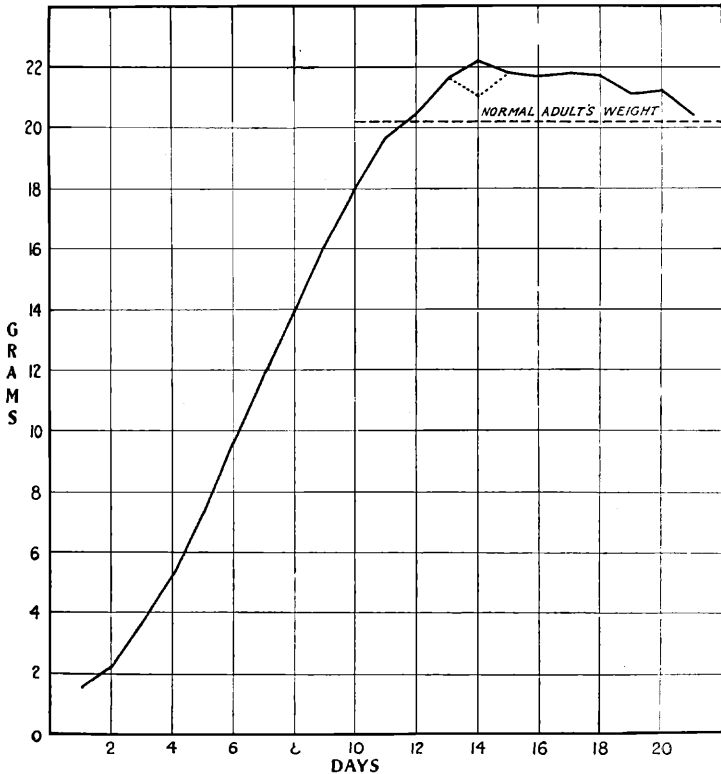


Figure 3. Average of Averages of Three Nests (9 birds).

fed twice and removed a sac. The male fed eleven times and also removed a sac. The young escaped from my hand on July 16th and flew off.

There seems to be little difference in the growth of this bird and the four in 129 and those in 408. The incubation period was about fifteen days and the period of adolescence was nineteen days, but the bird left prematurely.

WEIGHT GRAPHS

Figures 1, 2, and 3 show the growth of the young in grams to the nearest tenth. Fig. 1 shows the rate of growth of the

four nestlings in 129. The dip on the fourteenth day has already been explained; the shutter became closed accidentally and the birds were not fed. Fig. 2 shows the average of the four lines in Fig. 1, the average daily weight of the four young in 408, and the actual weight of the single bird in 116. Fig. 3 shows the average of Fig. 2 and gives a fairly good picture. The dotted line on the 14th indicates the loss of weight in box 129, as explained above, and the solid line for that date averages the other two nests alone.

The young gained approximately two grams each day for the first eleven days, dropping to one gram per day until the peak was reached on the 14th. They then seesawed, gradually losing weight until they left the nest. A great deal of the variation may be accounted for by the time elapsed between the weighing and the excreting. The fecal sacs vary in weight between one and two grams.

At their peak the young weigh more than the adults, but gradually regress to normal adult weight just before they fly. Two adults were weighed with empty stomachs, and two were apparently full. The weights were ♀ 19.5 g., ♀ 20.3 g., ♂ 19.7 g., ♂ 21.2 g. The average of the four is 20.2.

THE 1932 NESTING SEASON

It was impossible to watch so large a number of boxes as were used this year, and hence no further investigation was made of the duration of the incubation and adolescent periods as a whole. The season seemed normal and lacked the disastrous rains of the previous spring; in fact, it was so dry that insect food may well have been scarce.

At the Station 115 boxes were occupied as against 62 in 1931. The lay of eggs was exceptionally good; the average clutch numbered five, whereas in 1931 it was four and one half.

If Table 1 (see below) be compared with the table in *Bird-Banding*, Vol. III, No. 2, April, 1932, P. 42, it will be seen that

TABLE I.

Station		Substations A, B, C, H, F	Total
Eggs Per Nest	No. of Nests	No. of Nests	No. of Nests
7	4	2	6
6	24	5	29
5	64	8	72
4	17	3	20
3	4 (3 deserted)	0	4 (3 deserted)
2	1 (deserted)	0	1 (1 ")
1	1 (")	0	1 (1 ")

while five eggs per clutch still predominates, six has replaced four for second position. The number of large clutches and the comparative absence of small ones is encouraging. All of the latter but one (a late clutch in box 116) were deserted before they were completed.

The hatch was far more successful than in 1931. Whereas 30.5 per cent of the eggs failed to hatch in 1931, in all the boxes this year only 15.9 per cent were failures. Only 13 clutches, comprising 51 eggs, were complete failures. Six, containing 21 eggs, were destroyed by natural enemies, and in two of these cases the female was known to move into the next-nearest box and nest again. Seven nests with thirty eggs were deserted probably because the eggs were sterile or the young were killed by exposure. One female of this group was found subsequently nesting again in an adjoining box. Fifty-six eggs failed in boxes where other eggs hatched. The summary, then, in regard to hatch is 13 complete failures, 37 partial failures, and 83 complete successes.

Although the hatch was very gratifying, the mortality of nestlings was fully as disheartening as in 1931—162 young, 28.7 per cent of the hatch, died in the nest.

Table 2 shows the distribution of the mortality, from which it is evident that the larger the brood the more likelihood there is of mortality.

TABLE II

<i>No. of Young Per Nest</i>	<i>No. of Nests</i>	<i>No. in which there was Mortality</i>	<i>Percentage</i>
7	4	2	..
6	17	10	58.8
5	56	27 (24)	48.2 (42.8)
4	31	11	35.5
3	7	1	14.3
2	4	2 (1)	..
1	1	0	..

Of the 162 young which died in the nest, the cause of death was determined satisfactorily in but 22 instances, as follows:

Exposure and desertion following the blowing open of the box-cover.....	10 young
Deserted by parents and starved as result of experimental work.....	2 "
Crowded to death by their siblings in the nest.....	5 "
Killed by mammal (probably a red squirrel).....	5 "

The cause of death in the remaining 140 nests was not determined. No explanation seems satisfactory. The weather was fine throughout the period. No *Protocalliphora* have been found in the nests. If a disease or parasites were responsible,

one would expect whole broods to be wiped out each time. While twenty-one entire broods were annihilated, there was only partial mortality in thirty-two nests. Nine nests lost but a single bird, thirteen nests lost two, six of them lost three young, three lost four, and in one case six young out of seven died. Five of these casualties followed crowding by their older siblings in the nest when they were still very young, but most of the others were fully feathered, and a few died the day before their siblings flew.

One bird over seventeen days old was found just as it was dying. It appeared to be gasping for breath, and stretched out shortly and died. The bird was immediately autopsied by Dr. Oliver L. Austin. There was nothing in its œsophagus and no signs of hemorrhage or head injury. The heart, lungs, and liver were in good condition. A gross examination was entirely negative. The stomach contained about three grains of partially, digested insects. Two other birds in this nest had already died and two more survived and flew.

The following table sums up the 1932 nesting seasons of the Tree Swallow:

Number of eggs laid.....	671	
Eggs destroyed by natural enemies.....	21	
Eggs deserted by parents, cause unknown.....	30	
Eggs deserted by parents because of failing to hatch (bad and sterile).....	56	
Number of eggs hatching.....	564	84.1 per cent
Young killed by natural enemies.....	5	
Young crowded to death.....	5	
Young killed by an experiment.....	2	
Young killed by box opening.....	10	
Young dying due to unknown causes.....	140	
Total mortality to young.....	162	24.1 per cent
Number of young reared.....	402	
Reproductive efficiency.....		60 per cent