ROOSTING BEHAVIOR OF THE STARLING IN CENTRAL PENNSYLVANIA

BY JOSEPH F. JUMBER

THE European Starling (*Sturnus vulgaris*) is a gregarious species and can be found roosting in great numbers in all imaginable types of sites, varying from season to season. Not only is the accompanying noise of this activity annoying in itself, but all too frequently much damage is done when these roosts are in warehouses, in airplane hangars, in electrical substations, on bridges, or in evergreen trees growing near reservoirs.

The fact that practical methods of control have been very few suggests that much needs to be known about the roosting and associated activities of this species. For this reason, I tried to observe the following main points: 1. seasonal shifts in roosting; 2. stages in the assembly; 3. time and light intensity of the various stages of assembly and roosting; 4. effect of weather upon this activity; 5. permanence of roosts. The observations reported here were confined primarily to roosts found in the vicinity of State College, Pennsylvania, from September 1, 1952, to September 1, 1953, and a brief study in Philadelphia, Pennsylvania, in January, 1954.

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SEASONAL ROOSTING SITES

The Starling seldom, if ever, occupies the same roosting area for a whole year but changes from one roosting site to another. These shifts in roosting sites appear to be affected mainly by nesting activities, migration, weather, and, in the case of roosts in deciduous trees, the falling of leaves in autumn. Thus, Starlings may be found roosting at one place for months at a time, only to desert it within a matter of a few days or weeks for a different location. During this study, September 1, 1952, to September 1, 1953, Starlings near State College showed well-established patterns of seasonal shifts in roosting.

Summer roosts.—The requirements for summer roosts are not as

exacting as those for roosts used during cold, windy nights of winter and are well satisfied by the numerous deciduous trees along highways, in parks, and particularly in residential areas. At State College, these summer roosts in deciduous trees were scattered throughout the city.

The densely leafed Norway maples (*Acer platanoides*) and sycamores (*Platanus occidentalis*) were preferred above many other species growing along the streets. Even though there may be many such trees, it does not necessarily mean that all of them are equally suited as summer roosts, and if Starlings are repelled from the existing roosting areas they may leave the vicinity completely rather than roost in less suitable spots. The choice of certain areas seems to be based on the fact that there the trees grow close together, are heavily leaved, and thus form a dense canopy. I believe that this canopy-effect produced by the deciduous trees along the streets of many residential areas is one of the major factors inducing the birds to roost in cities and towns. In cases where the trees in such areas are topped or trimmed, the Starlings can be eliminated completely.

Autumn roost.—As the time of migration approached before the leaves finally fell from the trees, a shift in roosting site occurred. The Starlings left their scattered summer roosts to spend the fall evenings in a single roosting area. This site was also composed of deciduous trees and was not at the same location as any of the summer areas. The Starlings gathered here to roost prior to their partial fall migration.

When observations were first made at this fall roost, it included approximately 12 trees, and about 6,000 Starlings were roosting there nightly. The changes in the Starling population at this roost from October 2 to October 23, 1952, are illustrated in Figure 1. The last group of Starlings finally left the fall roost by the latter date, and shortly thereafter those which had not migrated southward were found roosting in more protected structures.

Winter roost.—Near State College, winter roosting occurred mostly in the cupolas of barns. Starling were found elsewhere, however, roosting in a variety of well protected locations, such as the ledges of city buildings, on the metal cross members of bridges, in airplane hangars, warehouses, viaducts, and even in electrical substations. In cities, where ideal roosting conditions may be lacking or overcrowded, Starlings may resort to roosting in the open on bare deciduous trees that are well protected by buildings. They may even be found spending their winter evenings in evergreen groves where they are well protected from the weather. Marples (1934) found

birds in Great Britain that roosted all winter in reeds (*Phragmites communis*), and Kennedy (1929) found them tunneling into thick matted grasses on the ground during a winter on an island off the Irish coast.

Spring roost.—At State College, evergreen roosts were not resorted to until early spring, when the more protected winter roosts were abandoned in favor of a large evergreen grove about six miles northeast of State College. The organization of this spring roost started early in March, when many of the spring migrants began to arrive,

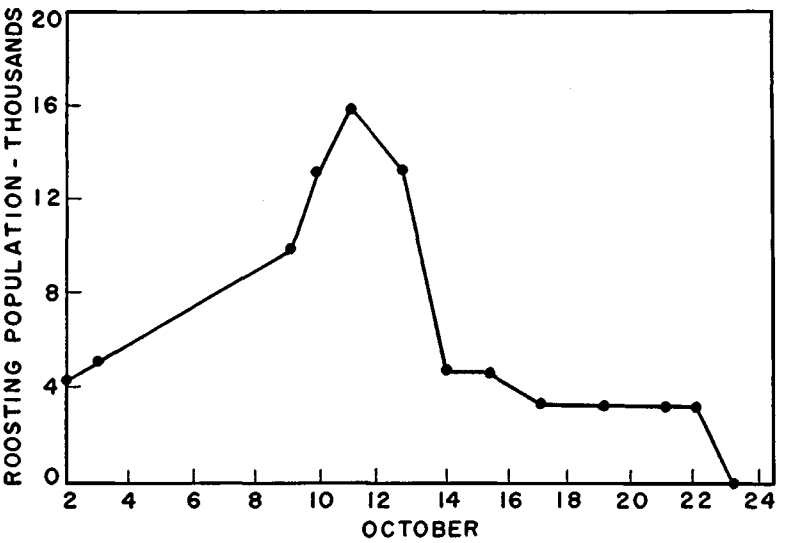

FIGURE 1. Fluctuations in the roosting population at the autumn roost at State College, Pennsylvania.

and reached a maximum late in March, when spring migration was all but completed.

This artifically grown covert was rectangular in shape and measured approximately 100 × 400 yards. The trees had grown to a height of about 30 feet and developed into a very thick grove, providing much cover for roosting Starlings.

This spring roost appeared to be strikingly similar to the autumn roost, in that it was the only roosting site used by Starlings from miles around. However, in contrast with the autumn roost, it should be more correctly called a "blackbird" roost, because it was also utilized by Red-wings (*Agelaius phoeniceus*), Purple Grackles (*Quiscalus quiscula*), and Cowbirds (*Molothrus ater*). In addition to these

species of blackbirds, the roost was frequented by Robins (*Turdus migratorius*), Mourning Doves (*Zenaidura macroura*), and by a single Ring-necked Pheasant (*Phasianus colchicus*).

Early summer roost.—After the break-up of the spring roost late in May, there was a shift to small roosting areas, coincident with the breeding season, before the Starlings finally moved back into their summer roosts discussed earlier. Starlings were found roosting from the mid-May to mid-June at an early summer roost composed of cattails (*Typha* spp.) intermixed with shrubby growth. The large roosting population at the spring roost had apparently broken up into smaller roosting groups, for only about 5,000 of the original 25,000 "blackbirds" roosted at this early summer roost. It was located 2 miles northeast of State College and was finally abandoned for the summer roosts by the middle of June, thus completing the seasonal shift in roosting sites.

ASSEMBLY

Perhaps one of the most interesting, and often confusing, activities of Starlings is their habit of gathering into large flocks before descending into roosts for the evening. This activity can be more or less subdivided into four distinct and separate stages of assembly: 1. that occurring while the birds are at their feeding grounds; 2. that occurring along definite, established routes leading toward the roost; 3. that taking place in the vicinity of the roost on trees, buildings, power-lines, television antennas, or almost any other high structure overlooking the roost; and 4. the final assembly of Starlings at the roost proper.

Feeding ground assembly.—Starlings begin to gather into small flocks at the feeding grounds and start moving toward the roost before sunset, the time depending somewhat upon the season of the year and prevailing weather conditions. This movement is very leisurely at first, with the flocks stopping frequently to feed, but it becomes more hurried as sunset approaches. Starlings using the summer roosts at State College began moving toward them from one-half hour to one hour before sunset. Where feeding grounds are more distant from the roost, Starlings may begin this movement as much as two hours before sunset (Wynne-Edwards, 1929).

Flight-line assembly.—Incoming flocks of Starlings fly towards a roost along definite, established routes, commonly referred to as flight-lines, and adequately described by Brown (1946). These are followed back to the feeding grounds in the morning. These flocks become larger and larger in size as they are joined by still other in-

coming Starlings, until the birds may number in the thousands as they finally reach the roost.

Observations made during this study revealed three main flight-lines leading to the summer roost: one from the northeast, one from the east-southeast, and the the third from the southwest. In addition to these, other minor flight-lines converged with the main flight-lines or more frequently led directly to the roost. These flight-lines were not straight, but twisted and curved. Starlings flying toward the roost avoided passing over even the smallest of hills and usually followed streams, rivers, or valleys where these led in the direction of a roost. This behavior was again evident in the morning dispersal of Starlings from their summer roosts. As the Starlings dispersed from the roosts in the northeastern end of town, they began moving down the valley in a steady, unbroken stream extending over three miles. From a high point of observation, I watched this long line of Starlings winding its way down the valley avoiding the smallest of hills when possible. A flight over this area in an airplane showed that the air to the right and left of this flight-line, and over the higher elevations, was much more turbulent than that along the flight-line.

Flocks of Starlings arriving along these flight-lines flew at noticeably different altitudes. Most flocks flew at altitudes of 200 to 300 feet. These were much larger in size and arrived later than those flying at altitudes of 50 to 100 feet. These observations corroborate the findings of Brown (1946) who reported that flocks which came from more distant feeding grounds were larger and flew higher than the smaller flocks which arrived from nearby feeding grounds.

Pre-roosting and roosting assembly.—Starlings arriving along these flight-lines assemble on trees, power-lines, television antennas, buildings, or on other such structures at, or near the roost before finally descending into the roost for the night. To avoid confusion during later discussions, this preliminary assembly of Starlings at such areas before they finally descend into the roost proper will be referred to as pre-roosting, in contrast with the term, assembly, applied to the final gathering of Starlings at the roost itself. The areas where this pre-roosting occurs may correspondingly be called pre-roosting areas to distinguish them from the roosts proper.

The first arrivals at the pre-roosting areas are few in number, but, as sunset approaches, larger flocks arrive, followed finally by smaller and less frequent flocks toward the end of the pre-roosting period. Before the last few Starlings arrive from the feeding grounds, some of the Starlings occupying the pre-roosting areas, as well as other

incoming Starlings, begin to assemble at the roost proper. Here, they follow rather closely the pattern found for pre-roosting, but the assembly at the roost proper takes a much shorter time.

The above pattern and intensity of pre-roosting and roosting assembly are illustrated by the data shown in Figures 2 and 3, obtained at a winter barn-roost numbering approximately 175 birds and at an autumn roost numbering over 25,000 birds, respectively.

Oddly enough, the data obtained at both roosts are strikingly similar, even though the one was a winter roost, with a very small number of Starlings, and the other an autumn roost, with a much

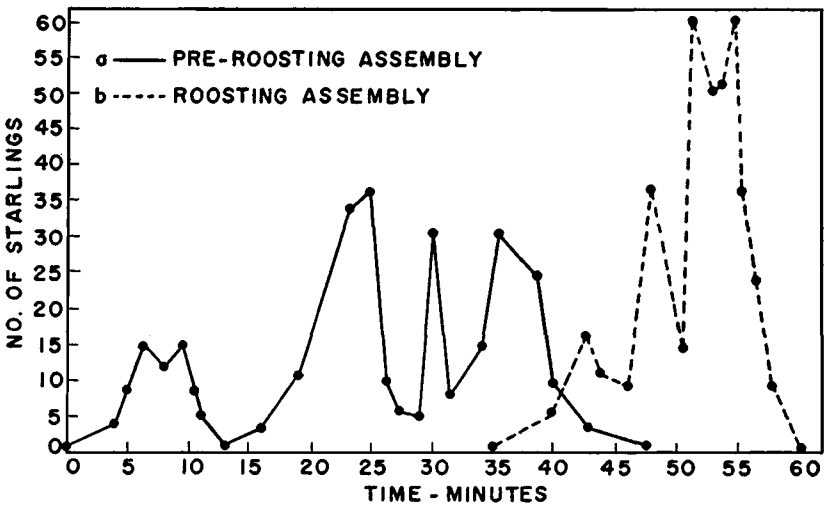

FIGURE 2. The pre-roosting assembly (a) and roosting assembly (b) at a winter barn-roost.

larger roosting population. At both the winter and autumn roosts, the complete cycle of pre-roosting and roosting assembly required approximately 60 minutes. Pre-roosting alone, at the winter and autumn roosts, was completed within about 45 minutes. A much shorter time, about 25 minutes, was required for final assembly in both cases. The intensity of assembly at the two roosts was also similar, with pre-roosting being at its height approximately 35 minutes after the start of the cycle.

A more detailed examination of the data in Figure 3 for pre-roosting shows one variation that can exist in the pattern of pre-roosting. This may frequently consist of two different and separate stages: earlier arrivals gather in numerous areas more distant from the roost,

only to regroup again at a single pre-roosting area conveniently located near the roost. This was well illustrated at the autumn roost in Bellefonte, Pennsylvania, where approximately 30,000 Starlings roosted in deciduous trees located on a hillside. Across the street and not more than 100 feet from this roost were located a number of large willow trees (*Salix* spp.) where the final stage of pre-roosting occurred (shown in curve "b") before the Starlings descended into the roost (shown in "c"). The pre-roosting areas used by the early arrivals varied from approximately 100 yards to several miles from the main roost. This earlier stage of pre-roosting

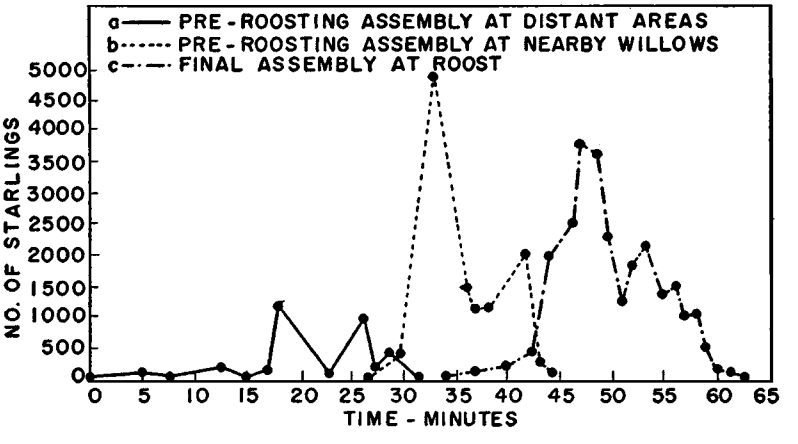

FIGURE 3. The pre-roosting assembly (a, b) and roosting assembly (c) of Starlings at the autumn tree-roost at Bellefonte, Pennsylvania.

(represented by curve "a") could be followed only in those areas which were relatively close.

Where pre-roosting areas are well isolated from the roost, fair approximations of the number of Starlings moving from one area to another can be made. Very often, however, the pre-roosting areas are closely associated with the roost, as for example where Starlings gather on the towers of buildings, trees, television antennas, and on other such structures that are located in or very near the roost, but still not used as definitive roosting sites. A quantitative separation of the two stages of assembly in such cases is all but impossible. To a distant observer watching flocks of Starlings descending into such areas, it would appear as though this assembly represents final or roosting assembly when, to be consistent with the well established patterns of assembly observed at other roosts, it actually

represents pre-roosting. A definite shift in the Starling population from one area to another begins shortly before the arrival of the last few birds from their feeding grounds. The pattern and intensity of this shift is similar to that described earlier for final assembly at the winter and autumn roosts.

Assembly and light intensity.—Starlings may be expected to assemble at or near roosting sites at more or less definite times before or after sunset. Some earlier workers (Brown, 1946) therefore, discussed the various stages of assembly in relation to sunset. Much variation was found in the times of assembly when referred to time before or after sunset. Nice (1935) found that the time of roosting was closely correlated with light. I also found that the time for various stages of assembly could be predicted more accurately by reference to light intensities.

Starlings may assemble at a roost a half-hour before sunset one evening and assemble as much as one hour before sunset the following evening, but at similar light values. This effect of light intensity upon the time of assembly is well illustrated in Table 1, showing sample data obtained on 31 January and 1 February, 1953. These data show that assembly began 25 minutes earlier on 1 February than on the previous day. However, the light readings for the two days differed by only 4 foot-candles. Assembly was also completed 33 minutes earlier on 1 February, but at a light value differing by only 3 foot-candles, from 286 to 290 and 70 to 67 foot candles, respectively. For reasons such as these the pre-roosting and roosting assembly was described in terms of light intensities.

During this study I observed pre-roosting and roosting assembly at various seasonal roosts, in Centre County, Pennsylvania, and in Philadelphia, Pennsylvania. The light values were recorded directly in foot-candles, using a mask (10×) equipped G.E. exposure meter (Type DW-68) directed toward the zenith, as the flocks of Starlings entered these assembly areas. Estimates were made of the sizes of the incoming flocks. These latter data are grouped and presented as the average percentages of total roosting population present at any particular light value.

The assembly of Starlings in a winter barn roost was watched on 16 evenings, when the weather was classed as fair, from December 8, 1952, to March 1, 1953. Assembly began at from 350 to 290 foot-candles and was completed at from 80 to 65 foot-candles (Figure 4a). The greatest percentage of the roosting population entered between 225 and 105 foot-candles, with assembly being at its height at approximately 175 foot-candles. Of seven evening observations

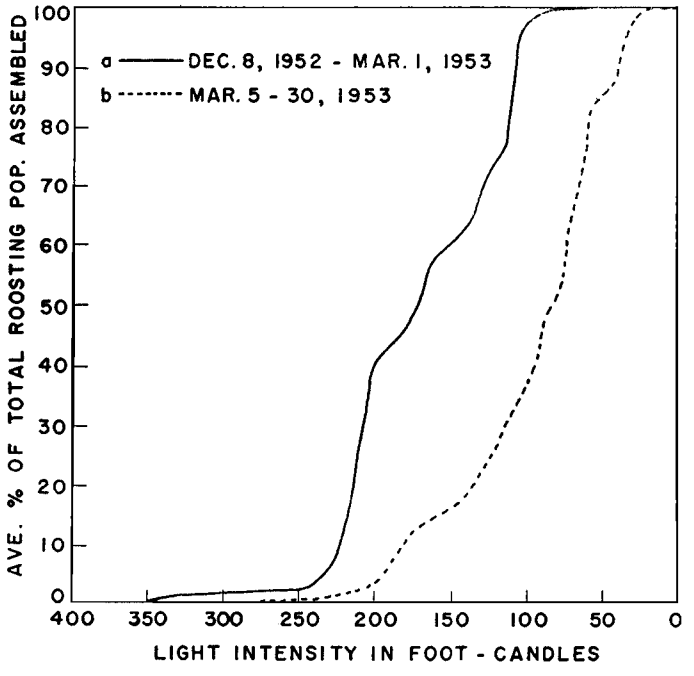

FIGURE 4. Assembly of Starlings at the winter barn-roost with *a* and *b* representing the average of 16 and 5 observations respectively.

made on pre-roosting at this winter roost, during the same period of time, the first few Starlings began arriving between the light intensities 640 and 450 foot-candles, with most arriving at the pre-roosting areas when the light intensity measured between 290 and 200 foot-candles.

TABLE 1

ASSEMBLY OF STARLINGS AT A WINTER BARN-ROOST, SHOWING THE RELATIONSHIP BETWEEN LIGHT INTENSITY AND TIME OF ASSEMBLY

Date	*Assembly*				*Weather*
	Minutes before sunset		*Light in foot-candles*		
	Start	*End*	*Start*	*End*	
January 31, 1953	32	— 5*	286	70	Clear
February 1, 1953	57	28	290	67	Cloudy

* Time after sunset.

The data obtained for assembly at this winter roost from December 8, 1952, to March 1, 1953, when the Starling roosting population remained rather constant at approximately 175 to 200 birds, were somewhat different from those data obtained from 5 to 30 March,

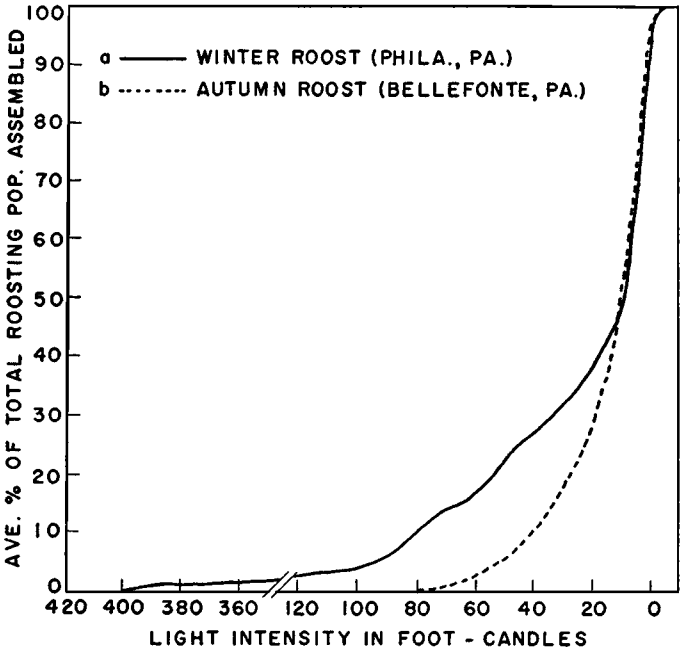

FIGURE 5. The average of 3 observations for assembly of Starlings at the winter building-roost at Philadelphia, Pennsylvania (a). The average of 4 observations for assembly of Starlings at the autumn tree-roost at Bellefonte, Pennsylvania (b).

1953, when an influx of spring migrants caused an increase in the roosting population (Figure 4b). In five observations made at this time, assembly occurred at much lower light intensities, starting and ending at approximately 275 and 15 foot-candles, respectively. Assembly was at its height at much lower intensities, being most intense between 130 and 60 foot-candles. Thus, increase in the roosting population, as a result of the spring migrants, appears to cause assembly to occur at much lower light intensities.

Observations made at a large winter roost located on City Hall, Philadelphia, Pennsylvania, on three evenings during the last week of January, 1954, also showed this characteristic of larger roosting populations. The first Starlings arrived at 400, 380, and 350 foot-candles for the three observations and perched on the many towers on top of the building (Figure 5a). The Starlings arrived at this roost gradually at first with approximately 30 per cent of the total Starling population being present by 40 foot-candles. Many of these that arrived later perched on both the pre-roosting areas and

on the ledges used as roosting sites. The Starlings gathered on these and more distant pre-roosting areas did not begin to assemble on the ledges until approximately 80 foot-candles, thus marking the actual beginning of final assembly. This was most intense at 20-0 foot-candles, when over 50 per cent of the total Starling population assembled. Assembly continued for at least 2 to 5 minutes after the meter first recorded the light intensity as zero but only 2 per cent of the Starlings were involved.

It was difficult to separate quantitatively pre-roosting from that of roosting assembly at this roost, and I consider the data represented by that portion of the curve between 80 and 40 foot-candles as a combination of both pre-roosting and roosting assembly. If separation were possible, a curve would probably have been obtained similar to that shown in Figure 5b for the final assembly of Starlings at the autumn roost at Bellefonte, Pennsylvania. There appears to be very little difference in the pattern and intensity of assembly in relation to light at the autumn roost and at the larger winter roost. At both, assembly began at approximately the same light values and was most intense between 20 and 0 foot-candles.

At some roosts, the stages of pre-roosting and roosting assembly are sometimes all but impossible to separate. At places, such as the winter barn-roost and the autumn roost at Bellefonte, the different stages of assembly were easily identified and recorded by making approximate counts of the Starlings going from one area to another. Where the pre-roosting areas were within or very near the roost proper, separate counts were difficult to make. This appeared to be true at the summer roosts at State College, but, with careful observation, it became evident that a definite shift took place from pre-roosting to assembly points within the general roosting area. This movement of Starlings began shortly before the last few Starlings arrived from their feeding grounds. Observations on the roosting activity of Starlings at this summer roost, numbering approximately 20,000 birds, were made on eight evenings from August 1 to September 27, 1953. The data shown in Figure 6 represent the averages, for the eight observations, in per cent of the total roosting population arriving at certain light intensities. To a casual observer it would appear that assembly occurs at much higher light values, like those normally expected for pre-roosting. However, the shift in the Starling population from pre-roosts in tree-tops to definitive roosts began at approximately 90 foot-candles and was normally completed at from 10 to 0 foot-candles. This shift of Starlings from one area to another was most rapid at 25 to 15 foot-

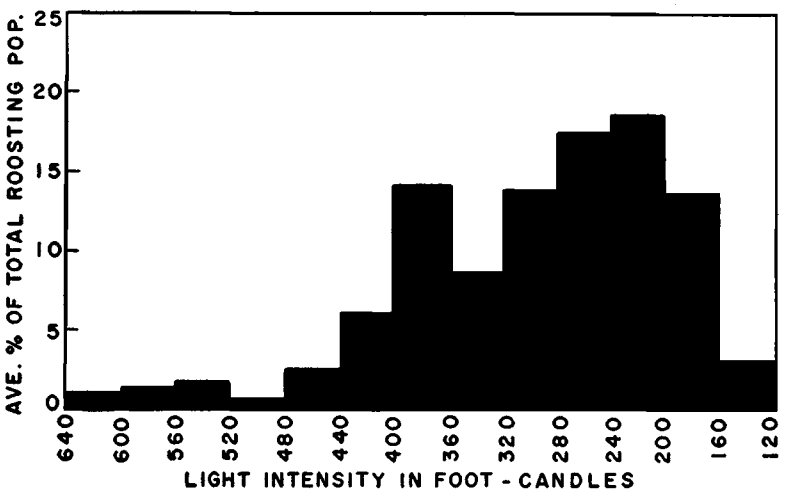

FIGURE 6. The arrival of Starlings at the summer roosts (average for eight observations).

candles. To be consistent with data presented for other seasonal roosts, this initial gathering of Starlings should be considered as pre-roosting, and the movement of Starlings occurring a little later as final assembly.

Assembly and weather.—Adverse weather conditions, such as winds of high velocity, low temperatures, rain, and snow may cause assembly to occur earlier and at higher light intensities than would normally be expected. The effect of weather upon the roosting of Starlings is well illustrated in Table 2, showing representative data obtained during six evening observations made at the winter barn roost, 14 to 19, February, 1953. The weather during the evenings of the 14

TABLE 2

SAMPLE DATA SHOWING THE EFFECT OF INCLEMENT WEATHER UPON ASSEMBLY

Date	*Minutes before sunset*		*Light in foot-candles*		*Weather*
	Start	*End*	*Start*	*End*	
February 14, 1953	44	5	370	66	Fair
February 15, 1953	57	23	550	210	Cold, windy, snow
February 16, 1953	57	19	595	110	Cold, windy, snow
February 17, 1953	87	16	590	330	Cold, windy, snow
February 18, 1953	83	11	550	72	Cold, snow
February 19, 1953	39	2	300	110	Fair

and 19, February, was classed by the writer as fair and the data should be compared with the data for 15 to 18, February, on which days there were low temperatures, snow, and winds of high velocity. February 18 was very cold, with snow covering the ground, but with winds of only moderate velocity.

During the two days when weather was classed as fair, assembly began at 44 and 39 minutes before sunset, respectively, at 370 and 300 foot-candles, and assembly was completed at 5 and 2 minutes before sunset, at 66 and 110 foot-candles, respectively. During

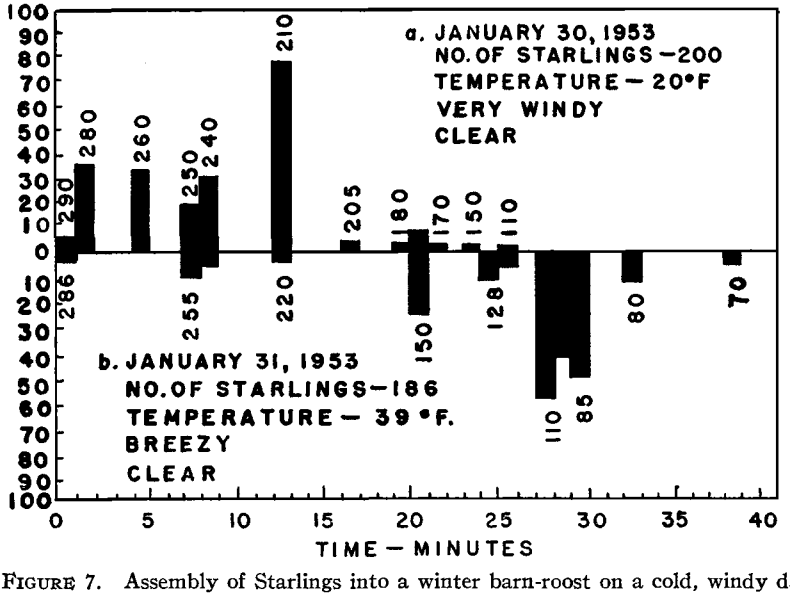

FIGURE 7. Assembly of Starlings into a winter barn-roost on a cold, windy day (a) and on a moderately fair day (b).

those days having adverse weather conditions, assembly began as much as 57 to 87 minutes before sunset and at light values ranging from 550 to 595 foot-candles. The completion of assembly for these days varied from 11 to 23 minutes before sunset and at light values, excluding 18 February, from 110 to 330 foot-candles. On February 18, assembly was completed at 72 foot-candles. Winds were moderate on this day. Thus, low temperatures coupled with strong winds are more effective in causing roosting to occur earlier and at higher light intensities than low temperatures alone.

The data shown in Figure 7, representing two evening observations made at the same winter roost, illustrate further the effect of low

temperatures and winds upon assembly. Little effect is evident on examining the light intensities for the beginning and the end of assembly. Assembly was initiated in both cases at approximately 290 foot-candles but was completed at different light values: 70 and 110 foot-candles, respectively. However, most of the Starlings assembled very early and between approximate light values of 280 and 210 foot-candles on January 30, a cold and windy day. On January 31, a cool, breezy day, most of the Starlings assembled at from 110 to 85 foot-candles. Assembly also occurred over a much shorter period of time during the day having low temperatures and strong winds.

ROOST PERMANENCE

As noted earlier, roosts are usually seasonal and are used only during certain times of the year. This was well illustrated at State College, where the summer roosts and the single autumn roost were established in distinctly different areas and used only during the corresponding season of the year. According to residents in the vicinity of the autumn roost, this area had been used for the past 15 years from late September through most of October and at no other time. As a result of work done in controlling the roosting activity of Starlings during the autumn of 1953 (Frings and Jumber, 1954) however, this autumn roost was not established that year.

Much evidence has been obtained by me and by other writers that supports the belief that the same Starlings assemble at the same roosting area, and each bird possibly at the same roosting site, each night. Kalmbach (1932), while banding Starlings in the tower of a church in Washington, D. C., found that each successive night disclosed a certain number of "repeats" from earlier bandings. As his operations caused a decrease in the total population of the tower, he found it necessary to go to higher and higher levels to obtain the birds, until the last several hundred were caught at the very top of the tower. Among the birds at the very top of the tower, not a single repeat was caught, although among the birds farther down in the tower about a fifth of the birds were repeats. Many of the "repeats" were found near the spot at which they were originally banded, indicating that each bird returned to the same spot in the tower that it had occupied at the time it was banded.

He uncovered further evidence of the attachment of Starlings to one site at the old Land Office Building, in Washington, D. C., where Starlings roosted on ledges above the upper story windows across the entire south side. He eliminated one of these roosting

sites by placing on the ledge a triangular strip of wood which formed an inclined surface. This piece of wood remained for three days and was then dislodged by the wind. The following night the ledge remained free of Starlings, although every window of the upper story had roosting Starlings. During subsequent evenings, this ledge was gradually repopulated.

I uncovered similar evidence during this study. While assisting in control experiments at State College, Pennsylvania, several blocks in the center of a large summer roost were cleared of roosting Starlings. These remained completely cleared for about one week, although the roosting pressure was great all around. About one week later, a few Starlings began to reoccupy the central portion of this treated area. At that time, the whole summer roost was cleared for the duration of the season.

Indirect evidence obtained by Kalmbach seems to suggest further that the same Starlings return to the same roost each year, as if having a homing instinct lasting from one season to another. These conclusions were based on the fact that the towers, which were cleared of roosting Starlings through banding operations, remained free of Starlings for a number of years. A somewhat similar incident occurred during this study, when Starlings were frightened out of the cupolas of a barn while I was capturing them for laboratory purposes. As a result, the following winter the barn was not used as a roost, although it had been used for a number of previous winters. Thus, indirect evidence points to the fact that the same birds use the same roosting area and possibly the same site every night. As Kalmbach suggested, further observations made on individually marked birds should settle the matter definitely.

SUMMARY

The Starling is a gregarious species and gathers at night into large flocks to roost. At State College, Starlings maintain summer roosts and a single autumn roost in deciduous trees; winter roosting takes place primarily in barns; and during the early spring, from late March through most of May, roosting occurs in evergreen trees. From late May to mid-June, during the breeding season, Starlings roost in shrubby vegetation growing in a marshy area.

Three main flight-lines lead to the summer roosts of State College. The flocks of Starlings arriving from more distant feeding grounds are much larger and fly at higher altitudes than those coming from nearby feeding grounds. Starlings gather first into definite areas called pre-roosting areas. The gathering of Starlings at these areas

is called pre-roosting in contrast with final assembly occurring at the roost.

At an autumn roost in Bellefonte, Pennsylvania, early incoming flocks assembled in numerous pre-roosting areas located at some distance from the roost and reassembled later with other flocks at a single and closer pre-roosting area. At the summer roosts in State College, pre-roosting areas were very near, or directly in, the roost proper so that a quantitative separation of pre-roosting and roosting assembly was impossible.

The time at which Starlings arrive at roosting areas in relation to sunset, varies with the length of day, weather, and numerous other factors. Time of arrival of Starlings at a roost is correlated with light intensity. Final assembly starts at approximately 80 foot-candles and is most intense between 20 and 0 foot-candles, when over 50 per cent of the total Starling population assembles. Adverse weather conditions, particularly high winds and low temperatures, may cause assembly to occur earlier and at higher light intensities than normal.

Indirect evidence suggests that the same Starlings use the same roosting area, and possibly the same roosting site, each night. The same Starlings and possibly their young may also use the same roost year after year.

LITERATURE CITED

BROWN, F. J. 1946. A Cheshire Starling roost, 1944–5. Journ. Animal Ecol., **15**: 75–81.

FRINGS, H. W., and J. F. JUMBER. 1954. Preliminary studies on the use of a specific sound to repel Starlings (*Sturnus vulgaris*) from objectionable roosts. Science, **119** (3088): 318–319.

KALMBACH, E. R. 1932. Winter Starling roosts of Washington. Wilson Bull., **44**: 65–74.

KENNEDY, P. G. 1929. Starlings roosting on the ground. Brit. Birds, **22**: 324.

MARPLES, B. J. 1934. The winter Starling roosts of Great Britain, 1932–1933. Journ. Animal Ecol., **3**: 187–203.

NICE, M. M. 1935. Some observations on the behavior of Starlings and grackles in relation to light. Auk, **52**: 91–92.

WYNNE-EDWARDS, V. C. 1929. The behaviour of Starlings in winter. Brit. Birds, **23**: 138–153.

Department of Zoology and Entomology, The Pennsylvania State University, State College, Pennsylvania, March 15, 1955.