GROWTH AND DEVELOPMENT OF ENGLISH SPARROWS *

RICHARD LEE WEAVER

THIS study was made on the campus of Cornell University during the summer of 1937. Due to the heavy concentration of English or House Sparrows (*Passer domesticus*) around the Agricultural buildings, augmented by the presence of 75 nesting boxes, a great amount of material was available for study. The nest sites were visited each day during the nesting season and the young were measured, weighed and examined at approximately the same hour. Most of the work was done between the hours of four and six in the afternoon. More than 2,500 measurements were taken on young birds during the course of the study.

Description of Newly Hatched Young

Contrary to Dwight's (1900:171) statement, English Sparrows have no natal down. They are entirely naked when hatched, as was later pointed out by Boulton (1927).

The feather tracts of the dorsal surface are discernible as blue lines under the skin but the skin is unbroken anywhere by feathers. The eyes are closed and the ears appear to be so. The body has a pinkish-flesh color except for the white edges of the bill and the white toe-nails. The organs of the abdomen show clearly through the skin, and the lungs appear somewhat lighter in color in the region of the thorax. The head and the dorsal surface of the wings appear just a trifle darker than the rest of the body.

Although the margins of the bill are almost pure white, the center is horn- or straw-colored, capped by a similarly colored egg tooth. The interior of the mouth is bright red.

Changes in the Young from the Second to the Fourth Day

Little change occurs in the second and third days, except that the feather tracts are much darker, and the points of the primaries have become evident on the posterior borders of the wings. By the fourth day the skin over the eyes has broken. The interior of the mouth is duller in color. The edges of the bill are now lemon yellow. All of the feather tracts are traceable. A continuous dark band extends from the nares over the head and down the middle of the back to the tail, outlining the capital and spinal tracts. The primaries project through the skin one to two millimeters. There is no evidence of the yolk mass. The ears are more evident now as small round holes. The general appearance of the bird is dark gray due to the developing feathers under the skin.

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Fifth, Sixth, and Seventh Days

The eyes are open by the fifth day. By the sixth day the young are half as heavy as when they leave the nest. Many of the contour feathers are through the skin on the sixth day. Marked changes occur in the appearance of the young birds by the seventh day after hatching. Feathers are breaking through the skin in parts of all of the feather tracts. Many of them, especially in the ventral tract, lose their sheaths immediately. The bird appears generally slate gray. The narrowing apteria appear flesh-colored. In the alar tract, the secondary coverts, and other

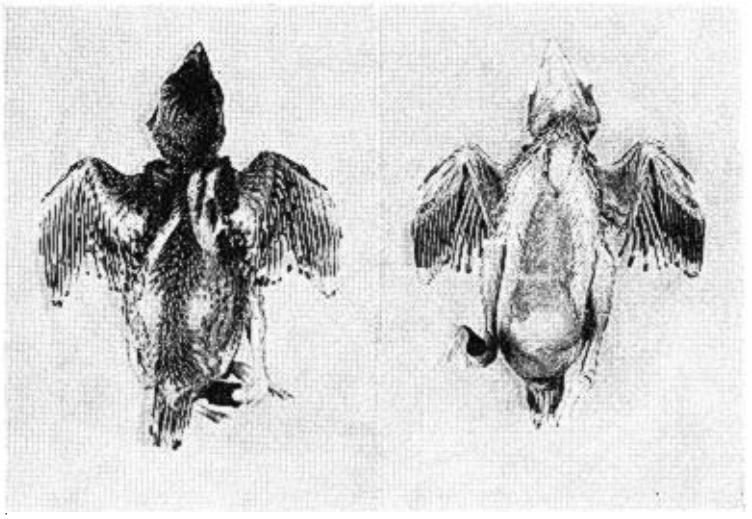

Figure 1. English Sparrows 6½ to 7 days old.

small feathers on the anterior and proximal portions of the wing are coming through the skin and unsheathing as they appear. These feathers are tipped with brown. The alula is 3 millimeters in length.

The primaries average 6.6 millimeters in length and have unsheathed one millimeter. The primary coverts are about 4 millimeters long and largely unsheathed. Three rows of feathers in the humeral tract have broken through the skin on the dorsal side of the tract and are unsheathed. On the anterior portion of the capital tract just above the bill the feathers are through the skin .5 millimeter, while only breaking the skin in other parts of the tract. The feathers in the cervical region of the spinal tract have projected through the skin 1.5 millimeters and are slightly shorter in other parts of the tract.

All of the feathers in the ventral tract have broken through the skin and are unsheathing as they appear. The rectrices are 5.3 millimeters long and are unsheathed only at the tips. The undertail coverts measure 1.5 millimeters and are white. All of the feathers in the femoral tract have broken through the skin, but few in the crural tract have appeared although they are very dark. The eye and ear openings each measure 3 millimeters.

Eighth and Ninth Days

The most noticeable change during these two days is the acquisition of color in the various tracts as the feathers continue to become un-

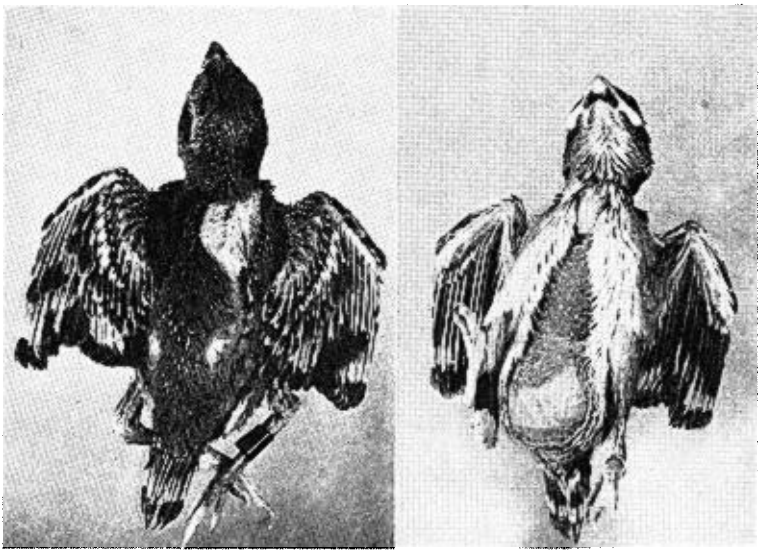

Figure 2. English Sparrow ten days old.

sheathed. The lesser coverts are tan and form a slight wing bar. The head is becoming brown, although remaining dark gray about the base of the culmen. The back is brown but the neck remains dark gray, almost black. The rectrices have brown tips, the upper tail coverts are light brown, the lower tail coverts white. The alula and primaries appear slate gray. The humeral tract is rich brown in color, while the upper feathers in the femoral tract are tan and the lower ones white. The feathers on the front side of the leg in the crural tract are white while those on the back are tan. The ventral tract is light gray to white.

Tenth to Fifteenth Day

Most birds which are handled daily for nine days will leave the

nest prematurely. Measurements were made on a limited number of banded birds retrieved after they had left the nest.

In these five days the feathers rapidly cover the apteria, giving the young birds a more adult appearance. The coverts on the wings and tail lose their sheaths more rapidly, accentuated to some extent by the use of the bill. The basal sheaths of the flight feathers are retained for some time after the young depart from the nest. A few sheaths are visible in parts of the spinal tract when the bird leaves the nest but none are evident in the ventral tract, except possibly in the cervical region.

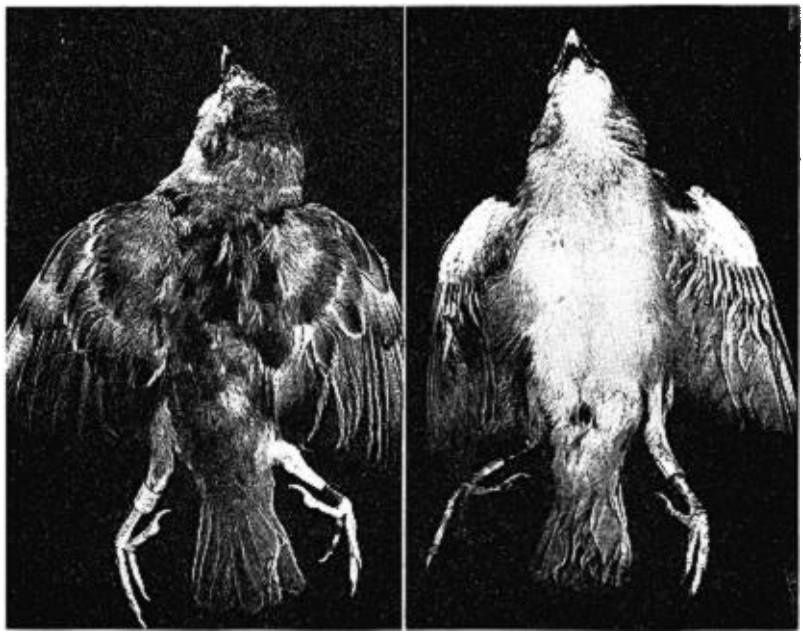

Figure 3. English Sparrow 14 days old.

The primaries grow from 20 millimeters on the tenth day to 44.6 millimeters on the fifteenth day and the sheaths on these feathers are reduced from four-fifths to one-fourth the total length. The rectrices advance from 11 to 30.7 millimeters in the same period and have become unsheathed from 3.6 to 21.7 millimeters.

The bill has a horn-colored tip, now surrounded by a black ring half way back. The soft portion of the bill has been reduced to about one-third of the horny central portion. The toe-nails are much darker than when hatched. The interior of the mouth has become pinkish-yellow. Young males will show signs of a black bib. In other respects the young birds look much like adult females.

Sixteenth to Eighteenth Day

Only a few birds were available for observation in this period as most of those observed earlier had left the nests. The most noticeable change is in the rapid rate of growth of the flight feathers. The primaries advance from 43 to 52 millimeters and the rectrices from 30.7 to 40 millimeters. The primary and tail coverts have reached maturity. The birds are very active and can fly rather well.

Comparison with Other Species

The development of the feather tracts, the pattern and centers of development, and the appearance of the individual feathers in the English Sparrow, follow very closely that found by Boulton (1927) for the House Wren, another hole-nesting species. However, when compared with the Tree Sparrow, studied by Baumgartner (1938), the Chipping Sparrow which I studied (1937), and the Song Sparrow studied by Nice (1937), there is a marked difference, which is expressed particularly by the early development of the contour feathers in these non-hole-nesting species. These birds progress more rapidly in their earlier stages, but the English Sparrow feathers out very rapidly in the later stages. Since it remains in the nest four to five days longer it is also more fully feathered when it leaves the nest, than are these other species.

Fledging Period

The time required for fledging varied from 12 to 16 days in 23 nests which were not used for measuring the young. In the nests where the young were handled daily the young left sooner than that. The average fledging period was 14.4 days in the 23 more or less undisturbed nests. The young left the nest at 12 days in five nests, at 13 days in seven nests, at 14 days in four nests, at 15 days in six nests, and at 16 days in one nest.

Witherby et al. (1938) give the fledging period in England as 15 days, but the Heinroths (1924) and Niethammer (1937) say that the young birds normally remain in the nest for 17 days in Germany.

Average Rate of Growth

Many birds of known ages were measured on each day of the fledging period. The average for all measurements and the number of birds used daily, are shown in Table 1. Although some are shown in fractions on the chart, it indicates merely the result of averaging the measurements of a number of birds. Weight increased about two grams per day for the first thirteen days, starting at 2.8 grams and reaching 25.6 grams, the greatest weight attained before leaving the nest.

Behavior of Adults During the Fledging Period

From the time the young birds hatch until they leave the nest both

TABLE 1

AVERAGE RATE OF GROWTH OF ENGLISH SPARROWS

Day	Number of measurements	Total length	Wing	Gape	Primaries	Primary coverts	Rectrices	Weight
1	53	40.0	6.1	7.5				2.8
2	39	48.6	7	9				4.8
3	33	56.1	9.2	10				6.9
4	30	63.8	12.5	11.8	pt.			10.2
5	23	67.6	16.5	12.2	1.4(pt.)*	.6 (0)	1.9(pt.)	11.7
6	31	73.0	17.9	12.8	3.3(pt.)	1.7 (0)	2.7 (1.0)	13.8
7	21	82.5	22.7	13.2	6.6 (1.0)	4 (0)	5.3 (1.5)	16.4
8	25	84.6	27.3	13.8	11.7 (2.0)	7 (1.4)	8 (2.0)	18.0
9	19	91.0	32.7	13.8	18.8 (4.3)	9.8 (1.8)	11 (2.0)	20.3
10	20	91.0	34.1	14	20.1 (4.5)	10.8 (3.0)	11 (3.6)	20.4
11	19	103.0	41.4	14.4	27.7(11.0)	15.2 (7.4)	17.8 (6.6)	22.7
12	10	107.2	45.8	14.4	29.9(16.7)	17.1(11.8)	21.2(10.2)	22.7
13	15	115.0	49	14.7	36 (25.0)	18 (13.6)	25 (15.0)	25.6
14	6	117.0	50	14.8	37.5(25.5)	18.1(14.8)	27.4(16.5)	25.2
15	4	123.0	57	14.8	43.6(32.1)	18.8(15.0)	30.7(21.7)	23.9
16	1	112.0	42	14.5	40 (25.0)	22 (14.0)	25 (22.0)	26.0
17	2	126.0	60	15	49 (43.0)	18 (18.0)	33 (31.5)	22.5
18	1	126.0	64	16	52 (45.0)	18 (18.0)	40 (30.0)	

Measurements are in millimeters and grams.

* "Pt." is used to indicate a mere point of feather—too small to measure readily. The second figures, in parentheses, indicate the amount of the same feather that had broken out of the sheath.

parents share equally the duty of feeding them. However, other duties are not shared equally. The female takes care of the nest sanitation and keeps the young warm at night. If there is overcrowding in the nest, the excrement may not be removed. Although I did not find any males spending any time in the nest box, Daanje (1941) in Holland reports that the male does share equally with the female in the brooding of the young. During the first five days after hatching the young are fed by regurgitation, but are not fed in this manner during the latter part of the period in the nest, as was pointed out earlier by Niethammer (1937) and Witherby et al. (1938).

SURVIVAL

From 180 eggs laid in 38 nests, 127 young were raised successfully, which is 70.5 per cent success. This corresponds very closely with that found for other hole-nesting species and is contrasted with 43 per cent success for species nesting in the open (Nice 1937: 142–144). In none of the 38 nests did six young survive, but in 7 five survived, in 12 four survived, in 11 three survived, in one nest two survived, and in two nests none survived.

Young Leaving the Nest

As the young develop and the time for them to leave the nest approaches, the larger ones are found to be the highest in the nest, with their heads sticking out the entrance. Thus, they have a distinct advantage during the latter part of the fledging period as all of the feeding is done from the outside of the nest cavity.

One young was observed to leave the nest under fairly normal circumstances. It was sitting in the entrance, while both of the adults were away. A door slammed nearby and the young flew out, landing on a shed roof close to the nest. It attempted to fly up the side of the barn when a person approached, but failed and stopped on a window sill, half way down the side. When the female returned, she found it there and coaxed it to a lower level and thence over the shed out of sight. The female and young were not seen again that day and the male continued to feed the young in the nest alone.

In several cases the young flew from the nest when I approached. The older ones commanding the highest position in the nest were always the first to leave. Two days often elapsed before the others were ready for their initial flight.

The young are able to fly rather well upon leaving the nest. One young bird was seen to leave a nest box about eight feet from the ground and to fly sixty yards, landing in the top of a tall elm tree. It was almost impossible to catch any young sparrows which left the nest around fifteen days after hatching. The longer period in the nests permits the English Sparrows to acquire more strength and better developed feathers than such birds as Robins, Chipping Sparrows, or Tree Sparrows.

Young Birds Out of the Nest

In the instance in which the young bird was observed to leave the nest because of the door slamming, the female soon found it and then remained with it, while the male cared for the rest of the family. At other times when the young left, both the male and female were observed feeding the same young. However, the more common procedure was for the female to care for several of the young and the male to care for the others. This seemed to be determined mostly by the manner of scattering as the young tried to follow the adults to secure food.

Contrary to Daanje's (1941) statement that the female takes most of the care of the fledged young (for the male may be more interested in starting the next brood than in the older young), I observed a fairly equal distribution of care during the period directly after the young left the nest. In one case the female withdrew within one week, starting a new nest while the banded male continued to feed the young for at least two weeks more.

Niethammer (1937) also observed this attention by the male, and

says that the young "are fed for a while after learning to fly, evidently especially by the male, then collect in flocks, which the older birds join later. At this time true mass gatherings often take place, accompanied by a great deal of noise, in densely foliaged tree tops, also in the middle of large cities."

The Heinroths (1924) observed that "the young have a strong bond to one another after leaving the nest, in contrast to thrushes, nightingales, and some other birds that prefer to be alone."

The adults feed the young for at least two weeks and may do so for a longer period. Since the English Sparrow raises two broods each year and the second brood may not be started for a month or more after the first was started, juveniles can be found in all stages of development during the latter part of the summer.

A complete post-juvenal molt begins four to six weeks after the birds take to the wing, the Heinroths (1924) setting it at five weeks. The general molting for all young took place at Ithaca during the early part of August and continued through mid-September, requiring four to five weeks to complete the molt.

Summary

English Sparrows are hatched without natal down.

The interior of the mouth of newly hatched young is bright red, but becomes pinkish-yellow before the young leave the nest.

The egg tooth disappears and the edges of the bill change from white to lemon-yellow by the fourth day after hatching.

The first appearance of the feathers and the sequence of their development in the various tracts and regions follows a very definite order which resembles very closely that found by Boulton in House Wrens and Weaver in Chipping Sparrows.

The greatest development in the plumage of young sparrows is delayed until the latter part of the period in the nest. The greatest change in appearance of young English Sparrows occurs between the age of six and seven days, when most of the feathers emerge and many of them lose their sheaths.

By the tenth day after hatching the color pattern is evident, showing a wing bar, and in some males a black bib.

Practically all of the sheaths have disappeared from the contour feathers and all but one-fourth of the flight feathers are unsheathed by the fifteenth day. These sheaths may remain one to two weeks after the young depart from the nest. The greatest amount of sheath is present in the flight feathers on the eleventh day. The amount of sheathing present gives an accurate criterion of the age of young birds in the nest.

Most of the young left the nest at about the fifteenth day, but English Sparrows may remain in the nest for seventeen days if entirely undisturbed.

Males and females share about equally in the feeding of the young at the nest, but the females do the greater portion of the nest sanitation. Both birds may brood the young, although the female does the greater part of it and always stays in the nest during the night. The young are fed by regurgitation during the first part of the period after hatching.

There was 70.5 per cent success of survival in thirty-eight nests which produced 127 young from 180 eggs laid. This corresponds closely to that reported for other hole-nesting species.

The older young are able to command the most advantageous positions in the nest and thus receive relatively more food and often are able to leave the nest several days before the other young. The young can fly rather well upon leaving the nest, considerably better than do the young of most species that nest in the open.

The young are fed by the adults for a period of two weeks, and probably more, after leaving the nest. The young have a strong bond for one another. The young, out of the nest, may be fed entirely by one adult or by both.

A complete post-juvenal molt begins about five weeks after the young leave the nest. It began in early August and ended in mid-September at Ithaca in 1937.

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Dartmouth College, Hanover, New Hampshire