

5. First sets were laid between April 6 and April 29; second sets, following removal of the first, were laid in the same nest after an interval of 10 to 12 days (five instances) or in a new nest.

6. The number of eggs in a clutch varied from 2 to 6 and averaged 4.4. Second sets were slightly larger than first sets.

7. Eggs weighed from 12.5 to 21.3 grams and averaged 16.6 grams. The first egg in a clutch was generally heavier than the last. Eggs in first and second nestings were equal in size. Eggs in small sets were slightly heavier than those in large sets.

8. Eggs were generally laid at the rate of one per day.

9. Experimental removal or addition of eggs during laying had little or no effect on the duration of the laying period or the number of eggs laid.

10. Eggs held in storage at 55 degrees F. for 5 to 7 days, failed to develop when placed in an incubator; 4 of 42 stored eggs developed when returned to incubating crows.

11. The incubation period was 16 to 18 days. Birds sat on sterile eggs as long as 32 days.

12. Eighty-eight percent of undisturbed eggs hatched.

13. Nestlings averaged 12.3 grams at hatching, grew slowly at first, then rapidly, then slowly to reach approximately 300 grams at fledging on about the 35th day. The development of the fear reaction on about the 18th day coincided with the acquisition of clear bright eyes.

14. Nestling mortality was 77%. Greatest losses occurred through desertion of nests by parents and through competition between nestlings in crowded nests. Only one nest held more than two young after the 15th day.

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## A COMPARISON OF TWO CHICKADEE SEASONS

By EUGENE P. ODUM

BETWEEN September 1939 and September 1940 the Black-capped Chickadee (*Penthestes atricapillus*) population on the Edmund Niles Huyck Preserve was kept under continuous observation. An analysis of this annual cycle has been published (Odum, 1941a, b, 1942). Opportunity was provided for a study of at least a portion of a second breeding season when the writer returned to the area during June and July 1941. In 1940 nearly all the adults on the 375 land acres of the Preserve, a number in adjacent areas, and 31 nestlings were color-banded. In 1941 few new birds were banded but every effort was made to locate and study all birds, banded or unbanded, within the same study area and to locate banded birds

in buffer areas. In general, observations were conducted so that results would be comparable with those of the previous season. The following notes constitute a brief comparison of the 1940 and 1941 nesting seasons. The writer is indebted to Mrs. E. N. Huyek, the officers of the Preserve, and its Scientific Advisory Committee headed by Dr. W. J. Hamilton, Jr. for opportunity to conduct the observations.

*Weather.*—The following is a summary of mean temperature (°F). and total precipitation (inches) data for Albany, N. Y., the nearest weather station. Since the Preserve is about 1500 feet higher temperatures average four to five degrees lower and precipitation somewhat higher. However, the Albany data should suffice for gross direct comparison of the two seasons.

	<i>Feb.</i>	<i>Mar.</i>	<i>Apr.</i>	<i>May</i>	<i>June</i>	<i>July</i>
Mean Temperature—1940.....	21.8°	26.8°	41.7°	58.4°	65.0°	71.0°
1941.....	23.4°	27.9°	52.2°	59.3°	68.7°	73.4°
Total Precipitation—1940.....	2.83	4.53	3.93	3.68	2.83	4.23
1941.....	2.33	1.85	0.72	1.19	1.56	4.45

As can be seen the 1940 season was consistently colder and wetter, but by far the greatest difference occurred during April. This is important to note since in April the reproductive cycle begins to get underway. Temperatures were 5.1° below normal in April 1940 and 5.4° above normal in April 1941. March temperatures were 5–6° below normal both years. Except for March and April the 1941 season was near normal in temperature although somewhat below normal in precipitation. As will be noted below these differences in weather seem to be correlated with certain differences in chickadee behavior.

*Population.*—The total population on the Preserve was higher in 1941, being thirteen pairs or about 7.0 birds per hundred acres as compared to ten pairs or 5.4 birds per hundred acres in 1940. Excluding the 153 acres of early seral habitat which is not generally suitable for nesting or feeding activities in summer, the density figures are 11.8 and 9.1 birds per hundred acres of chickadee habitat, respectively. Single unbanded adults were also seen more frequently in 1941 (not counted in above figures); in 1940 there was almost no supply of unmated birds since birds which lost their mates had difficulty in replacing them (Odum, 1941b). The greater 1941 population together with success of more second broods (see below) is interesting in view of the marked invasion of Black-caps into the New York City and adjacent regions the following (1941) autumn (see Audubon Mag. "Season" reports). Wallace (1942) also reports an increase in chickadee population on the Pleasant Valley Sanctuary at Lenox, Massachusetts in 1941 following a progressive decline since 1937–38. Perhaps, therefore, the eruptive southward migra-

tion might be the result of a generally rising population level plus an early and successful nesting season. Certainly, most if not all of the chickadees reported from such unusual habitats as New York skyscrapers during the autumn invasion must have been immature birds of the year, since they are normally given to wandering while adults seem to be relatively sedentary (granted, of course, that adults do not also become long-distance wanderers during periods of population pressure!). The net increase in population during the summer of 1940 was threefold. It was not possible to obtain comparable figures for 1941, but success was apparently even better. If such trends occurred over wide areas it is easy to see how the numbers of birds necessary for an invasion could be produced, although the problem of what causes the surplus to move into new areas (where many undoubtedly perish) still remains to be considered.

Although it is dangerous to generalize on the basis of small samples it seems safe to say that such eruptive movements are not to be correlated with any one factor, but rather with a fortuitous combination of factors both biological and environmental. To understand these movements, therefore, we need not only to know the life history of the species, but need quantitative data on populations (including trends) as well as weather and other environmental data during critical periods in the life history.

*Returns.*—Of eighteen color-banded adults known to be present at the end of the 1940 breeding season ten or about 56% were located in 1941. If it is assumed that birds not found perished, the year's mortality comes to 44%. It is quite possible, of course, that individuals might be missed since chickadees are relatively hard to locate during height of nesting. Also birds might have wandered too far from the area to be found. As evidence against the latter is the fact that all ten returns were located on or reasonably near their territories of the previous season, indicating that the adults return to (or remain on) the same general areas to nest even though they may wander more widely at other seasons or occupy a different area in winter. The return of males was better than that of females; seven out of eleven males were found but only three out of seven females. None of the 31 birds banded as nestlings could be found. As previously shown (Odum, 1941b) the young tend to separate from their parents and wander widely in late summer and autumn; apparently few may be expected to nest in the immediate area where hatched.

If Wallace's (1941) mortality figures for 1938 and 1939 are averaged with mine we get a chickadee mortality figure of 38% or roughly 40% and a theoretical average length of life of 2.5 years (reciprocal of 0.4). This yearly mortality figure is about the same as that computed by Nice (1937) for the Song Sparrow, a larger bird,

but is considerably lower than the mortality rate of the House Wren (Kendeigh, 1937) which is about 66%.

*Pairings.*—Of seven pairs in which both birds were known to be alive and banded at the end of the 1940 season, only one was the same in 1941. This pair occupied virtually the same territory as last year. One pair was missing entirely and in five pairs one bird was the same as last year but the other was a new, unbanded individual. In no case could the missing individuals be found; in other words no “divorces” could be demonstrated, the assumption being that the missing bird was dead or at least strayed far beyond its former haunts. The missing bird in four out of five cases was the female of the original pair.

With this additional evidence the question of permanence of mating in this species seems to be something as follows: Members of a pair remain together after nesting and may be expected to nest together the following season if both survive (or remain in same locality). Bonds between them, however, are quite loose, if existent, during the fall and winter flocking periods; at least I was not able to identify pairs by behavior during these seasons. Because of the relatively high rate of mortality the chances that one or both birds will not survive to a second season are considerable. If we take 40% as the average yearly death rate, from two-fifths to four-fifths (depending on whether one or both members die) or an average of three-fifths of the pairs will be disrupted annually. If mortality increases to 50% an average of three-fourths of the pairs will not be same the next season. Actually, therefore, the number of repeating pairs is likely to be in the minority rather than the majority, as was the case in the present study (see also Butts, 1931).

*Territory.*—Observations on territory in 1941 largely confirmed those of 1940, although because of my late arrival territories could not be mapped as accurately. In contrast to 1940, however, there was one case where territories overlapped, at least during the late stages of nesting. This occurred at the north end of the Preserve where population was most dense. The two nests were only 150 yards apart, and when discovered both pairs were busily engaged in feeding nestlings. The two pairs generally moved in different directions but a good part of the feeding areas overlapped. On one occasion when the male of one pair came within 50 yards of the other nest, he was immediately challenged and driven away, otherwise no contacts between the pairs were observed. As pointed out in the previous paper (Odum, 1941a) the size and the vigor of defence of the territory decreases as nesting progresses. Probably, therefore, the territories of these two pairs were much more distinct at the beginning of nesting than towards the end when all energies of both sexes are used in the care of the nestlings.

The most spectacular territory battle which I have observed in the chickadee occurred on June 20. Male R-BY with a new mate (his third in two years) was located this year on an area adjoining his last 1940 territory; on June 18 the pair were feeding nearly full grown young. In the meantime a new pair entered the unoccupied area and started a late nesting about June 4. On June 20 R-BY and his mate wandered over into his old but now occupied land (the young were nowhere to be seen); immediately the new male, R-AR, attacked, and for the next forty minutes a running battle occurred for about 200 yards along the east boundary of the territory. I was attracted by the first outburst and was able to observe the entire proceedings at close range since birds were mostly down low and paid no attention to me. All the characteristic notes and behaviors were observed, but there was much more actual fighting than usual. R-BY was clearly the better fighter and on more or less neutral ground continually repulsed the other's repeated attacks. However, when the invader moved well into the territory the resident bird seemed to redouble his efforts and would succeed in driving the invader back each time, a very nice illustration of advantage held by the established owner of a territory. The females of both pairs were present but were generally content to remain a few feet back of the broad fighting zone and give vocal encouragement, while the males flew back and forth at each other. At least once, however, when male R-AR (the owner) was particularly hard pressed his mate dashed into the fray. At intervals she would return to the nest to incubate (nest was about 200 yards from scene of most of fighting), but at each fresh outburst she would come dashing out to the scene of battle. Finally, the invading pair drifted off toward the east leaving the owners in full possession.

*Time of nesting.*—Nesting was fully two weeks earlier in 1941. The average hatching date of six nests in 1941 was May 23 (determined by figuring back from time young left the nest) as compared to an average of June 5 for seven nests in 1940. Assuming an average incubation period of thirteen days and seven eggs per set, the average date of the laying of the first egg would be May 5 and May 18, respectively. This difference is apparently correlated with the difference in April temperatures since weather conditions during the other months were not greatly different (see above data). In 1940 the preliminaries to actual nesting (spring movements, breakup of flocks, pairing, etc.) were noticeably prolonged as flocks would alternately break up and reform at each April cold spell. In 1941 the warm weather of April undoubtedly speeded up these activities, enabling actual nesting to begin sooner. In an analysis of fourteen House Wren seasons Kendeigh (1937) found that time of the laying of first egg varied eighteen days and was inversely corre-

lated with temperature, particularly average night temperature. No statistical correlation was obtained with precipitation, relative humidity, wind velocity, or total possible hours of sunshine (p. 112).

*Number of broods.*—There was only one second brood completed in the area in 1940 as compared with at least three in 1941, probably correlated with the earlier season. This illustrates how progress of spring may influence the amount of reproduction since apparently a second brood is more likely to be attempted at this latitude when the first brood is completed fairly early in June.

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THE LIFE SPAN OF THE COMMON TERN (*Sterna hirundo*)

By OLIVER L. AUSTIN, M.D.<sup>1</sup>

THIS paper is based solely on work which has been done in a group of colonies of Common, Roseate and Arctic Terns which breed annually on Cape Cod, Massachusetts. This group's present composite population of about 30,000 individuals has remained practically stable for the last thirteen years. The banding of chicks in these terneries which was instituted in 1922 and trapping their adult members, first done in 1928, have been continued through the 1942 nesting season without interruption and with progressively increasing thoroughness. Personnel from the Austin Ornithological Research Station began work in these colonies in 1929 and since 1931 their study and conservation has been one of this station's major undertakings. Descriptions of these colonies as they have varied from time to time, their locations and histories as well as

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