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WINTER STUDIES OF COLOR-BANDED CHICKADEES

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INTRODUCTION

WINTERING chickadees at the Pleasant Valley Bird and Wild Flower Sanctuary in Lenox, Massachusetts, apparently exceptionally abundant both because of favorable range and build-up from a decade of winter feeding, have been the subject of detailed observations during the past three years, chiefly from the time of their arrival at the feeding stands in November to their dispersal in March and April.

As material for winter studies, the Black-capped Chickadee (*Penthestes atricapillus atricapillus*) offers singular advantages. Tame, friendly and sociable, they lend themselves admirably to close observational work. Widely distributed and of great abundance, they provide unfailing study material in all favorable environments within their wide range. And since they are at least in part non-migratory, banding work is particularly practicable and populations of marked individuals can be followed more or less indefinitely. The wealth of published observations makes the literature at least a quantitative mine of information, though a little library work soon disclosed an unfortunate dearth of data on some pertinent questions.

Consequently the chickadee may well be regarded as the key to the solution of many ornithological problems: the organization and social relations of the flock, the formation and function of the winter range, seasonal movements and migration, fluctuations in population, longevity and mortality. All these topics need much enlightment, part of which is obtainable from window-sill observations in winter. The aim of this investigation has been to answer some of these questions, but even after three winters it is obviously too much mere accumulation of data, too little the actual solution of the problems involved.

Grateful acknowledgments are made to the Sanctuary Association for providing the opportunity and certain facilities for pursuing this work, to the libraries of the New York State Museum at Albany and the New England Museum of Natural History at

Boston, to Mr. Rawling, the Sanctuary workman, for manual assistance in the matter of traps and banding operations, and to Mrs. Wallace for typing and reference work.

TECHNIQUE OF THE INVESTIGATION

Color-banding methods are now so universally known that the technique of this investigation needs only brief mention. Four colors, red, blue, green, and yellow, which seemed to be most clearly visible in the field, were used. After a few trials black bands were discontinued because of their confusing resemblance to blue in poor light. One-hundred-twenty-five chickadees were marked during the three winters, 74 in 1937–38, 22 additional ones in 1938–39, and 29 more in 1939–40, each with a different combination of color or position of color, so that individuals could be identified on sight. Chickadee tarsal length, however, imposes a limitation on the number of bands applicable to a single bird. Two color bands (6 mm. wide) or one color band and the numbered aluminum band cannot be accommodated on the same leg. Consequently weakened and less visible halved bands had to be resorted to after running the gamut of a few colors on the right and left legs. One or two color bands plus the aluminum were sufficient for the first two winters, but for the third winter another color band had to be added, making the combinations more difficult to read and possibly overburdening the birds by excessive use of bands.

Apprehensions that the weakened half-band might come off were apparently unfounded. None of the forty-five marked chickadees that returned the second winter had lost a band. During the third winter one bird lost a half-band that had been worn two and a half years, but its loss was detected and remedied almost immediately. During the fourth winter one bird returned minus a half band; one minus a leg that had carried a metal and a colored band. Marked Blue Jays, on the other hand, were found to lose even whole bands occasionally.

Color banding of chickadees is by no means a pioneer enterprise. W. K. Butts in particular, one of the originators of the use of color bands, and later Dorothy Baldwin, at Hardwick, Massachusetts, made extensive studies of marked chickadees and published the fruitful results of their research in various papers (Butts, 1927, 1930, 1931; Baldwin, 1933, 1934, 1935a, 1935b, 1935c). That there is ample opportunity for additional work in already exploited fields hardly needs to be mentioned. At least two other present day investigators are also at work on chickadees, yet the possibilities for future study are far from exhausted.

SOME GENERAL AND INDIVIDUAL CHARACTERISTICS

One of the first and most obvious results of color banding is the

distinction of the individual from others of his kind, thereby disclosing wide and hitherto largely unsuspected differences in disposition and behavior. Tameness, for instance, appears to be chiefly an individual matter. Some seem inherently tame, feeding from human hands with little or no preliminary enticing, while others require patient and repeated inducements before coming into hand. No. 51 at the Sanctuary was particularly fearless and even in summer frequently surprised visitors by alighting on their heads or shoulders; but his mate no. 55, could be seduced only in winter after repeated proffers of seed or suet. Banders are familiar with occasional wary individuals of various species which elude all attempts at capture by trapping, and chickadees are no exception.

Individuals differ in quarrelsomeness. Some are comparatively peaceful in relation to their neighbors, though the majority are persistently squabbling over apparent trifles. No. 70 proved to be an extreme example of a dog in the manger and refused, with outstanding success, to tolerate another chickadee in a feeder with himself. With unusual displays of ferociousness he challenged all comers, charging right and left with open beak, often to the neglect of his own feeding operations. The whole matter of quarrelsomeness is of course intricately tied up with a scale of peck dominance, a field of study in which Mrs. F. M. Hammerstrom, Jr., (unpublished) has gathered many useful data on chickadees.

Individual tastes in items preferred and manner of feeding are often manifest at a feeding stand and not infrequently individuals can be identified by little give-away traits without observing their color combinations. The chickadee's preference for sunflower seeds and peanut products is well known, but there is a probability that their choice of seeds at a stand is governed to some extent by size as they seem to select the larger items first. The orthodox procedure is to snatch as much as the beak will hold, which in the case of sunflowers is usually one seed, and to dash hurriedly away, eating the seed at a distance or storing it for possible future consumption. Whittle (1938) states that a few of his birds learned to open one sunflower at the feeder and to carry the kernel plus one unopened seed away, a feat also recorded by Roberts (1934). Chickadees at the Sanctuary have proved inferior in this respect.

Chickadees quickly learn the make-up of banding traps and go in and out at will, stealing all the bait intended for other birds. Mrs. Coutant (1928) writes of a chickadee that for four days brought his three young to a trap with which he had previously been familiar, lined them up in a row outside, went in himself and proceeded to feed the young through the bars of the cage. When one of his offsprings ventured to enter, the adult drove him back to the safety of his outside perch. None of the young could be captured.

ORGANIZATION OF THE FLOCK

Chickadees normally wander about, except in the breeding season, in small groups of several to six or eight individuals. In Christmas Census reports for Bird-Lore, W. P. Smith, at Wells River, Vermont, records the number of flocks encountered as well as the number of individuals, which, by simple division, gives a flock size that varies but little from an average of seven. This is in keeping with other published reports (Whittle and Fletcher, 1924; Whittle, 1926). The chief exception at Lenox has been that in the past two winters (1938–39 and 1939–40), with chickadees decidedly on the decline, a number of flocks were reduced below standard size. Odum (unpublished), in Rensselaerville, New York, likewise found smaller flocks in the hard winter of 1939–40. There may also be some difference in interpretation of flock size. Small groups of three or four may be merely a stray segment temporarily separated from the rest of the flock, as individuals do not necessarily stick together in all their wanderings. Butts (1931) concluded that the complete flock numbered about fifteen and was made up of semi-permanent units which repeatedly split and rejoin; but since his studies were conducted on areas where artificial feeding had previously been maintained it is not unlikely that two or more groups which might otherwise have remained apart were called together occasionally by patronizing the same feeding stand. Forty or more chickadees may visit one window feeder at the Sanctuary in a day, but are roughly divisible into separate flocks. More information on what actually constitutes a flock is needed before reaching conclusions as to what governs its size.

One of the early results of bird banding was the discovery of group habit among birds, the tendency of certain individuals of wintering and migrating flocks to stick together not only through one season but more or less permanently. Whittle and Fletcher (1924) have shown that juncos banded one winter came back the following year on the same date in the same association and that the individuals were usually together at subsequent retrappings. Perhaps even more remarkable is Van Tyne's report of Indigo Buntings on their wintering grounds in Guatemala (Van Tyne, 1932). Of 99 buntings banded in April, 1931, nine were retaken the following April when a trap was operated for a few days in the same spot, evidence indicating a flock of about a hundred birds wintering together in a grassy clearing of Guatemala, probably migrating as a unit and returning together the next year to the identical place.

Winter flocks of chickadees at the Sanctuary bear out, perhaps in a less dramatic way, the close association between certain individuals. Although there is usually a confusing mixture of 20 to

60 birds at the cottage, which seems to be a common feeding ground for all the flocks within a half mile, each woodland station is normally patronized only by the individuals that chance to be wintering within the territory in which the feeder is placed. Of ten chickadees banded at the St. Francis Spring station (three-fourths of a mile from the cottage) in the winter of 1937–38, nine were back the following year, a fact remarkable not alone because of the 90% return of birds banded the previous winter but also because the same individuals were together again in the same association and never seemed to mingle with their neighbors at other stations. At the Beaver Pond station three birds, the sole survivors of the former year's flock, were back together and remained together all winter, though in February their territory was invaded a few times by birds from an adjacent range. The same situation prevails at other stands, each of which is regularly patronized by a group of linked individuals, nearly always together or within calling distance of one another, and whose status, with minor exceptions, remains unchanged through the winter, and as far as survival permits, winter after winter.

Some observers have ventured the seeming logical prediction that roving bands of chickadees are family groups, but proof of this by actual checks appears to be nil with regard to fall and winter flocks. The chickadees at the Sanctuary, moreover, quite obviously are not family groups. Banded old birds came back the second winter, unaccompanied by unbanded birds that might have been their young. The Beaver Pond trio, as mentioned previously, had with them no other birds, either young or old. The nine returns at St. Francis Spring had with them only one unbanded bird which could have been their young. By the end of November in that second winter 34 returns were secured, but only eight new ones, these chiefly by themselves in the final days of the month—a singularly poor showing for the younger generation. Part of this was undoubtedly due to low nesting success in 1938 with a consequent shortage of immature birds in the fall; but in 1939, after an obviously successful breeding season, the young chickadees so abundant in the woods in late summer seemed to disappear in the early fall and to be replaced later by birds of unknown origin and source. The unbanded birds that finally joined the old birds at the feeders had to fight their way into a partially closed hierachy before being accepted by the old-timers. Baldwin (1935) noted that a pair of her color-banded chickadees came to her feeding stand in October unaccompanied, although they were known to have raised two broods nearby. The conclusion, to be borne out more forcefully in connection with other topics, is that young chickadees, though obviously in company with their parents in late summer, tend to wander away from the more sedentary adults in the fall.

WINTER RANGE OR TERRITORY

The winter territory, established in the fall when wandering individuals settle on an area perhaps already occupied by a pair of permanent residents, is retained with only minor changes until spring dispersal takes place. Sharp defense of the wintering area is apparently not the rule, for occasionally, though not habitually, neighboring flocks will mingle with a fair degree of peacefulness around a concentrated food supply. Even in these exceptional circumstances, however, the flocks retain their identity and the invaders can usually be distinguished by their subordinate status.

Since at least part of the birds on a given territory inhabit it only during the winter the question of their origin becomes intriguing. In the first place it is clear that an area occupied by one or more pairs of permanent residents is built up to some extent by a shift in local birds that have been summering in an area not suitable for winter use. Carpenter (1935) has shown that populations of wintering birds, including chickadees, occupied "one preferred exposure to the marked exclusion of those habitats which are more rigorous." Chickadees and juncos chose the east exposure which was the "lee" side with reference to the prevailing winds. Stoner (1932) found chickadees nesting more abundantly "in the north-side wooded sections [of Oneida Lake] than anywhere in the immediate south-side of the lake" but "after the breeding season it spreads into the adjacent open country and cultivated areas." Consequently chickadees that may nest by preference on a northern slope or otherwise cool habitat may shift in winter to the nearest favorable wintering area, where they would be joined by other local birds seeking a winter haven. Then to this nucleus of permanent residents and the winter residents moving in from only a short distance may be added some wanderers from afar, an account of which can best be considered in a subsequent topic entitled "Seasonal Movements and Migration."

The size of the winter range is, fortunately, a less theoretical subject, for although it varies somewhat, presumably with the quantity and quality of food and cover and perhaps to a less extent with the density of the population, on the whole it proves relatively stable. Butts (1927) reports one bird that travelled three-fourths of a mile between two stations, an exceptional occurrence. At Ann Arbor, Michigan, two stations said to be one-half mile apart were frequently visited by the same five birds (Lyon, 1923); but Horsey (1924) operating two stations only 835 feet apart, at Rochester, New York, never had any crossing over from his sixteen banded birds, a difference that might be readily explainable if the territorial conditions in the two cases were considered.

At the Sanctuary, out of 130 banded birds (five not color-banded)

in three winters, none were known to have crossed between two stations nine-tenths of a mile apart (except in a homing experiment). In exceptional circumstances, to be mentioned below, a few travelled between stations three-fourths of a mile apart. Chickadees came in to the cottage only occasionally and irregularly from woodland stations about one-half mile away, but frequently and more or less regularly from stands a quarter of a mile or less out, thus giving an average territorial diameter of less than half a mile. This is in keeping with Butts' fairly extensive studies on the spacing of feeding stations.

Exceptions occurred during the third winter. The weather was unprecedentedly severe, and chickadees, reduced to nearly half the number present the first winter, apparently had wider cruising radii than in the previous years. Several birds crossed repeatedly between St. Francis Spring and the cottage (three-fourths of a mile) whereas none had been known to do so in mid-winter before. Whether the thinness of the population permitted larger ranges or whether the severity of the winter caused woodland birds to venture repeatedly into better feeding grounds at the cottage is uncertain, but at least the birds exhibited greater mobility in foraging operations.

Individual differences also play a significant role in distances traversed. In a given flock certain individuals are mobile, wide-ranging birds, others less so, with an occasional individual extremely stationary. No. 64, obviously belonging with the Beaver Pond group, was often found astray from his less mobile companions whom he regularly rejoined after solitary excursions afar. No. 63, of another flock, was the opposite extreme. His disappearance in January of the first winter caused him to be set down as dead until rediscovered the following year in a territory less than a quarter of a mile from the cottage. Subsequent check-up revealed that he was a singularly stationary member of a flock whose other members quite regularly included the cottage feeders in their daily cruises, but during three winters of residence No. 63 was seen at the buildings only once after his disappearance that first January. His sole appearance was in March, a time when chickadees are more inclined to wander than in mid-winter.

Information on cruising limits and winter ranges is of importance to feeding station operators who wish to attract birds. Many a well-meaning stand has gone unpatronized because of failure to consider the restricted ranges of chickadees and their associates, and the fact that the station must be in a place fulfilling at least in part the requirements of a winter home. Chickadees, essentially woodland birds even in winter, can rarely be baited out of their chosen habitat unless there are suitable avenues of approach to and from nearby wooded sections, or, as often happens in the case of

well-planted gardens and estates, there is sufficient vegetative cover at the station to meet their winter territorial requirements. Winter resident Tree Sparrows, Blue Jays, and probably woodpeckers have greater cruising radii than do chickadees, but apparently White-breasted Nuthatches do not.

The abundance of chickadees at the Sanctuary cottage grounds, where 20–40 or more different individuals daily visit the stands, may at first glance seem incompatible with the usual restrictions in the size of a flock and its range. The explanation seems to lie in slightly overlapping territories of a number of ordinary-sized flocks which more or less regularly include the cottage stands in their excursions for food. A few, perhaps a half dozen or more, are virtually star-boarders, living about the feeders from morning till night. These are believed to occupy the immediate precincts of the buildings as their winter territory. The bulk of the visitors, however, appear less frequently, perhaps for a little while in the morning and again in the afternoon. These are assumed, and in some cases known, to have their headquarters at a little distance, merely coming in a few times daily for extra rations. Still other chickadees, a dozen or so, appear either very irregularly or rarely, in some cases as rarely as a few times all winter. These apparently have a double explanation, first some birds from distant flocks whose main stamping grounds are too remote to take in the cottage feeders regularly, second the more sedentary members of near-by flocks who are "stay-at-homes," like No. 63, and do not accompany their companions on all their foraging expeditions. Then in addition to these resident types a few unbanded wanderers may appear from time to time during the winter, sometimes in the form of a pronounced February influx.

It may be seen from the foregoing data relating to winter flocks and their territory that both the flock and the range are remarkably stable. The same individuals are to be found in the same limited area day after day and in so far as survival permits, winter after winter. Only in rare instances have individuals been observed to change in winter from one flock to another or from one range to another, and if deliberately moved from their territory and associates, as shown by a few homing experiments, they will return.

The few homing experiments conducted fulfill the expectation that chickadees are sufficiently attached to their home and associates to return from short distances. In January, 1938, three birds were taken from the Sanctuary to a village station two miles distant and liberated among other chickadees. One of the three was back the following day; the second returned a week later (a violent storm in the interim may or may not have had some bearing on his delay in returning). The third was never seen again at either place and is believed to have been lost from injuries suffered in transportation

(he escaped from his cage and was noted to have a bulging bloodshot eye when released from the car). The following year a winter resident bird was taken to another part of the Sanctuary, to a station from which other chickadees had not been known to cross to the cottage grounds (nine-tenths of a mile). The bird quickly disappeared on release and was back at the cottage when I returned a few hours later. More experiments are needed to confirm these initial results.

Long-range homing experiments have been carried out with other winter birds with rather inconclusive results. A Golden-crowned Sparrow has been known to return to its winter territory at Berkeley, California, in 17 days from a distance of 84 miles (Sumner, 1936), and a Gambel's Sparrow from a distance of 34 miles (Nice, 1936), but most of the individuals in the experiment were lost. Wholesale transportations have been made with birds from winter roosts in Germany, with very variable results (Nice, 1936). With chickadees, if not with other birds, homing trials need to be carefully controlled to give satisfactory results. Moving chickadees too early or too late in the winter when they are apt to be "unsettled," or using individuals whose territorial status is unknown, might prove relatively valueless. Only the selection of individuals established on a winter territory could be expected to demonstrate a homing capacity or lack of it.

SEASONAL MOVEMENTS AND MIGRATION

On the controversial question of migration there have long been two schools of thought,—those who maintain that the species is strictly non-migratory with winter concentrations due entirely to local birds moving in to the vicinity of dwellings from the surrounding woods, and those who feel the species is partially or irregularly migratory. Supporting the former view are three convincing lines of evidence: (1) There are many and indubitable records of banded individuals and pairs remaining throughout the year in a given locality. (2) Of the several thousand return records for chickadees nearly all have been taken at, and only at, the original banding stations. (3) Chickadees are present in winter near the northern boundaries of their breeding range, often in considerable abundance as is well illustrated by nearly 40 years of Bird-Lore's Christmas Censuses.

On the other hand there is even stronger evidence of migratory movements among chickadees. In the first place there are a few significant banding recoveries, which appear not to be well publicized. Perhaps the most striking is of a bird banded at Amherst, Massachusetts, October 7, 1932 by Mrs. Cutler and caught by a Persian kitten at Belvidere, New Jersey, on December 24 of the same year, some 200 miles southwest of the original banding station

(Cutler, 1933). Hammerstrom (unpublished) mentions a recovery in Wisconsin from over 50 miles, the information received by her in a letter. Lincoln, in a letter to Taverner, discloses that in the banding files at Washington there are six chickadee returns which can be regarded as long-range (Taverner, 1940). It should also be pointed out, in accounting for the paucity of migrational returns, that banding of this species is done almost entirely with winter resident birds at feeding stations. Migrating flocks pass by earlier in the fall and later in the spring, out in the woods and out of the reach of banders.

Records of apparently migrating flocks are not uncommon. Van Tyne (1928) records a compact flock of 50 chickadees taking off from Sand Point, a strategic flyway jutting out into Lake Huron. The flock restlessly worked its way through saplings up to the water's edge and after several false starts finally left the mainland, across miles of open water, toward Charity Islands in the distance. Magee, at Saulte St. Marie, Michigan, reports frequent flocks of 50 to over 100 chickadees in September and October, apparently crossing the St. Mary's River from Canada, congregating on telephone wires in the manner of many migrating birds, and eventually disappearing southward (Butts, 1931). Data at Point Pelee, Ontario, by Taverner and Swales (1908), at least suggest marked spring and fall movements through that region. Bowdish (1938) records a spring movement of chickadees at Demarest, New Jersey, in March 1938, when sixteen newcomers replaced the winter residents that had been repeating at his station all winter. Bagg and Eliot (1937) concluded that a flock of chickadees encountered at Northampton, Massachusetts, on May 9, 1933, at a time when the local birds were all paired, were late-nesting northerners journeying poleward. The spring and fall flocks of this sort occasionally seen at the Sanctuary usually consist of unbanded birds, whereas the resident flocks are chiefly banded old-timers.

There is some evidence of a partial withdrawal from northern regions during certain winters. At Ottawa, in 1934, eight parties of Christmas Census observers comprising 21 people combed the woods and fields from dawn until dark and found only 5 chickadees, whereas during the five preceding years fewer observers had seen more than a hundred each year. Other Canadian stations sent in unusually low figures that year, but totals for New England stations ran slightly higher than usual (Bird-Lore, 1935). Years of scarcity in northern regions, though perhaps cyclic or merely fluctuating with productivity, may simply mean a movement of part of the population out of the region. Bain (1885) thinks that chickadees are less abundant in mid-winter on Prince Edward Island.

Along the southern boundaries of the chickadee's range there is often a pronounced winter influx. Regional reports in Bird-Lore

as well as Christmas Census records indicate its partial or complete absence during many winters, its relative abundance during others. In the winter of 1913-14 there was an overflow of black-caps into Chevy Chase, Maryland, where the Carolina Chickadee is usually the predominant form (Mellot, 1914). Stone (1900) lists it as a winter visitant near Philadelphia, not a permanent resident. Rogers (in a verbal communication) gives the Raritan River in New Jersey as the dividing line between their breeding range and their winter range, breeding only north of the river, wintering south of it, a line of demarcation also recorded by Stone (1908). Monson (1934) gives *atricapillus* as a common winter visitant in northeastern North Dakota, the winter influx taking place in late August and September, the departure in March and early April. Rarely a few breed along the Red and Sheyenne Rivers.

Even more striking are the marked winter fluctuations within the breeding range that can be most logically accounted for by irregular flights, presumably largely from the north. In the fall of 1878 Berrier (1881) noted that great hosts visited Hamilton, Long Island, but the following winter not one was seen. Ten years later Crolius reported their unusual abundance in Central Park (Crolius, 1899). The Bird-Lore's Christmas Census work began, indicating Central Park as a zero station until the great influx of 1904, an influx also recorded by Dwight (1904) in a paper read to the Linnaean Society in which he called attention to the invasion of the city by chickadees. Similar seasonal fluctuations, some little short of phenomenal, have been reported for other regions: in Ohio by Lynds Jones (1915), in the Waukegan region of Illinois by Lyon (1924), in New Hampshire by Whittle (1938) and White (1932), in New Jersey by Rogers (1915, 1916) and Bowdish (1938). Even Block Island, off the Rhode Island coast, gets its occasional winter visitation of wandering chickadees. How much these fluctuations are due to the varying survival rate of essentially local birds and how much to extended seasonal movements is uncertain, but that there must be considerable long-distance wandering seems indubitable.

The chickadees banded at the Sanctuary during this investigation are divisible into four status groups on the basis of their seasonal occurrence. Some are permanent residents, remaining on the grounds throughout the year. Equaling or exceeding them in numbers are the winter residents that arrive chiefly in late November and December, a month or more after the permanent residents appear at the feeders, and depart in March and early April, before the permanent residents cease to patronize the stands. The bulk of the chickadee population is apparently composed of these two groups, which comprise 80% or more.

The two minor groups are the summer residents, indicated by the

presence of a few unbanded birds in a breeding season following a winter of intensive banding, and the transients. The transients are probably more numerous than banding records reveal, since they may pass through quickly and unobserved, without visiting the feeding and banding stations. However, of seven birds that disappeared shortly after banding in November and early December in 1937, five were retaken in March, along with six new unbanded birds. The unbanded birds were promptly trapped and marked, but soon disappeared. Though this experience of March returns of November-banded birds was not repeated in the two succeeding winters, there is always a heavier loss of November-banded birds than can be logically accounted for by mortality. Winter populations are relatively stable, with only occasional losses, but in November and early December the disappearances are disproportionately high, theoretically, at least, due to wandering individuals that pass on to other regions.

Three of these status groups, then, exhibit some seasonal movement, only the permanent residents being strictly sedentary. The probability is, however, that each of the non-sedentary groups include some birds that are essentially of local origin or that eventually become non-migratory. The winter residents include some, perhaps many, shifting from breeding grounds not far beyond the Sanctuary limits. Some of the summer residents, though absent their first winter, presumably remain as winter residents after their first breeding season. And of the five above-mentioned, March-returning transients three became winter residents the second year, status changes that lend evidence to the belief that wandering or migratory young birds become more sedentary with age.

An interesting parallel in connection with these status groups is furnished by studies of color-banded Blue Tits (*Parus coeruleus*) in Europe where Kenrick (1940) finds four similar seasonal classes. Three-eighths of the population, Kenrick says, is resident, one-eighth summer resident, one-fourth winter resident and one-fourth transient. Except for the smaller winter resident group these compare closely with the chickadee classes outlined above; but the Blue Tit groupings appear to have been worked out with greater mathematical exactness.

Interesting by way of comparison also are the results of other color-ringing experiments with European titmice, disclosing by banding proof a situation which may well exist in the case of chickadees. Both the Great Tit (*Parus major*) and the Blue Tit (*Parus coeruleus*) are essentially, although not without exception, sedentary as adults, but the young wander widely, birds banded as nestlings having been taken from 40 up to a maximum of 812 miles from the nesting site. (Of three nestlings banded in Poland one was killed the following December in France 1300 kilometers southwest,

another was found in February 825 kilometers to the northeast, and a third was found nesting 165 kilometers northeast of its birthplace. —Nice, 1938. In Switzerland a Great Tit banded as a juvenile in 1927 was taken 40 miles west on October 30, 1930; an adult banded May 12, 1929, was found in December, 1930 two hundred miles south; and a juvenile Blue Tit banded in May, 1930 was taken 250 miles soutwest the following autumn.—Nice, 1933. Bährmann, contrary to some, in agreement with others, thinks that artificial feeding is making permanent residents out of normally migratory titmice (Nice, 1937), but of course this conclusion might be reached by observing birds that were naturally migratory as young, becoming sedentary as adults.

From the foregoing data relating to seasonal movements it is apparent that the Black-capped Chickadee is neither strictly sedentary, as has often been maintained, nor is it regularly migratory. Adult birds, mated and established on a territory are often essentially sedentary, but young birds, obviously not remaining with their parents in family groups their first winter, wander widely, and on occasions, perhaps in years of high productivity and consequent population pressure, may, like the classic lemmings, undertake considerable migration. Clearly a very intricate situation exists in regard to the chickadee's migratory behavior, a situation which requires much more study and experiment before final conclusions are reached.

LONGEVITY AND MORTALITY

The comparative ease with which chickadees can be trapped and banded and the high percentage of return records make longevity and mortality studies of the species particularly practicable. Of chief interest in connection with longevity is F 17028, banded at the Sanctuary by Maurice Broun on January 21, 1931 and reappearing in the winter, probably yearly, through the winter of 1938–39 (last observation April 22, 1939). His failure to return in the fall of 1939 in all probability indicates his death during the preceding summer at which time he would have been at least nine years old. His nearest competitor is another Sanctuary bird banded December 14, 1931, by Seward Donaldson. A winter resident during the course of this study, this chickadee ceased to come to the feeders in February, 1940, at which time he would have been at least 8½ years of age. Though his disappearance is most logically due to death, the more rapid than usual drop-off in the number of chickadees at about that time suggests the possibility of a mid-winter movement away from the Sanctuary.[1]

[1] Neither the 8½-year-old bird nor any of those disappearing in mid-winter returned in 1940–41.

Cooke (1937) summarizing records in the files of the Biological Survey gives dates for thirteen birds varying in age from five to a maximum of seven and one-half years, including the age records published by Harding (1932) and Baldwin (1935a). Five of these records are in the 5-year class, five in the 6-year class, and the remaining three in the 7-year class. Bagg and Eliot (1937) mention a seven and one-half year record, a bird banded by Harry Woods at Chester, Massachusetts, February 11, 1925 and retaken November 22, 1931, which seems not to be included in the above records, although reference was made to two other birds banded by Woods. Since published reports lag so far behind actual records it is not unlikely that other valuable age records are not yet on file. These data indicate the chickadee to be a relatively short-lived bird, for of more than 3500 return records for this species, many of which have been observed at feeding stands winter after winter, only 16 exceed five years of age, and only the two Sanctuary birds mentioned above are here known, from banding records, to have passed the eight-year mark, and only one to have approached the ripe old age of nine years.

It has long been assumed that the hazards of winter take a heavy toll of insectivorous birds in northern regions, a theory supported not only by circumstantial evidence but by the fact that such birds lay large clutches of eggs. Chickadees commonly lay 6–8 eggs, sometimes as many as ten, and often raise a second brood—ostensibly a safe-guard in the maintenance of a species kept down by high mortality. Nevertheless, carefully kept records of color-banded individuals at the Sanctuary indicate that losses during the winter of 1937–1938 were relatively small. Of 63 wintering chickadees one is known to have come to grief by faulty operation of a banding trap and another was lost in a homing experiment—not natural losses. Six others were unaccounted for at the time of spring dispersal (one was never seen after color-banding on December 17, two others disappeared in the final days of the month, one dropped out in January, and two more in February). Most, if not all, of these losses are attributable to death, though other explanations are conceivable. These figures, then, indicate less (possibly considerably less) than a 10% loss from natural causes. Careful check was made on the chickadee population after heavy snows, ice-storms (which happened to be frequent in the Berkshires that year), and the few periods of protracted cold, but not a single bird was missing immediately after these climatic crises. Winter's usually heavy decimating factors, if such exist, did not operate severely in 1937–38, or else Sanctuary protection gave chickadees considerable immunity from them.

During the following winter (1938–39), however, losses were heavier. Out of a slightly smaller population (about 55), eleven,

or possibly more, seem to have been lost during the winter, some 20% or roughly double the preceding year's loss. During the winter of 1939–40 the initial population was slightly smaller and subsequent disappearances greater, but the status of many of the individuals was rather questionable, making actual losses impossible to estimate accurately. Five birds disappeared soon after banding in November, followed by two more in the first part of December, losses probably largely attributable to migration rather than death. But others, including some old-timers, continued to drop out all through the winter, their place being filled in mid-winter by newcomers of unknown origin. From January on, the winter of 1940 was one of almost unprecedented severity. Perhaps this condition was responsible for a heavy mortality, but perhaps it also caused a migration of part of the population away from the Sanctuary, just as there was a mid-winter influx of birds from an outside source. If a migratory movement were responsible for any of the disappearances it may be indicated this coming winter (1940–41) with the return of a few of last year's lost birds.

Gratifyingly high returns were secured during the second winter. Out of the 60–70 birds present in late winter (1938) 45 were back the following year, close to 70%. The number of newcomers, however, ostensibly small because of an excessively rainy breeding season in 1938, failed to bring the second winter's population up to that of the first. Returns the third winter were also lower. Out of the 50–60 birds present in late winter (1939), 31 were back in the fall, less than 60%. The number of newcomers, though not as high as the good breeding season of 1939 augured, was slightly higher than the preceding year, but both the new and the old continued to drop off so rapidly that the third winter's population was reduced to nearly half that present the first winter.

Figures for the three-year period point to a rather steady decline from a possible peak in the winter of 1937–38 to a possible low in the winter of 1939–40, although over so short a period there is no knowing when the cycle was at its peak and whether or not it has yet reached the bottom. Conceivably, as a number of writers suggest, chickadees fluctuate in periodic rhythyms of 3 or more year cycles, but in the published cases here examined the evidence supporting the suggestion seems inadequate. Many hours of statistical work with the Christmas Census data in Bird-Lore, even with the help of a mathematically-trained wife, proved little or nothing with regard to cyclic periodicity.

Even in lean years, however, chickadees are relatively abundant, and cyclic drops, if such occur, are apt to go undetected. Their abundance is due to many factors. By reducing migratory flights to a minimum they have eliminated the hazards incident upon such journeys. The perhaps equally hazardous northern winter they

have successfully challenged, first by their omnivorous habit, which adds seeds, fruit, and many miscellaneous items to their normally insectivourous diet, and secondly by their oft-rewarded confidence in man, which has been responsible for many a full stomach in a time of need. Their habit of travelling in loose flocks may give them some immunity to predation as an alarm signal from one would offer timely warning to the others. And lastly their large broods of young, reared in a comparatively safe nesting cavity, zealously cared for by both parents mean no little to the outstanding success of the Black-capped Chickadee in "the fight to live."

A few observations tend to confirm the probability that chickadees by their alertness and quick action often escape predatory dangers. Sutton (1928) in an analysis of 113 stomachs of Pennsylvania Sharp-shinned Hawks found in them remains of only one chickadee, and concluded that, though abundant in the autumn woods from which the sharp-shins were collected, chickadees were seldom caught. Tyler (1912) describes the spectacular escape of a chickadee from a Northern Shrike by its strategic maneuvers in and out of the dense branches of a red cedar. Scott (1938) lists the chickadee among the potential prey of Saw-whet Owls in central Iowa, but found none in 56 pellets. By day the chickadees fed in the outer branches of the owl's roosting tree without arousing more than passing interest from the owl.

Thus it appears that although a comparatively short-lived species, the Black-capped Chickadee is outstandingly successful since by reason of its limited migration, ability to withstand northern winters, resourcefulness in time of danger and its high reproductive capacity, it minimizes many of the hazards that beset other passerine birds.

SUMMARY

1. This account presents the results of a three-year study of color-banded chickadees at Pleasant Valley Bird and Wild Flower Sanctuary in Lenox, Massachusetts, the observations confined largely to the winter months—1937–38, 38–39, 39–40.

2. One hundred twenty-five chickadees were marked during the three winters, each with a different combination or position of red, yellow, green and blue color bands.

3. Some individual characteristics disclosed by color banding are differing degrees of tameness and quarrelsomeness, differing methods and preferences in feeding, and resourcefulness at traps.

4. Winter flocks, consisting of several up to a standard of 6–8 individuals, are remarkably constant in individual composition, the same individuals remaining together day after day through the winter, and, as far as survival permits, winter after winter.

5. The Sanctuary flocks were not made up of family groups in

winter. The young of the year apparently disperse in the early fall and wintering flocks are made up of a nucleus of old-timers returning to a former winter territory, added to gradually by newcomers from various sources.

6. The winter range is established in the fall and retained with only minor changes, and usually without sharp defense, until spring dispersal.

7. Birds on the winter range consist of permanent residents that use approximately the same territory in summer, winter residents which merely shift from nearby summer habitats not suitable for winter use, and wanderers, probably chiefly immature, that eventually join the more sedentary birds.

8. Average cruising limits for chickadees rarely exceed half a mile, often are considerably less, and the territory occupied, though remarkably constant through the winter, apparently varies with the quantity and quality of food and cover, severity of the winter, thinness of population, and individual mobility.

9. Ordinarily chickadees cannot be baited out of their preferred woodland habitat to feeding stations unless there are suitable avenues of approach, or the station simulates woodland conditions to some degree; but good stands maintained over a period of years build up a large patronage by causing an overlap in feeding ranges of all the flocks within a half-mile.

10. A few homing experiments fulfilled the expectation that winter resident chickadees are sufficiently attached to their territory and associates to return from short distances.

11. On the controversial question of migration versus a strictly sedentary species the evidence of (a) known permanent residents, (b) lack of long-distance banding recoveries, and (c) the winter occurrence of chickadees on the northern boundary of their range is cited in support of the non-migratory theory.

12. Evidence even more strongly supporting, if not proving, considerable migration is: (a) the existence of a few long-range banding recoveries (paucity of such recoveries due to migrants going through woods in fall and spring and not visiting feeding and banding stations), (b) the many records in the literature of obviously migrating flocks, (c) probable partial withdrawal from northern borders in certain winters, (d) frequent extensions in winter beyond the normal summer boundaries, (e) pronounced winter fluctuations, often little short of phenomenal, within the breeding range, and (f) the four seasonal status groups worked out at the Sanctuary—permanent residents, winter residents, summer residents, and spring and fall transients.

13. Comparisons are made with the similar situation among closely related European titmice and further investigations urged in order to reach more definite conclusions.

14. Sixteen longevity records of more than five years are cited, the oldest a Sanctuary bird that attained nine years of age, the next oldest another Sanctuary bird of at least eight and half years.

15. Chickadees during the first winter of study showed less than a 10% mortality, but this loss was approximately doubled during the second winter, and in the third winter was complicated by other factors so that the actual loss could not be accurately determined.

16. Approximately 70% of the banded birds surviving the first winter returned the second winter (45 out of a possible 60–70), but the return percentage the third winter decreased to less than 60% (31 out of a possible 50–60).

17. Additional dropping off in the third winter, part of which was possibly due to mid-winter migration because of the unprecedented severity of the season, reduced the population to nearly half that present at the beginning of the study—a steady decline over a three year period from a peak in the winter of 1937–38 to a low in the winter of 1939–40.

18. Chickadees may fluctuate in three or more year cycles, but the evidence supporting it in this or in other studies seems far from adequate.

19. Chickadees' abundance over a wide range is due to reducing migration to a minimum, omnivorous habit and adaptability in winter, high reproductive capacity, and alertness in escaping predatory dangers.

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