INTEGRATING MECHANISMS OF WINTER FLOCKS OF JUNCOS

By WINIFRED S. SABINE

In two earlier papers (Sabine, Physiol. Zool., 22, 1949:64–85; Condor, 57, 1955: 88–111) observations have been reported which suggest that the social activities in winter of the Slate-colored Junco (*Junco hyemalis*) and of the Oregon Junco (*Junco oreganus*), when studied by means of marked individuals, involve an orderly but rather complex type of flocking. The significant point is that although the migrant individuals which are to become winter residents arrive irregularly over a period of several weeks, they somehow manage to form themselves into distinct, stable winter flocks with mutually exclusive foraging territories. It is the intent of this paper to indicate the mechanisms which appear to bring about this result.

Materials and methods have been described in the papers cited. Wild, free-living birds, conspicuously marked for individual identification, were used in these studies. Two marked flocks of Slate-colored Juncos were observed by attracting them to a feeding station in Ithaca, New York. One marked flock of Oregon Juncos was studied at Deep Springs, California, and another at Seattle, Washington. A third marked flock of Slate-colored Juncos was observed in Ithaca in 1953. The results of this last study (unpublished) were corroborative of those obtained in the four preceding studies. In all instances the feeding stations were observed from an indoor post.

These five runs of observations were made on two species, and one of these doubtless included two races. The behavior patterns consistently displayed in flocking were, however, in all five flocks so closely in agreement as to be indistinguishable. This does not mean that each run of observations included all the data. On the contrary, new facts were constantly presented as conditions varied. Circumstances limited the number of times that the following important phenomena could be observed. (1) The build-up of the winter flock from the beginning of the fall migration was observed only at Deep Springs; the Seattle work was started in December. In Ithaca, for some reason not understood, the fall migrants do not visit the feeding station, although the spring migrants do so. The first juncos to appear there in November or December are already in an organized flock. (2) The behavior of the banded adults surviving from the flock of the year before was observed in Ithaca. There was no opportunity to study flocks of *Junco oreganus* in the same place for two successive years. In view of the similarity of the flocking patterns in five flocks, it is assumed that the patterns involved in the early development of the flocks and in the role of the experienced adult also are similar.

The junco flock is an association of birds which is firm in the identity of the individuals associated. It is therefore a socially segregated group. It is also spatially segregated. In a given small area a single group will be seen and no other. The formation of firm associations and the occupation of definite foraging areas take place at once among the earliest arrivals; it becomes obvious as soon as the first migrants are marked. The late comers are integrated into existing groups. The flock thus formed does not fly about as a unit, however. There appears to be no limit to the size of a foraging group. It may include the whole flock or it may consist of a single bird. The entire flocking procedure is marked by the continual forming and dissolving of groups of unpredictable size consisting of individuals that consort together and are daily visitors at the feeding sites.

It is especially to be noted that each bird shows its ability to fly about or perch, forage, and rest in solitude. This is an enlightening modification of the tendency to join fellow members, because it indicates that each bird has an independent knowledge of the limited environment it frequents.

In seeking the mechanisms on which this pattern of mutually exclusive flocking territories depends, there are certain possibilities that may be ruled out. (1) Since solitary foraging is observably not uncommon, there can be no leadership. Each individual knows independently the foraging territory of the flock. (2) Members of different flocks show no hostility to one another such as might produce a barrier between flocks. Although members of a flock keep to their feeding areas on the whole, this tendency does not rigidly control behavior. Individuals, usually alone, sometimes visit other flocks. During a long period of heavy snow in Seattle, birds not belonging to the occupant flock frequently visited the feeding station and were marked; they disappeared when the snow thawed (Sabine, 1955, *op. cit.*). In this interflock visiting, intruders did not meet with hostility on the part of members of the occupant flock; the latter were not even consistently dominant to the intruders. In fact, the intruders had a normal stability of rank in the pecking order. These two possibilities being excluded, it appears that the mechanisms which keep the flock together must be sought in forms of individual behavior operating uniformly within the flock. Such behavior arises, of course, from the environmental, social, and internal stimuli to which the birds respond.

The most obvious among these are the environmental stimuli which attract the juncos to their characteristic habitat—to localities under or near trees, to "edge" situations or open wooded areas.

Almost equally obvious are the responses to social stimuli. Clearly the junco is attracted by fellow members of the species and spends most of its time with its fellows. Two comments, however, must be made concerning the social responses of the species.

It has been noted that occasionally the social attraction lapses, and an individual forages and rests in solitude. In such cases it may be presumed that stimuli to which the bird responds in maintaining vital activities such as eating, resting, or exercising are temporarily in conflict with social stimuli and lead it either to leave its group or to remain behind when the latter departs. It is possible also that another drive is sometimes operative in the solitary junco. Such a bird has been observed many times to eat more slowly and in a relaxed posture, sitting back on its "heels," but it straightens up, eats faster, and hops in the normal restless manner when companions arrive. There may be an internal drive to be alone.

The stable winter flock is composed of birds which recognize each other at the distances maintained in foraging together. This conclusion rests on observations designed to force the birds to approach each other closely enough to stimulate pecking and thus show their rank in the pecking order. Food was offered exclusively on small trays (1 foot square or 1 by 1.5 feet). An incoming junco usually perched on the brush-pile and looked down at the line of trays. It was notable that the bird could withhold an immediate feeding reaction while it hopped along the brush surveying the situation. If the incoming bird was subordinate to all but one of the birds occupying trays, its reaction was predictable: it would go to the tray occupied by its subordinate. This predictable response to a complex stimulus-situation can be explained only on the supposition that the incoming bird recognized all of the individuals on the trays. Are the birds able, however, to recognize each other as individuals, visually or by call-notes, at longer range? If so, is a familiar group a more powerful social stimulus than a strange one? If these questions could be answered affirmatively, the capacity to recognize individuals would be one of the integrating mechanisms of the flock. Unfortunately there are no observations bearing on such a discriminatory response. The suggestion that it exists is merely a somewhat plausible speculation.

Among responses to internal stimuli, the exploratory drive of the junco shows two aspects that seem to be especially relevant to their flocking behavior. First, their feeding

is selective in the sense that they return repeatedly to certain spots. Within a day after being marked, at Deep Springs, recent migrant arrivals which later proved to be members of the stable winter flock were observed to be making repeated visits to the feeding station, and also to three natural unbaited sites. It is no doubt true that through trial and error learning they selected spots where an abundance of food reinforced the original stimuli; this was evidently true at the feeding station. However, in the case of the unbaited sites it can hardly be supposed that there were not unvisited spots "just as good" as those selected. Second, the feeding spots selected fell into a relatively limited foraging area or circuit; the sites known were not more than 200 or 300 yards apart. The flock was regularly observed only within this foraging circuit; the birds showed no tendency to range at random over large areas of the ranch. This flocking pattern suggests that the junco tends to develop routines and to move in an environment within which it has familiarized itself. Such a drive would be an important factor in shaping the flocking behavior.

This characteristic behavior of the junco was thrown into relief by the contrasting behavior of 12 House Finches (*Carpodacus mexicanus*) marked at the same time and place. Several of these were never seen again. Some were seen in parts of the ranch farther from the feeding station than any of the junco sites. One visited the station once in mid-winter, and one visited the station regularly throughout the entire winter, coming as often as the juncos and frequently with them, and continuing in the spring after the juncos departed.

It is obvious that the integrating mechanisms described above—attraction to a special kind of habitat, social attraction to their own species, and a tendency to routinized circuits—though indispensable to explaining the pattern of junco flocking, are still not sufficient to explain the distinctive feature of that pattern. This, as has been noted, is the two-fold fact that each individual junco can and does forage alone over the flock's circuit and that all the members of the flock forage over the same limited circuit and in the same feeding spots. Evidently an additional factor is needed to explain the segregation shown by the flock, and there is some evidence to indicate that this factor is the presence in a winter flock of a percentage of migrants which have survived from the previous year. Such adult homing birds, there is reason to suppose, start at once to visit areas familiar to them. Unfortunately the writer was not able either at Deep Springs or in Seattle, to observe flocks of Oregon Juncos in two successive years. The data which suggest that the behavior of the homing adult is a critical factor in enabling a population to become segregated into flocks are based on studies of the Slate-colored Junco.

At Ithaca, when there had been no feeding station the preceding year, the juncos first appeared as a flock in the edge of the woods during snow storms: that is, when the station had not been operated in previous years and there were therefore no banded homing birds familiar with the station, the flock was late. This occurred three times, in 1946, 1951, and 1953. In the fall of 1947, 1954, and 1955, when the feeding station had been operated in the preceding years, banded adults returned. Three characteristics distinguished their behavior. (1) Each year these banded birds appeared with the first group of juncos that arrived at the feeding station. In one instance a banded bird alone was the first junco seen. (2) The dates of their first appearance were earlier than the date for the appearance of junco flocks in years when the feeding station was not operated the preceding year. The banded individuals appeared in two instances in mid-November and in the third on December 3 and 4, whereas in other years the junco flock appeared in late December. (3) The feeding station in Ithaca is open lawn and needs large heaps of brush and evergreens for perching places and cover in order to attract juncos from the "edge" situation about fifty feet away. The banded birds came to the

site, however, even though it had not been thus equipped and would not normally attract a junco. In one instance, in 1947, even before food was provided at the station, three banded birds (from a flock of 14 in 1946) repeatedly visited the site, sometimes accompanied by a small number of unbanded birds. In 1954, although food was provided, there was no dense cover. Yet at least three banded adults (out of a flock of nine from the preceding winter) and an unknown number of unbanded birds used the station for the entire winter. No birds were banded in 1954, but at least two banded birds appeared in 1955 which must have survived from the banding of 1953. At their first appearance, food was provided but no cover or brush, and so long as this condition continued not more than four birds were seen at one time, and these invariably included two banded individuals. As soon as a brush heap was installed, the flock increased immediately to at least 16. When three small red pine trees were added for dense cover, the flock increased at once to more than 30. The promptness of this developmnt was probably aided by a snow storm.

The influence of the old birds on the inexperienced birds of the year does not need any particular explanation. The old birds go about their routes with the firmness that seems to attach to familiarization. The young birds, already endowed with tendencies to restrict their movements and to select and frequent definite areas and to join fellow members, have only to follow the old birds in order to develop the familiarity they seek. There are evidences that at the beginning of a season this process does not instantly work out to perfection. In the group of birds marked earliest at Deep Springs there was occasional absenteeism from the feeding station which did not occur later, and in the case of one bird about two weeks elapsed between the time when it was marked and the time when it became a regular member of the flock (Sabine, 1955, *op. cit.*). It seems that, granted the presence of a few homing adults, the operation of ordinary responses observed to be common to the species is sufficient to explain how all individuals come to frequent the same foraging territory and thus create the segregated flock.

Since the winter flocking pattern is a controlling influence in the activities of the winter resident juncos, its possible biological value might be conjectured. There seem to be two functions which could run concurrently. First, it seems most obviously to be a spacing device which tends to distribute the population over the available suitable territory. Second, it suggests that a definite, well-experienced homing goal must be developed in the individual birds, analogous to the breeding territory with the nest, in order to focus the migratory flights. It seems possible that the young junco, flying over a varied land topography, is able in one experience to acquire a photographically correct picture of its flight, which is useful in reverse the following spring. However, it would appear that both homing goals require the attractiveness of limited familiar territory to control the flight. The long activities of the breeding season provide this familiarity for the spring migration and the organization of the winter flock for the fall migration.

Ithaca, New York, February 15, 1956.