SEASONAL CHANGES IN FLOCKING BEHAVIOR OF STARLINGS AS CORRELATED WITH GONADAL DEVELOPMENT

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This paper presents data on the seasonal variation in population and flocking behavior in Starlings (*Sturnus vulgaris*) as correlated with gonadal changes. Most research of Starlings has considered specifically the breeding biology (Kliujver, 1933; Marples, 1936; Bullough, 1942; Kessel, 1957; and Collins and deVos, 1966) or the aggregations of Starlings (Wynne-Edwards, 1929; Brown, 1946; Davis, 1955; and Jumber, 1956) with little attention focused on the relationship between the two. With the aid of four weekly census routes to determine the extent of seasonal variation in Starling population and flocking behavior, the relation between the flocking behavior of Starlings and the reproductive cycle is presented.

MATERIALS AND METHODS

Most data were collected in McDonough County, Illinois between 27 June 1965, and 25 June 1966, from four, 25-mile census routes designed to include the four predominant ecological-land use patterns in west-central Illinois. One census route was located such that over 90 per cent of the land adjacent to the road was intensively farmed; the predominant soil type was dark silt loam. A second route was located where 39 per cent of the land was under cultivation while the remainder was composed of oak-hickory forest or woodlots and bluegrass pastures situated on a silty clay loam soil. The other two routes represented situations intermediate to that for the two routes described above. Each route was covered once a week by automobile driven at 25 miles per hour beginning 30 minutes after sunrise. Censuses included only those Starlings located within a 100 yard radius of the car. If possible, censuses were not taken on days when visibility was poor or when it was raining at the starting time as these conditions usually caused counts to be lower than on clear days at the same time of year. Starlings observed along the routes were recorded as to number, activity, adjacent cover, relationship to farm complexes and location on the transect. Starlings were recorded as perching if sitting above ground level and not engaged in feeding activity. Any Starling sitting on the ground was recorded as feeding. Flying was the third type of general activity recorded. Weather conditions at the time of each observation also were recorded. Supplementary data were obtained from 28 morning and 55 evening observations of Starling activity at communal roosts in the Macomb, Illinois area between 10 July 1965, and 28 October 1965, and by random observations of Starlings throughout the study.

RESULTS AND DISCUSSION

Annual Changes in Population Levels.—As reported by many workers (Marples, 1936; McAtee, 1940; Ball, 1945; and Kessel, 1957) recently fledged Starlings occur in flocks varying in size from five to over 300 birds

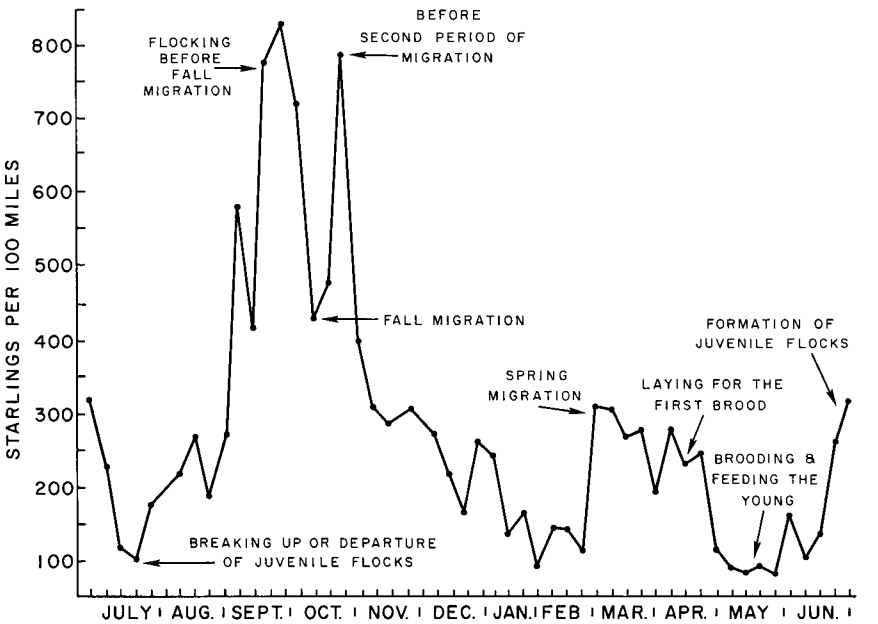

FIG. 1. The numbers of Starlings observed per 100 miles on four, 25-mile census routes each of which was driven once a week from 27 June 1965, through 25 June 1966, McDonough County, Illinois.

throughout June. During late June formation of juvenile flocks caused the census counts to increase from 150 birds to over 300 birds per 100 miles (Fig. 1). However, from 3 July through 24 July few Starling flocks, adult or juvenile, were observed and counts along the census routes declined to about 100 birds per 100 miles—one of the lowest levels of the study (Fig. 1).

There are few data in the literature concerning observations of Starlings during July which I interpreted as reflecting this low level of Starling activity in July. Random observations of Starling flocks by the author during July and August, 1967, and June and July, 1968, near Madison, Wisconsin further supported the hypothesis that Starling activity is at one of the lowest levels of the year in July. A possible explanation for this low population density and low level of activity in July is that the young birds migrate northward from the general area where they were fledged. Niethammer (1937) reported such movements in Switzerland where young Starlings migrated to the vicinity of the North Sea soon after the juvenile flocks formed. An alternative hypothesis is that the low numbers observed in July are a mani-

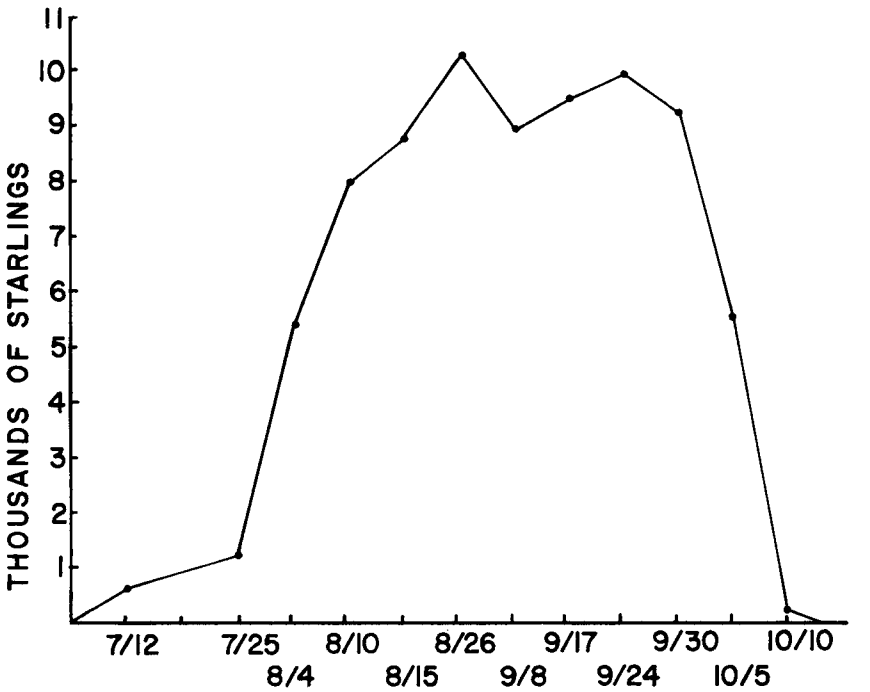

FIG. 2. Numbers of Starlings observed at communal roosts near Macomb, Illinois, during the period 12 July 1965, through 10 October 1965.

festation of the initial stages of summer molt. According to Kessel (1957) the postjuvenal molt of Starlings begins four to six weeks after the young birds have been fledged. Therefore, in Holland (Kluijver, 1933), New York (Kessel, 1957), Ontario (Collins and deVos, 1966), as well as Illinois (Davis, 1966) the postjuvenal molt for the first brood would begin in the early part of July, the period corresponding with the observed decrease in numbers seen during July in Illinois and Wisconsin (Fig. 1). Presumably while molting Starlings are less active and so are less conspicuous to the observer, and their behavior might be of a more secretive nature during this time.

Following these periods of low populations Starling numbers recorded increased gradually and by 21 August a level of 275 birds per 100 miles was recorded (Fig. 1). After 21 August the numbers increased rapidly to about 800 birds per 100 miles and remained at that level from 20 September through 9 October (Fig. 1). During August and September in the Macomb area the number of communally roosting Starlings also increased rapidly to the highest level recorded for the study. By late August numerous small flocks using

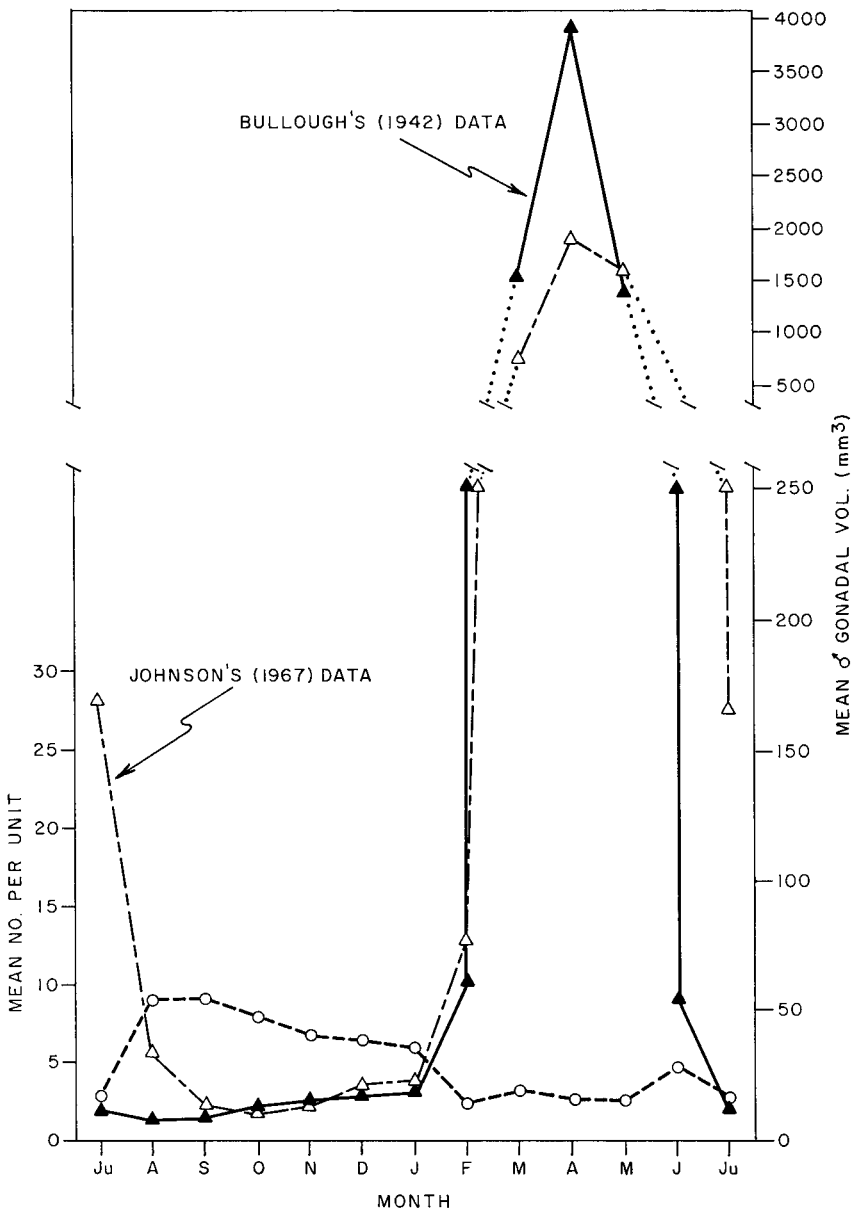

FIG. 3. The average Starling flock size, by monthly periods, observed on four 25-mile census routes each of which was driven once a week from 27 June 1965, through 25 June 1966, in McDonough County, Illinois in relation to average monthly volume of Starling testes as adopted from Bullough (1942) and Johnson (1967).

temporary roosts had consolidated into one large flock using a single communal roost (Fig. 2). The tendency of Starlings to aggregate was noticeable in the census counts, for as the population increased through August the number of individual flocks observed decreased from 45 per 100 miles (25 July through 31 July) to 27 per 100 miles (15 August through 21 August). This late summer change in flocking behavior is reflected more dramatically in the average flock size which was two and one-half birds in July while in August, the average flock size had increased to over eight birds per flock (Fig. 3).

From these results it would appear that the southward migration of the northern adult Starling populations began as soon as August flocking occurred. Bullough (1942) after completing a study on the reproductive cycles of British and Continental Starlings concluded that sex hormones in the blood inhibited fall migration (Fig. 3). He believed that as the gonads decreased in size, reaching their smallest size in July and August, the amount of sex hormone released into the blood decreases and the birds are induced to migrate southward. Once Starlings begin southward migration they are thought to travel slowly and leisurely along definite routes.

A few banding returns from west-central Illinois suggest that Starlings migrate into and out of west-central Illinois by two different routes; one to the northeast along the Illinois River and along either side of Lake Michigan and the other along the Mississippi River (C. Martin, unpubl. data). The west-central Illinois study area is situated midway between these two flyways and so, the period of maximum population density, 20 September through 9 October (Fig. 1), probably represents the convergence of migrating Starlings from these two migration paths. These migrating birds appear to remain in the west-central Illinois area through September as a settled population feeding throughout the day in large flocks in hog and cattle pastures, and roosting communally at night.

This period of high population density, 20 September through 9 October, was followed by a sudden decrease in the Starling population to about 400 birds per 100 miles of census route, which in turn was followed by a marked increase to about 800 Starlings per 100 miles during the week of 18 October through 24 October (Fig. 1). The following week of 25 October through 31 October, the Starling population again returned to a level of 400 birds per 100 miles. Throughout this entire period, 10 October through 31 October, no large feeding flocks or communally roosting Starlings were observed in the Macomb area (Fig. 2).

The sudden decrease in population which occurred during the week 10 October through 17 October is thought to be the result of most of the adult population migrating southward from the west-central Illinois area because

of food shortage and cooler fall temperatures. A possible explanation for the second peak in population density during the period 18 October through 24 October is that young Starlings were migrating through the area after the adults already had migrated. As stated previously, Niethammer (1937) reported northward movement by juvenile Starlings after fledging. Because of this summer movement northward, he suggested that young birds would migrate south later than the adults. This hypothesis is further supported by the observations in Illinois that during this second period of high population density no communal roosts were found in the west-central Illinois area and flying Starlings constituted a larger proportion of the censused population than at any other time of the study (Figs. 1 and 2). The data indicate that these Starlings were passing through the area rather quickly.

During the period November through February, Starlings remaining in the area for the winter were observed roosting only in small groups in natural cavities and buildings and they fed nomadically throughout the day near cattle and hog feedlots or refuse areas. Census counts throughout the winter fluctuated with weather conditions; i.e., severe winds or cold temperatures made the birds less active and thus less conspicuous to the observer resulting in lower census counts (19 December through 25 December and 26 January through 1 February). During the colder part of the winter, 13 December through 26 February census counts dropped 48.1 per cent to slightly over 100 Starlings per 100 miles (Fig. 1).

Part of the observed winter decrease in Starling numbers can be interpreted as winter mortality which according to Kessel (1957) is nearly 25 per cent of the spring population. However, most of the observed decrease in Starling population during the winter is thought to have been the result of "weather movements," i.e., when increasingly cooler temperatures occurred in an area birds migrated to warmer climates and to a more available food supply.

During February the average flock size decreased from over 6.5 birds per flock to near 2.5 birds per flock (Fig. 3). At this time Starlings began showing an interest in potential nest sites as also observed by Kluijver (1933), Marples (1936) and Kessel (1957). During the period 27 February through 6 March, the first signs of additional birds migrating into west-central Illinois were observed as population levels increased from 120 birds per 100 miles to over 300 Starlings per 100 miles of census route (Fig. 1).

These February observations are difficult to interpret. The interest shown by the permanent residents in potential nest sites is believed to be the effect of rapidly increasing gonadal activity preceding the approaching nesting season (Bissonette and Chapnick, 1930 and Bullough, 1942). Bullough (1942) in his study of reproductive cycles of Starlings (Fig. 3) concluded that the

increase in gonadal activity in February caused higher levels of sex hormones in the blood which stimulated the Starlings to migrate in the spring (Fig. 3). Spring migration is accomplished in a different manner than fall migration (Fig. 1). Spring migration in France (Quepat, 1874) and New York (Kessel, 1957) also occurred in the first part of March. Szmirnov (1929–30) reported the rate of spring migration in Finland and South Russia was 32 miles per day. If Starlings migrate in Illinois at the rate of 32 miles a day, it seems probable that Starlings migrate in a less gregarious manner and over a longer period of time in the spring than in the fall since spring migration did not show dramatic increase of Starling population or the large flocks associated with fall migration (Fig. 1).

Through March and April the Starling population in west-central Illinois remained at between 250 and 300 birds per 100 miles of census route, even though Starlings still were migrating through the area (Fig. 1). The spring population is composed of two distinct Starling groups, the nesting population and the nonbreeding or migratory population. The nesting population always was near potential nest sites, perching, displaying, or building nests. The nonbreeding or migratory population showing only slight gonadal activity (Johnson, 1967) occurred in small flocks flying in open fields or perched near farm feedlots.

After spring migration and during the height of the nesting season, 20 April through 26 May, the Starling population as determined from the census routes, was low, or about 100 birds per 100 miles of census routes (Fig. 1). The number of Starlings did not increase appreciably until after the fledged young of the first brood were being observed in late May and throughout June. Then Starling population levels increased to over 250 birds per 100 miles during the last week of the census, 19 June through 25 June.

The decline in population during the nesting season can be attributed to the fact that one half of the adults were at the nest sites incubating eggs or brooding the young and could not be observed during the census. The gradual increase in population in May and June was the result of first family units being observed (Marples, 1936) and later the formation of the juvenile flocks (Kessel, 1957).

Flocking Behavior.—The flocking behavior of Starlings is distinctly different in two periods of the year: there is a 6-month period during which there is a tendency to flock and a 6-month period during which there is almost no tendency to flock (Fig. 3). During August, 1965, the average flock size increased suddenly from 2.5 birds per flock to nearly 8 birds per flock. Then for the next five months the average flock size decreased gradually until January when the average was about 6.5 birds per unit. In February the average flock size fell sharply to 2.5 Starlings per flock where it re-

mained through July, except for a slight increase in average flock size during June resulting from the formation of juvenile Starling flocks (Fig 3).

If gonadal volume of male Starlings of the west-central Illinois population (Johnson, 1967) and an English population (Bullough, 1942) are plotted in relation to the average monthly flock size as determined by the census routes in this study (Fig. 3), it appears that as the gonadal size increases (which is a general indicator of the amount of sex hormone produced) average flock size decreased. I suggest that the tendency to flock among Starlings is inversely related to the level of sex hormones in the blood. This is further supported by observations in the spring that flocking birds show little or no gonadal development (Kessel, 1957).

SUMMARY

1) Starling populations in west-central Illinois dropped to one of its lowest levels of the year in July 1965 (100 birds per 100 miles of census route) as a result of either young Starlings migrating northward or the postjuvenal molt making the Starlings less active flyers and less conspicuous to the observer.

2) The initial stages of migration were observed in August as the average flock size increased from 2.5 birds per unit to over 8 birds per unit. From this time the Starlings began to accumulate until populations reached a peak of over 800 Starlings per 100 miles of census route during the period 26 September through 2 October.

3) The migration from further north of young Starlings through west-central Illinois after the adults already had migrated through was thought to be the cause of a second peak in the population to nearly 800 birds per 100 miles of census route in late October.

4) Starling populations gradually declined over the winter from 250 birds per 100 miles to about 100 birds per 100 miles of census route as a result of "weather movements."

5) In late February the average flock size decreased from 6.5 to 2.5 birds per unit as some Starlings began showing an interest in potential nest sites.

6) Spring migration into west-central Illinois which began in the first week of March did not exhibit the large flocking tendency of fall migration and it occurred over a longer period of time.

7) During the nesting season the numbers of Starlings observed along the census routes were low, about 100 birds per 100 miles of census route, because the adults were confined to the vicinity of the nest by nesting activities. The numbers along the census routes did not increase again until June when the fledged young formed into juvenile flocks, and the counts rose to near 300 birds per 100 miles of census route.

8) The flocking of Starlings was of two distinct types: during August through January, there was a tendency to gather into large flocks and during February through July, there was a tendency to occur only in pairs. It is believed that the tendency to flock among Starlings is inhibited by the level of sex hormones in the blood.

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