ANALYSIS OF A RESIDENT FLOCK OF STARLINGS

By Hannah B. Suthers

INTRODUCTION

Starlings (*Sturnus vulgaris*) in tree cavities in Hopewell Borough, New Jersey, appear quite sedentary, but the estimated flock of 500 in an evergreen roost in the Sourland Hills migrate in mid-November. The migrants follow the ancestral western European NE-SW direction (Kessel, 1953; Bordner et al., 1968; Richardson and Haight, 1970). Starlings in North America developed migratory patterns after their introduction into the United States. Recently settled birds in the Pacific Northwest again follow the same pattern in that some are sedentary, some migratory (Johnson, 1974). Davis (1960) urged the study of Starlings to clarify the unsolved problem of the origin of migration. Data on the migration of adult breeding birds are meager. There are yet insufficient data on the age and sex of Starlings at the time of their banding (Johnson, 1974); subsequently little age and sex information has been available on recoveries. In this study banding, color banding, and field sightings were coordinated to observe the population of Hopewell Starlings through their life span, in their own natural colonies.

MATERIALS AND METHODS

Starlings are "trap inhibitable" (Suthers, 1974), that is, once caught, their aversion to being handled exceeds the attraction of a free meal, and they tend to avoid traps. Large pull-string traps (2′ × 1′ × 4′), and large openings (4″ × 6″) to the all-purpose ground trap, baited with suet and bits of bread, eased cautiousness by Starlings, especially when snow was on the ground.

Trapping operations began during the last week in December and continued into May. "Winter" was considered to be the last week of December to mid-February, and "spring" began in mid-February to include early migrations. Birds were banded with Fish and Wildlife Service aluminum bands and color bands in combinations to indicate year and season. Data were taken on characteristics that may be variable and therefore useful for determining sex and particularly age. Direction of departure was noted. These data were taken again on repeats and returns.

Field observations, roost-nest surveys for banded birds, were done with 7 × 35 binoculars. The roost trees were marked on a street map according to house number, and roosting-nesting cavities were diagrammed in community trees. Coding by position of bands on the legs was noted. Behavioral notes were taken. Field hours were matched for the winter roosting and spring nesting census.

BANDING RESULTS AND DISCUSSION

Table 1a and b summarize the total birds banded, and the cumulative returns. There were 256 repeats, and 17 recoveries. During the 7th and

8th winters 558 control birds were banded two miles out of town from the study area.

TABLE 1

Banding and field summaries of Starlings.

(a)Total birds banded, winter and spring

	1970	1971	1972	1973	1974	1975	Total	Av.
Winter	—	77	75	56	76	97	381	76
Spring	74	5	27	11	26	114	257	42
							638	

(b) Cumulative returns by season of return

	1970	1971	1972	1973	1974	1975	Total	Av.
Winter	—	12	14	16	13	21	76	15
Spring	—	2	2	2	5	15	26	5

(c) Total population in area, banded and unbanded

	1970	1971	1972	1973	1974	1975	1976	1977
Winter	—	124	55	122	174	102	181	209
Spring	72	91	122	129	57	—	96	118

(d) Cumulative banded birds sighted, winter and breeding

	1970	1971	1972	1973	1974	1975	1976	1977
Winter	—	7	11	25	24	25	71	57
Spring	11	23	21	28	21	—	31	36

(e) % sightings of banded birds in total population

	1970	1971	1972	1973	1974	1975	1976	1977
Winter	—	6	20	20	14	24	39	27
Spring	15	25	17	22	37	—	32	30

Sex

All birds were sexed. Starlings can be sexed externally as young as six weeks when the iris starts to change from juvenile bluish gray to a solid dark brown in the male, and to a yellowish eye-ring in the female (Kessel, 1951). Birds in breeding condition are sexed by the rami according to Kessel (*in* Wood, 1969).

Starlings with a completely dark bill and only a partial, dark ring in the iris can be sexed in another way, namely the number of secondaries showing iridescence on the edge of the distal vane, viewed from the top (Spencer, 1967). Males will show iridescence on the outermost or next to outermost secondary, females only on the first few, with little or no iridescence on the outer 4 or 5 secondaries. I find that second-year (SY) females have no iridescence on the outer secondaries, and after second-year (ASY) females have narrow iridescence. ASY males have wider iridescence than SY males.

Age

Starlings are aged by length of iridescence in the throat hackles, as outlined in Wood (1969). They are adults at two years after hatching. Narrow hackles and the wearing away of spangling on the head, chin, throat, and breast indicate an adult bird. Wide hackles with heavy spangling indicate a young bird. These indications are useful when hackles have worn shorter than adult lengths.

Because the young of some species (e.g., Gray Catbird, *Dumetella carolinensis*) have sparse thigh feathers, I measured the length of iridescence of thigh feathers and hackles of 75 Starlings at banding and at returning. The length of iridescence of thigh feathers correlated with that of the throat hackles and increased with age from SY to ASY (correlation coefficient, 0.76 for males, 0.64 for females).

Because the pattern of yellowing of the bill differed from that of Bullough (1942a), and timing is different geographically (Wydoski, 1964), I made and used my own scoring system (Fig. 1). Adult males already had some yellow in December before adult females and young did. SY males yellowed before SY females, and the progress of yellowing was highly related to time from the last week in December to mid-April when the completely yellow bill, with pink or blue rami, was attained (correlation coefficient, 0.81 for males, 0.85 for females).

Darkness of the underwing coverts is useful in separating adults from young birds (MacBriar, 1968). I scored the underwing coverts at banding and on the returns to see if additional rows darkened with age. Returns up through A7Y kept the dark lesser and median coverts, dark gray in females, almost black in males. Darkening of the greater coverts seemed to be an individual variation rather than age related.

Another age indicator appeared quite by surprise, in the iris color of multiple returns. Old males ($n = 5$) were coming back with a trace of a ring in the once-brown iris, and old females ($n = 6$) were coming back with the once-defined ring darkened or reduced to a trace. The males ($n = 42$) and females ($n = 29$) that had partial or faint rings at banding could well have been older birds, A4Y or more, judging from the returns. The possibility of aging Starlings by the iris ring deserves further consideration.

The Problem of Indeterminates

The study of returns helped clarify the status of indeterminates, birds with hackle measurements between those of clearly young birds and adults. Davis (1959) theorized that these indeterminates were immature birds, between 19 to 23 months in age. If this were so, then my SY birds should have returned with indeterminate hackle lengths when they were 19–23 months old. This was not the case with my 9 SY birds that re-

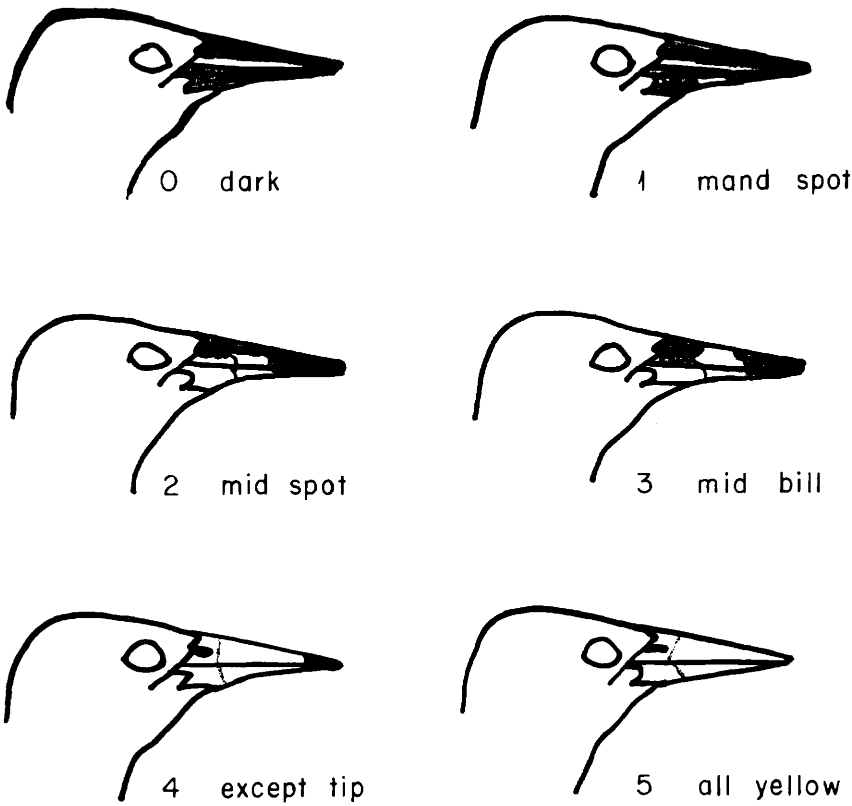

FIGURE 1. Progress of yellow in the bill: score 0, dark gray with ivory seams; 1, a spot of yellow appears at the base of the mandible; 2, the yellow extends onto the edge of the maxilla; 3, the mid bill is yellow, and the rami have lightened to pink or blue; 4, the bill is yellow except the tip, the pink or blue of the rami extends over the nostrils; 5, the bill is all yellow, with pink or blue rami.

turned the following year. None failed to reach ASY hackle measurements.

Then the unexpected showed up with old birds. Females ($n = 8$), returning at A3Y and older, and males ($n = 7$) A4Y and older, had shorter hackles (Table 2). Hackles wear faster on old birds. If they were captured for the first time as old birds, they would be classified as indeterminates, and, according to the earlier theory, considered young. The other age indicators described above have to be used together to age a bird with indeterminate hackle length.

Age-sex Ratio

The sex ratio of all my banded Starlings, males to females, was 1.1:1. Stegeman (1954) also found a 1.1:1 ratio in Syracuse, New York. Yom-

TABLE 2

Change in length of hackle iridescence[1] with age, banding and return data.

Band No.	SY	AHY	ASY	TY	ATY	4Y	A4Y	5Y	A5Y	A6Y
Males										
702-73526		10–11	*11–12*							
40	7–8			*12–13*						
752-26717			18–18				13–13		14–15	*12–13*
772-29528			13–14		13–13		*12–14*			13–15
58			13–14		*12–13*					
59	8–9							*12–12*		
670	7–7			*12–12*						
Females										
702-73517			8–8		*6–7*					
51		6–6	*6–7*							
752-26783			10–10		8–9		*7–8*			
762-41661			8–9				*7–7*		*5–6*	
69			7–9		*5–7*					
73	4–5						*6–7*			
772-29631			8–9		*7–8*		9–9			
98		6–7	8–8		*6–7*					

[1] The length of iridescence on mid-throat hackles is measured on three different feathers and the range given (in mm). Measurements are taken again each time a bird returns. The *italicized* measurements are smaller than previous measurements in most cases, or are borderline between two age designations.

Tov et al. (1974) found a 1.5:1 ratio in Aberdeen, Scotland. Figure 2 shows the age-sex ratio of my banded birds by season. Only the difference between ASY males and females in the spring was significant ($\chi^2 = 7.6$). Two factors have a bearing. The recoveries showed a possible higher female death rate in the late winter and spring. Secondly, if the indeterminates were included in the adult sex ratio data, the ratio would be closer to equal ($\chi^2 = 2.9$).

Returns and Recoveries

The returns, birds captured 3 months or longer after banding, indicated a resident core population. Of 69 individuals returning, 47 were recaptured in a different season than banding (winter or spring), 23 were multiple returns (up to 5 times), making a total of 102 return captures. Of 17 recoveries, birds found dead by others and reported to me through the Fish and Wildlife Service, 9 were banded in one season, winter or breeding, and recovered in the other; therefore they were also resident. This high proportion of resident birds is in contrast to Davis' findings (1960) that birds banded from roosts in marshes and

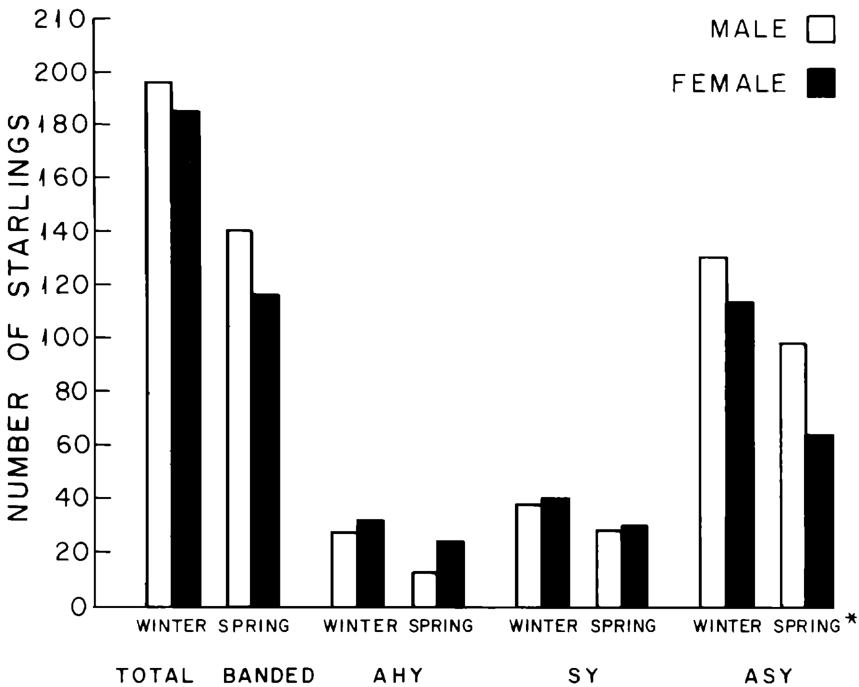

FIGURE 2. Age-sex ratio of banded birds by seasons. *In the spring significantly more males were banded than females. However, if the indeterminate (AHY) were considered adults (ASY or more) the ASY age-sex ratio would be essentially equal.

buildings in New Jersey are highly migratory, moving northward in the spring.

Figure 3 shows the age:sex composition of the returns. Females were more willing to enter the traps again whereas the males sat on top and gave warning calls. Then the differential death rate caught up with the females, leaving more males, however cautious, to return.

The return data were used to calculate weighted mean survival according to Robbins' method (1969), summarized in Table 3. Seventeen recoveries were insufficient for constructing a Life Table according to Hickey (1952). Both returns and recoveries showed that most male deaths occurred after banding year 2 when the birds were at least 4 years of age, and most female deaths occurred by banding year 2, before the birds were 3 years of age. Kessel (1957), Davis (1959), and Fankhauser (1971) also reported higher survival rates of males over females. Fankhauser quoted an explanation given by Coulson in 1960, that the differential mortality appeared over a short period after the birds' first year, probably because more first-year females than males bred in their first year. Collins and DeVos (1966) in Guelph, Ontario, found that 13% of the yearling females bred, but yearling males did not.

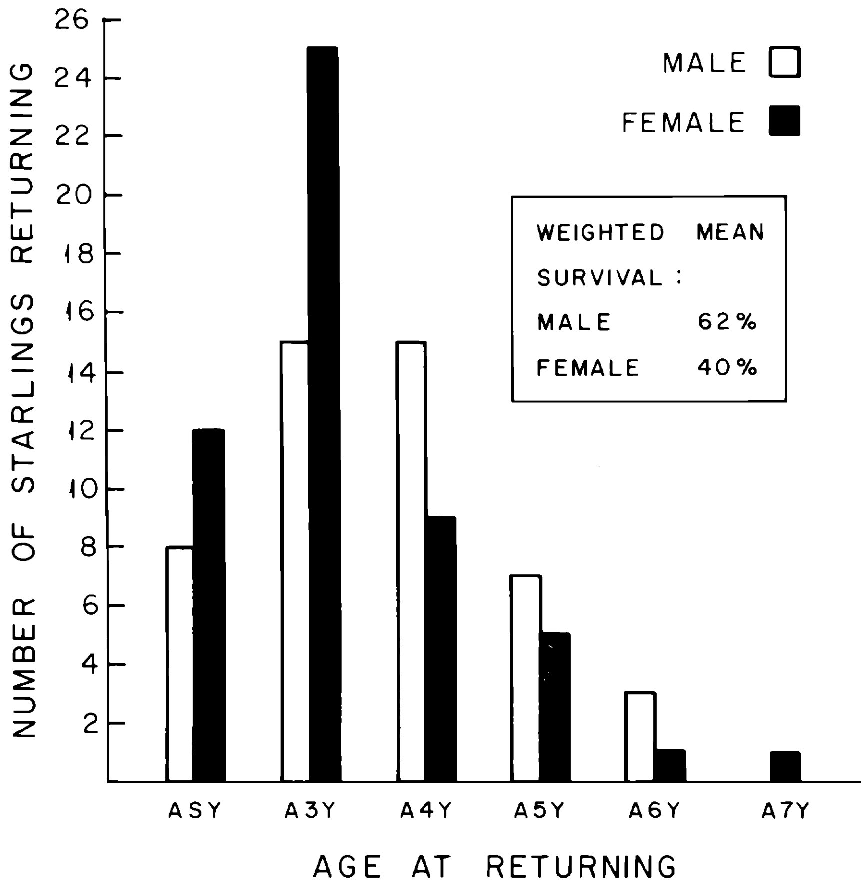

FIGURE 3. Age at returning. Females re-enter the traps more readily than males; then the differential death rate results in more males returning.

FIELD RESULTS AND DISCUSSION

The study area consisted of three blocks on the east side of Hopewell, and both sides of the streets in between and bordering them. The trees involved in the study area bordered the sidewalks. The Starlings used almost exclusively the 50 to 100-year-old Silver Maples, locally called Swamp Maples (*Acer saccharinum*). These trees are soft, break easily, and rot out quickly inside the branches, providing cavities. The County trims trees under power-lines, and these rot out faster than the untrimmed trees. The Starlings used 33 of the 51 Swamp Maples in the area, the others being too young to have cavities of the favored size. In contrast, Starlings used only 2 of the 49 Norway Maples, 1 of 4 Black Maples, the only Ash, and Catalpa.

The Borough has been replacing fallen Swamp Maples with sturdier

TABLE 3
Survival rates from return data.

(a) Robbins' method

	Males, year after banding	Females, year after banding
year 1 to year 2	10:12 = 83%	7:22 = 32%
2 3	5:10 = 50%	6:7 = 86%
3 4	2:5 = 40%	0:6 = 0
4 5	1:2 = 50%	1:0 = 0
weighted mean	18:29 = 62%	14:35 = 40%

(b) birds counted alive every year until last return

	Males, year after banding	Females, year after banding
year 1 to year 2	17:23 = 74%	14:30 = 47%
2 3	7:17 = 41%	8:14 = 57%
3 4	2:7 = 29%	1:8 = 12%
4 5	1:2 = 50%	1:1 = 100%
weighted mean	27:49 = 55%	24:53 = 45%

Norway Maples and Pin Oaks. During the seven years of the study, 10 young Swamp Maples (diameter 19–29 cm) were cut down, involving only one nest, and one untrimmed tree over 100 years old (diameter 115 cm) involving 2 roost-nests. Storms felled 8 middle sized trees (diameter 48–58 cm) dislocating 13 nesting cavities. As the availability of Swamp Maples dropped the birds began utilizing rotted spaces under eaves of buildings.

The most densely occupied trees still stand. The largest (diameter 107 cm) has 9 nests, another (diam. 102 cm) has 7 nests, feral Pigeon holes, and House Sparrow nests. A large (diam. 97 cm) untrimmed tree has 6 nests and a Screech Owl hole. A storm-broken tree (diam. 72 cm) has 4 nests. The most densely occupied street has 7 Swamp Maples with 11 nests. Feral Pigeons and House Sparrows also use these trees.

Stable Starling Population

Table 1c gives the results of sightings at roosts in the winter and at nest holes in the spring, a yearly average of 104 birds in 21 Swamp Maples. The higher total count in the winter than in the spring can be explained by the birds' habit of communal roosting in winter. As many as 25 birds roosted inside an old community tree, with up to 4 birds per cavity. Their numbers appeared stable during the winter, judging from counts at the trees at sundown. When established at nest sites in the spring, these birds tended to stay on to roost the following winter, and nest again until dying or being driven out by other Starlings or a felled tree.

Proportions

In the study area, only about 1 in 5 (23%) of all locally winter-roosting birds were banded. The other banded birds winter-roosted completely out of town and flew in to feed on the lawns. Likewise only about 1 in 5 (24%) of all locally nesting birds were banded. As of the seventh spring, no banded Starlings were staying in an adjacent control area with 59 old Swamp Maples. But a town-banded bird was sighted 2 miles out of town. Table 1e shows the increase of banded birds sighted as original birds were replaced by the newly banded ones. By two years after the banding of town birds terminated, the banded birds sighted declined from 71 to 57 in the winter but held at 36 at nests.

Replacements

New banded birds resident in the study area, an average of 10 birds a year, 4 in winter, 6 in spring, represented the replacement by banded and unbanded in the respective banding year. The 17 recoveries indicated a similar pattern of more deceased to be replaced in the spring (14) than in the winter (3).

The origin of replacement birds was the foraging flock, rather than the young. The young aggregated in large flocks out of town and were not seen at the roosting cavities at the postbreeding census. During the 5 years of banding I banded only 78 young out of 638 birds, not enough for replacements. Of these, only 10 returned. None of the 558 control birds, banded out of town in the past two years, have moved into town as replacements. I sighted two of these control birds on the roadside 5 miles and 9 miles out of town in opposite directions.

A behavioral clue to the origin of the town residents was the vocal imitations of other birds. A Starling imitating other town-breeding species was likely of town origin. A bird that imitated species of forest edges and fields could have come only from the same habitat.

BEHAVIORAL OBSERVATIONS

Winter Routine

Starlings emerged from the knot holes and broken branches after sunrise and perched in a row on the branches in the morning sun, then moved from branch to branch, to the next tree and back, with chattering. They drank melted water in the crevices of the bark. They flew to the ground and sought food among the grass. If a puddle on the ground was thawed, they bathed, flew up and moved from branch to branch until they were dry. Some sat on a nearby furnace chimney presumably for warmth. They sat and preened, reached over a dropped wing to scratch the head, and rubbed the head on the underwing coverts in a circular motion. They went to the nearest feeders. Finally they gathered with birds that arrived from out of town, into flocks up to 45 birds, and flew the neighborhood rounds to feed. Many were back at midday to preen, rest, sing, and visit the local feeders again. In the evening they congregated at their roost trees, bathed, moved about, preened, soaked up the last bit of sun, and slipped into the cavities. Because of these habits of lingering about the roost, sunrise and sunset were the best times to take a winter census.

Nesting Activity

In the spring the communal roost hole thinned down to one pair. The nesting pairs pre-empted a second cavity for roosting. I observed a courtship ritual, a leaf-in-bill chase. The male tore off a piece of maple leaf, larger than his head, and pursued the female with it from branch to branch with much chattering. The pairs chose each other in a process of examining the nest hole, going in and out, singing from it or by it. They both sang. The male performed a wing-flapping-singing display. As a signal for copulation, the female lightly pecked him behind the ear and he mounted. They both brought up nesting material, including grasses, dandelion and plantain heads, cigarette butts, foil and cellophane candy wrappers, balloon mouthpiece, cinquefoil leaves, and maple leaf. Both parents incubated, and there was a recognition-change-of-duty ritual with chattering, in which the departing bird burst out of the cavity, and the arriving bird looked around and slipped in. Both parents fed the young and foraged within a few blocks of the nest. As the young matured and called louder, the parent at the nest entrance answered their cries with warning calls. Both parents carried away fecal sacs, until the nearly-fledged young moved to the outside edge of the hole and defecated outward. Usually one (two at the most) fledgling was seen following a parent. The cat, dog, and car tolls were high. Only 11 fledglings were sighted in a first-brood census.

Bachelor Males

An average surplus of 20 males occupied cavities as roosts in 21 Swamp Maples, but did not pair off and nest. Such a male in a community watched over the foraging pairs on the ground. He called and flew over to foragers flying in to perch. According to their response, the arrivals belonged and stayed, or moved on. The bachelor males attacked intruding squirrels, and were joined by parents if nearby. I observed a bachelor feeding the young of a pair. When the young fledged, the females went with them to continue feeding them. The remaining males guarded the tree. By keeping the cavities available to themselves for future roosting and nesting, these males were keeping the sites available for Starlings.

The males that stayed behind had yellow bills and blue rami in the postbreeding season, September and October, when others had dark bills. Wydoski (1964) cited Hilton (1958) as reporting that birds involved in a second brood keep the yellow bill during the second nesting period. However, I have seen dark-billed parents feeding second brood young at the nest during the first week in July.

The second nesting in the study area occurred at the end of May to early June. A variety of activity occurred in a 4-day period, 30 May to 2 June 1973, at 35 nest holes. Four pairs were involved in leaf-in-bill chases, 3 pairs in courtship chases and wing-flap-display songs, 5 matings, one in which the female jumped on the male and another male chased both away. Two pairs were carrying nesting material, males and females were carrying away fecal sacs, young were heard peeping, and an adult was being followed by two fledglings. The feeding parents had bare faces. Starlings were catching insects on the wing and eating fallen caterpillars off the pavement. On 24 June, a flock of about 30 loud fledglings and adults were in a field on nearby hills. On 26 June, second broods in the study area were running in and out of nest holes, begging for food, looking ready to fledge. The second nestings were not completely synchronized, depending, perhaps, on the success of the first attempt.

SUMMARY

Starlings in Hopewell Borough established communities of resident adult birds in Swamp Maples. The availability of roost-nest cavities in these maples determined the population density. Vacancies were filled mostly by adult birds flying in from out-of-town roosts; the young migrate. The banded residents lived within the immediate (3 block) area of the banding station or completely out of town. Only 1 in 5 birds of the foraging flocks in the study area resided in the study area. The feeding flock composition changed constantly.

Banding return and recovery data showed a balanced sex ratio among young birds, and a higher death rate among young females, resulting in an excess of adult males. Studies of returns indicated that birds of indeterminate hackle length, and therefore indeterminate age at banding, were old birds. Age characteristics that should be watched are faster hackle wear, fading of iris ring in the female, and acqusition of an iris ring by the male.

The winter and spring routines are described, including birds packing into common winter-roost cavities in community trees, bachelor males and their apparent function, a leaf-in-bill courtship chase, removal of fecal sacs from the nest, and imitations of other birds.

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