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MIGRATIONS OF THE LEAST FLYCATCHER IN SOUTHERN ONTARIO

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A preliminary study in 1965 showed a marked difference between the timing of fall migration of adult and immature Least Flycatchers (*Empidonax minimus*) at Long Point, Ontario, with adults preceding immatures by about a month (Hussell et al. 1967). Subsequently Clench (1969) reported no age-related differences in the timing of fall migration in southwestern Pennsylvania in the years 1964–1967. In west-central Kansas, however, Ely (1970) noted a pattern similar to that reported at Long Point. An analysis of fall specimens from North and Central America indicated an early southward movement of adults, consistent with the Kansas and Ontario results (Hussell 1980).

In 1966–1968 an intensive study of the spring and fall migrations of *Empidonax* flycatchers was undertaken by the Long Point Bird Observatory, with the objective of documenting the timing of migration and occurrence of molt in species which occur regularly during migration at Long Point. The timing of migration of each species in the spring, and of adults and immatures of each species in the fall, was determined. Evidence of differential timing of migration between sexes was sought both from birds captured for banding and from museum specimens.

In this paper, I present results for the Least Flycatcher from the 1966–1968 study together with a summary of other Long Point banding data for the years 1966–1978. Also included are previously unpublished results for the fall migration at Powdermill Nature Reserve, Pennsylvania, in the years 1968–1977, which were kindly provided by M. H. Clench.

METHODS

Flycatcher migration was studied at the Long Point Bird Observatory's field station at the eastern end of Long Point (42°33′N, 80°03′W) on the north shore of Lake Erie during April–October, 1966–1968. The area consists of open dunes with scattered cottonwoods (*Populus deltoides*) allowing easy observation and capture of migrant birds. Data were gathered as part of the Observatory's regular migration monitoring and banding program, but special emphasis was placed in those years on

accurately estimating *Empidonax* numbers and obtaining large samples for banding.

Each morning during the migration seasons (15 April–15 June and 1 July–31 October, for our purposes) a bird census of about 1 hr duration was conducted over an approximately 2 km circuit covering the last kilometer of land at the eastern tip of Long Point. *Empidonax* were either identified to species or recorded as "unidentified *Empidonax*." At the end of the day, all observers present conferred and reached agreement on estimates of the totals of each species (and unidentified *Empidonax*) present during the entire day, based on the results of the census, on birds captured for banding (see below), and on any other observations.

Migrants were captured in Heligoland traps (4 in 1966 and 1967, 3 in 1968) supplemented by up to 10 mist-nets when needed (Hussell and Woodford 1961). Trapped and netted birds were banded, wing chord measured to the nearest 0.1 mm (believed accurate to about ±0.2 mm, based on repeated measurements of the same bird by the same and different people), the skull was examined for pneumatization, and the bird was weighed. Least Flycatchers, Yellow-bellied Flycatchers (*E. flaviventris*) and "Traill's" Flycatchers (*E. traillii* and *E. alnorum*) were identified using methods described in Hussell et al. (1967) and later incorporating those of Phillips et al. (1966). Emargination of the outer web of the 6th primary was regarded as an important character for distinguishing Least Flycatchers from "Traill's" Flycatchers for those birds with wing chord measurements of 63–68 mm. Using these methods, few identification problems were encountered.

A sample of birds was examined for molt each season. Numbers of feathers in active molt in various parts of the plumage were counted or estimated and body molt for each area was scored 0–3 by the scale defined in Table 1. A composite body molt score with a possible range of 0–3 was then calculated for each bird by summing the scores for each of the nine plumage areas and dividing by 27. The flight feathers and wing coverts were also examined and evidence of molt recorded.

Birds hatched in the current calendar year are called "immatures" while all older birds are "adults" ("Hatching Year" and "After Hatching Year," respectively, in banding terminology). In contrast to many temperate zone passerines, adult Least Flycatchers molt the flight feathers in the winter quarters following fall migration (Dwight 1900, Johnson 1963, Hussell 1980). After 1 July all birds were carefully examined for wear of the flight feathers and tips of the greater and middle secondary coverts. Birds with worn flight feathers, narrow whitish wing bars, and completely or almost completely pneumatized skulls were classified as adults and those with little or no wear on the flight feathers, broad buffy wing bars, and substantially unpneumatized skulls were called immatures. Nearly all birds readily fell into one of these two categories.

Because banding effort was not constant from day to day, it is believed that daily estimated totals for each species provide the best measure for

TABLE 1. Definition of body molt scores.

Plumage or body area	Number of feathers in active molt for body molt score of: 0 (none)	1 (light)	2 (moderate)	3 (heavy)
Head	0	1–5	6–10	11+
Upper back	0	1–5	6–15	16+
Lower back	0	1–5	6–15	16+
Upper tail coverts	0	1	2–4	5+
Scapulars (both sides)	0	1–2	3–4	5+
Throat	0	1–5	6–10	11+
Breast	0	1–5	6–15	16+
Abdomen	0	1–5	6–15	16+
Under tail coverts	0	1	2–4	5+

determining seasonal patterns of migration. Numbers of Least Flycatchers present on any day were estimated in the following way. Daily estimated totals of all unidentified and identified *Empidonax,* determined as described above, were lumped into a single total. This number was then divided among Least, Yellow-bellied, and "Traill's" flycatchers according to the proportions of those flycatchers present in the banded sample (including newly-captured birds and retraps of birds banded on previous days). On the few days when no birds were caught, which usually occurred when few birds were present, daily estimated totals were assigned to "species" according to the proportions in banded samples on the nearest adjacent days. Estimated daily totals calculated in this way were rounded to the nearest 0.1 bird. Autumn totals for each species were subdivided by age in the same way, according to the proportion of adults and immatures of each "species" in the banded sample, to give daily estimated totals for each age class of each "species." To show seasonal trends in migration, a 5-day moving average was calculated of the daily estimated totals for all three years combined, for each "species" and age class. These 5-day moving averages were used to determine 3-year median and percentile dates. Although considered to be less satisfactory, daily banding totals were treated in the same way for comparison.

Numbers of Least Flycatchers banded in the years 1969–1978 at the same location as the 1966–1968 study (station No. 1) and at a second station (No. 2), 19 km west of station No. 1 on Long Point (42°34′N, 80°17′W), in the years 1966–1978 are also presented. One to three Heligoland traps were used at station No. 1, one Heligoland trap at station No. 2, and up to 12 mist-nets at each station. Because coverage of the migration seasons was incomplete at one or both stations in many years, the average number of Least Flycatchers (divided into age classes in fall) per day of coverage was calculated for each station for arbitrary 5-day periods. A day of coverage was any day on which any trapping or netting of land bird migrants was attempted at that station. These weighted

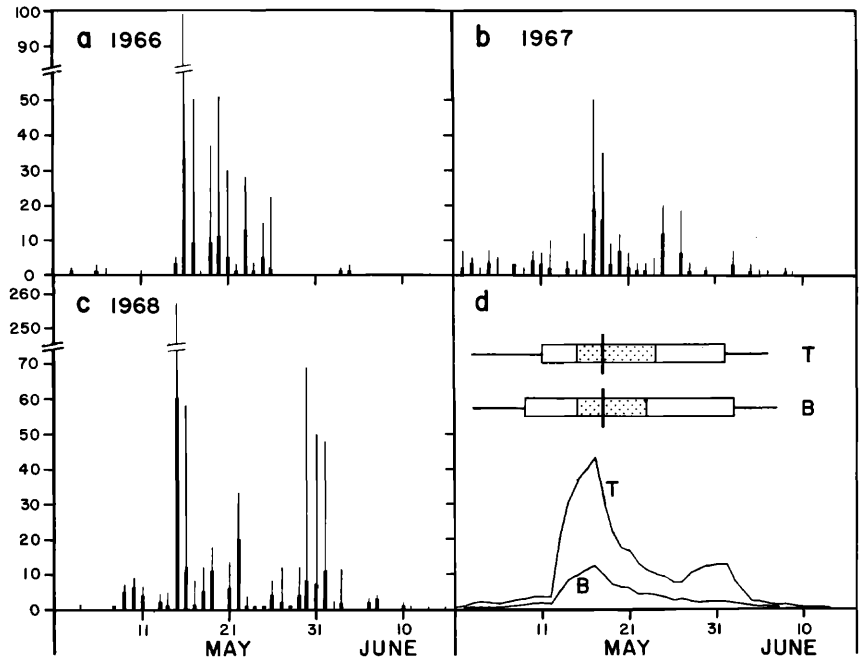

FIGURE 1. (a–c) Spring migration of Least Flycatchers at Long Point, 1966–1968. Narrow and broad columns represent daily estimated totals and banded samples, respectively. (d) Seasonal pattern of spring migration, 1966–1968. The continuous lines in the lower section of the figure are five-day moving averages of the daily estimated totals (T) and banded samples (B). The upper section shows median dates (vertical bars), middle 50% and 90% (stippled and open sections of horizontal bars), and middle 98% (horizontal lines) of the daily estimated totals (T) and banded samples (B).

averages of numbers of flycatchers per 5-day period were used to estimate median dates.

Least Flycatcher specimens taken in spring before 11 June south of latitude 45°N in Ontario and Michigan were examined in the collections of the Royal Ontario Museum and the University of Michigan Museum of Zoology. Specimens were identified and measured in the same way as banded birds. Sex determinations were those of the collector.

RESULTS

Spring migration.—Numbers of Least Flycatchers at Long Point during the spring each year, from 1966–1968, are shown in Figure 1a–c. Although a few birds occurred as early as 2 May, the first large influx always took place on or soon after 15 May. Median dates for bird-days in the three years 1966–1968 were 19, 18, and 16 May, respectively. The seasonal pattern of migration for the three years combined is shown in Figure 1d. The median date is 18 May and the middle 90% of the

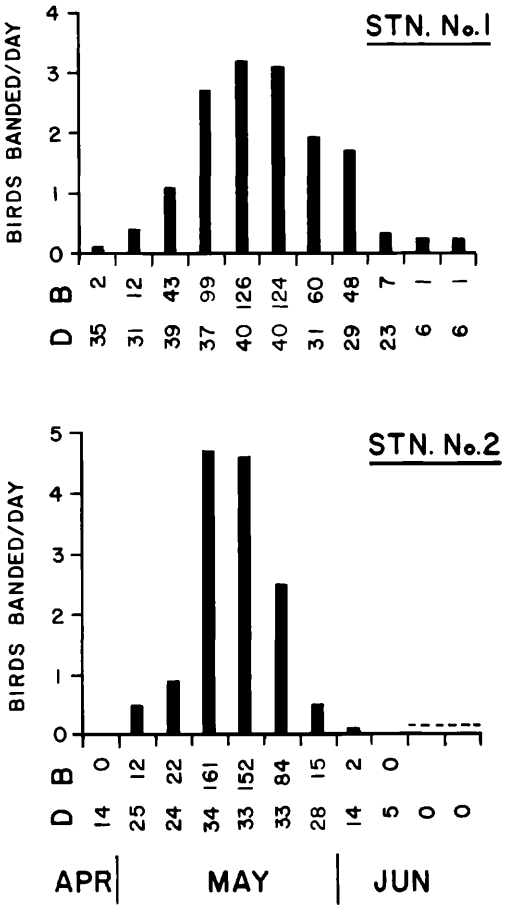

FIGURE 2. Average numbers of Least Flycatchers banded per day during spring migration at Long Point in successive 5-day periods from 27 April–1 May through 16–20 June. Upper: station No. 1, 1969–1978. Lower: station No. 2, 1966–1978. Broken horizontal line = no data. D = days of coverage, B = Least Flycatchers banded, for each 5-day period.

bird-days occurred in a 22-day period from 11 May to 1 June. Total bird-days for the spring migration were 357.9, 251.6, and 661.7 for 1966, 1967, and 1968, respectively.

Timing of migration based on banded samples alone for 1966–1968 agrees well with that from daily estimated totals, with the median also on 18 May (Fig. 1d—"B"). Other banding data, presented in Figure 2, show a similar pattern with medians on 21 and 17 May at stations Nos. 1 and 2, respectively.

Although the migration pattern in Figures 1d and 2 are not strongly

bimodal, there is evidence both from the Long Point data and from museum specimens that males tend to migrate earlier than females. Figure 3 shows change in the distribution of wing lengths at Long Point during the spring migration together with comparable data for sexed specimens from southern Ontario and Michigan. Wing lengths of males average longer than females but there is a wide range of overlap: males 60–67 mm (one 57 mm); females 56–63 mm (one 65 mm). In contrast, wing length separated the sexes in all birds but those with a wing length of 62 mm in a sample of 74 immature Least Flycatchers at Huntington (Long Island), New York in the fall (Phillips et al. 1966). The greater overlap between sexes in the spring specimens may be due to inclusion of "adults" of the previous fall (which presumably have longer average lengths in both sexes) and to more variable wear of the wing tip since the preceding molt than would be the case with fall immatures. In addition, some museum specimens were probably incorrectly sexed.

Males with wing lengths of 63.5 mm or more predominate among specimens collected before 10 May, while after that date shorter-winged males appear in substantial numbers (Fig. 3b), suggesting that old males (which have undergone at least one complete molt of the flight feathers) arrive earlier than second-year (i.e., one year old) birds. Very short-winged birds (less than 58.5 mm) occur mainly after 17 May and, although the specimen sample is small, this indicates the possibility that older females may also arrive slightly ahead of second-year females (cf. Johnson 1965, 1973).

In the Long Point banded sample, 17 among 348 birds examined (4.9%) had small unpneumatized areas in the skull. Although the median dates for the 2 groups are the same (18 May), only 3 (18%) of the incompletely pneumatized group occurred before 17 May, whereas 132 (40%) of the birds with completely pneumatized skulls did so. Birds with incompletely pneumatized skulls averaged 0.9 mm shorter in wing length than those with completely pneumatized skulls (60.1 versus 61.0 mm). Shorter wing lengths and later occurrence suggest that most birds with incompletely pneumatized skulls are in their second year.

The median date for spring specimens in southern Ontario and Michigan is 15 May, three days earlier than for the 1966–1968 Long Point sample. The specimen sample appears to be strongly biased to the early part of the season (25% of males and 16% of all specimens were collected by 9 May, whereas only 4% of all birds occurred at Long Point by this date) and toward males (64 males to 33 females). The median for male specimens alone is 14 May and for females it is 20 May. If there was a similar difference in the timing of migration between males and females at Long Point, the median date for males was probably about 17 May and for females about 23 May in 1966–1968. These estimates appear to be consistent with the wing length distributions in Figure 3.

Among 135 Least Flycatchers examined between 14 May and 10 June (1967 and 1968) only one showed any sign of body molt. Its molt was

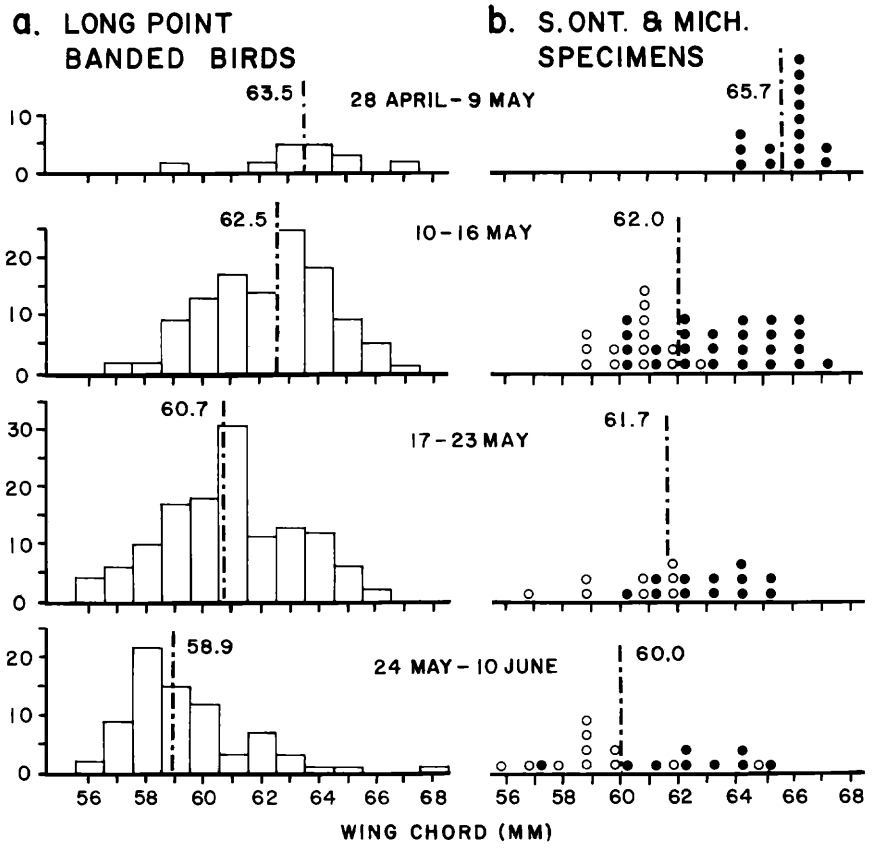

FIGURE 3. Distribution of wing lengths of banded birds and specimens in relation to date during spring migration. (a) Long Point banded sample, 1966–1968. (b) Southern Ontario and Michigan specimens; open circles = females, solid circles = males. Wing chords are grouped as 55.5–56.4, 56.5–57.4, etc. Vertical broken lines indicate median wing lengths.

rated light on the lower back and it had a composite body molt score of 0.1.

Fall migration.—The fall migration of adult and immature Least Flycatchers at Long Point in the years 1966–1968 is shown in Figure 4a–c and the pattern for the 3 years combined is in Figure 5. The first adults appeared in the period 4–13 July and their migration continued at a high intensity throughout the remainder of July and the first 10 days of August, after which there were a few late stragglers with none after 29 August. The median dates for adult bird-days in the 3 years were 2 August 1966, 20 July 1967, and 25 July 1968. For the 3 years combined,

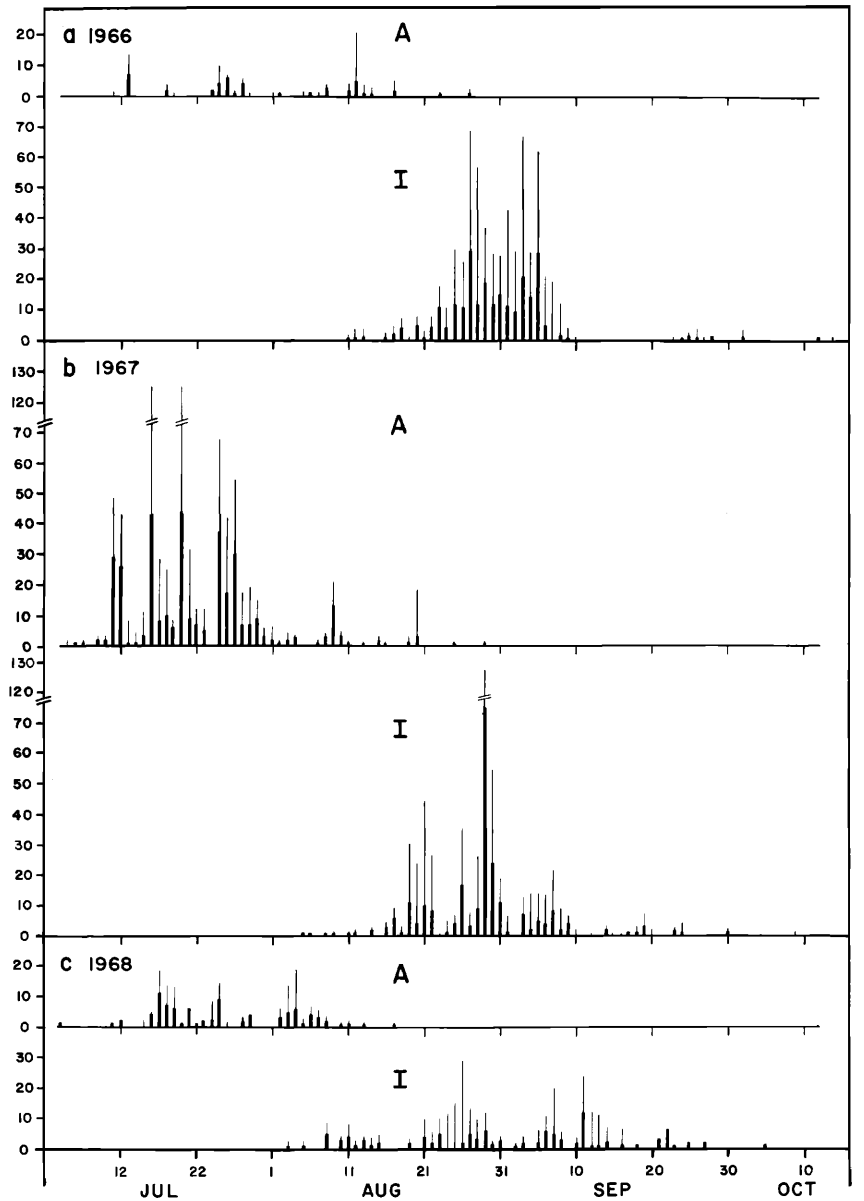

FIGURE 4. (a–c) Fall migration of Least Flycatchers at Long Point, 1966–1968. See Figure 1 for explanation. A = adult, I = immature.

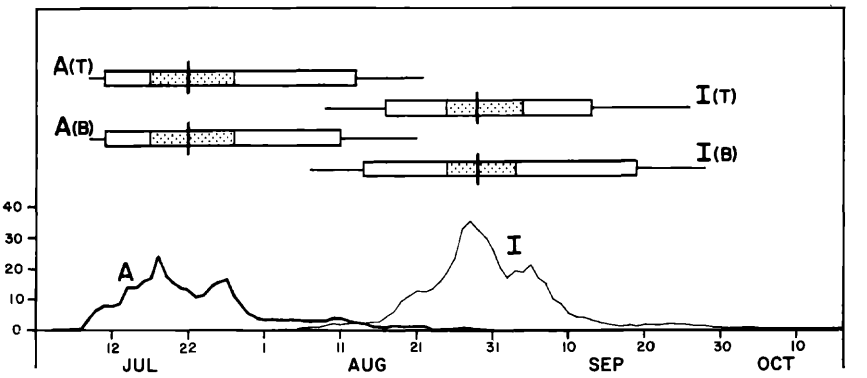

FIGURE 5. Seasonal pattern of fall migration of Least Flycatchers at Long Point, 1966–1968. The continuous lines in the lower section are five-day moving averages of the daily estimated totals. A = adult, I = immature. See Figure 1d for further explanation.

the middle 90% of adults occurred in a 34-day period, 11 July–13 August, with the median on 22 July.

Immatures appeared in the first 10 days of August and their migration peaked in the last week of August and first week of September with a few late birds into mid-October. Median dates for immatures were 31 August 1966, 29 August 1967, and 28 August 1968. These dates are 29, 40, and 34 days later (average 34 days) than the median dates for adults in the same years. For the 3 years combined (Fig. 5), the median date for immatures was on 29 August, 38 days later than for adults, and the middle 90% occurred in a 28-day period, 17 August–13 September.

Median fall dates of adults and immatures in the banded samples in 1966–1968 are in exact agreement with those based on daily estimated totals and the overall patterns derived from the two procedures differ only in minor details (Fig. 5). Other Long Point banding data (Fig. 6), show the same general pattern and give median dates for adults and immatures of 24 July and 26 August at station No. 1. Coverage at station No. 2 was inadequate in July, but available data give median dates of 2 and 23 August for adults and immatures, respectively.

Wing lengths of birds banded at Long Point in 1966–1968 showed no obvious trend with date within age classes, so it is likely that there are no marked differences in timing of fall migration between sexes. Phillips et al. (1966) concluded that there was no differential migration between sexes among immatures at Huntington, New York.

Sixty birds identified as adults by plumage color and wear had small unpneumatized areas in the skull. This is 13% of the total number of adults examined. It is unclear why this percentage is higher than in the spring sample.

Both the total numbers and the proportions of adults and immatures

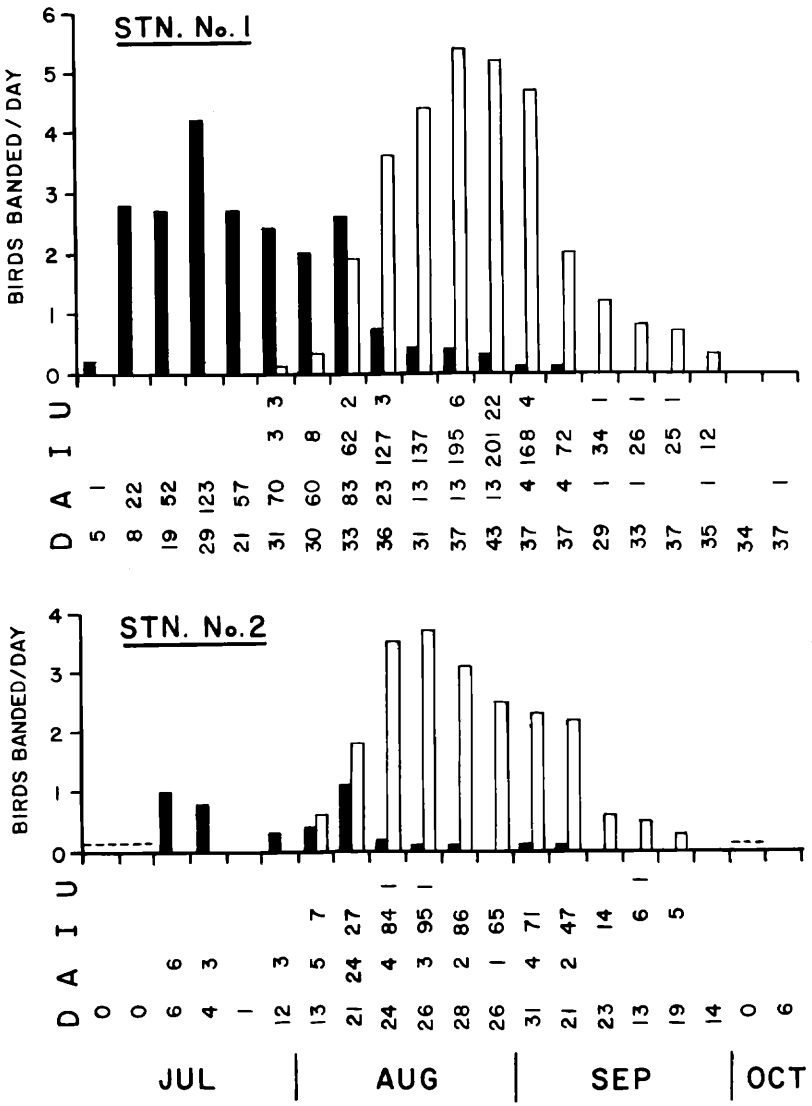

FIGURE 6. Average numbers of adult and immature Least Flycatchers banded per day during fall migration at Long Point in successive 5-day periods from 3–7 July through 6–10 October. Upper: station No. 1, 1969–1978. Lower: station No. 2, 1966–1978. Solid columns = adults. Open columns = immatures. Broken horizontal line = no data. D = days of coverage, A = adults banded, I = immatures banded, U = unaged birds banded, for each 5-day period. (Data for days with 50% or more unaged *Empidonax* at any station were excluded. The remaining unaged birds were assigned to age classes in proportion to the known-age birds before calculating averages for each 5-day period.)

TABLE 2. Numbers of adult and immature Least Flycatchers at Long Point 1966–1968.

	Number of bird-days				Number of banded birds			
Year	Total	Adult	Imm.	% Ad.	Total	Adult	Imm.	%Ad.
1966	747.4	96.7	650.7	12.9	288	44	244	15.3
1967	1357.1	793.7	563.4	58.5	586	347	239	59.2
1968	457.0	159.3	297.7	34.9	196	87	109	44.4
1966–1968	2561.5	1049.7	1511.8	41.0	1070	478	592	44.7

varied substantially from year to year (Table 2). There were consistently large numbers of adults in July 1967, low numbers of adults in 1966, and consistently low numbers of both adults and immatures in 1968. There was an average of 41.0% adults during the 3 years, based on bird-days, or 44.7% based on birds banded. Other Long Point banding data (Fig. 6) give 41.4% adults at station No. 1 and 16.5% at station No. 2. The lower percentage of adults at station No. 2 may be site-related, as a similar difference also occurs in warblers (Dunn and Nol 1980).

Nearly every individual examined in autumn showed some evidence of body molt. Among adults there was less evidence of molt in late-migrating individuals than in early migrants. Mean body molt scores, ranges, and sample sizes (n) for the four periods 4–17 July, 18–22 July, 23–28 July, and 29 July–27 August, each of which represent about 25% of the migration, were, respectively: 1.39 (0.3–2.7, n = 42); 1.37 (0.1–2.7, n = 43); 1.09 (0.6–2.1, n = 37); and 0.77 (0–2.4, n = 74). The earliest immatures were molting more heavily, on average, than the adults and the decline in molt during the season was less marked. Mean body molt scores, etc. of immatures for the four periods 3–25 August, 26–29 August, 30 August–4 September, and 5–30 September, were, respectively: 1.53 (0.1–2.8, n = 110); 1.19 (0.1–2.4, n = 53); 1.17 (0.1–3.0, n = 28); and 1.15 (0–2.8, n = 56). As expected (Dwight 1900, Johnson 1963, Hussell 1980), there was no evidence in either age class of sequential or symmetrical molt of the remiges or rectrices, although one or a few growing feathers were found on some individuals, particularly among the rectrices.

Fall migration at Powdermill, 1968–1977

The timing of fall migration of adult and immature Least Flycatchers at the Powdermill Nature Reserve, Pennsylvania, in the years 1968–1977 is summarized in Figure 7. Coverage was essentially complete and numbers of nets in use were approximately constant from year to year (M. H. Clench, pers. comm.), so results are given as total birds banded in each 5-day interval over the 10-year period. As previously reported (Hussell 1980), the median period for adults is 28 July–1 August and for immatures it is 1–5 September. These results are in general agree-

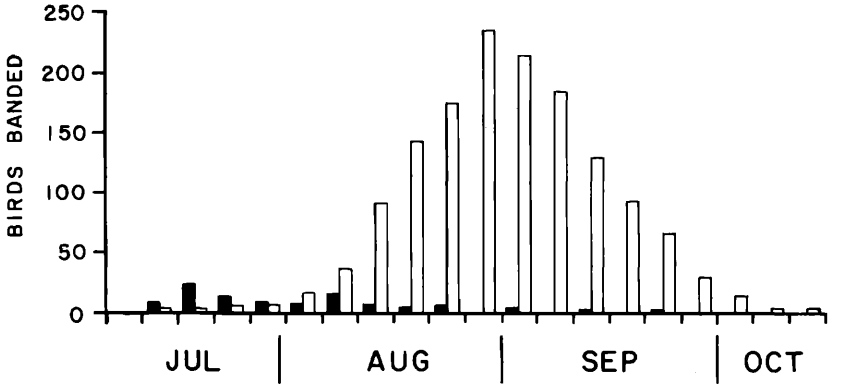

FIGURE 7. Numbers of adult and immature Least Flycatchers banded at Powdermill Nature Reserve, Pennsylvania, in successive 5-day periods from 8–12 July through 11–15 October 1968–1977. Solid columns = adults. Open columns = immatures. One adult banded 19 November 1977 is not shown.

ment with the findings at Long Point, but the timing of adult migration is earlier than reported for the years 1964–1967 (Clench 1969). Adults made up only 6.4% of all Least Flycatchers banded at Powdermill in 1968–1977 (99 of 1535), in contrast to 20.1% (82 of 391) in 1964–1967 and over 40% at Long Point's station No. 1.

DISCUSSION

Male Least Flycatchers preceded females in spring migration by about 6 days and wing length distributions indicate the possibility that second year birds tend to migrate later than older adults. In the Hammond Flycatcher (*E. hammondii*), Johnson (1965) aged specimens and showed that peak migration of adult males occurred first, followed by second year males and adult females, and lastly by second year females. In the Western Flycatcher (*E. difficilis*), adults also preceded second year birds, but a clear difference in timing between males and females was not detected (Johnson 1973). More detailed examination of Least Flycatcher specimens is needed to confirm that the sequence of spring migration is similar to that of the Hammond Flycatcher.

The age-related differences in timing of fall migration described here for Least Flycatchers in southern Ontario confirm the findings of Dwight (1900), Johnson (1963), Hussell et al. (1967), Ely (1970), and Hussell (1980). Recent data from Powdermill Nature Reserve, Pennsylvania, are also consistent with this pattern. The evidence indicates that there are no major differences in the timing of migration between sexes in the fall.

Although daily estimated totals were considered to be the best measure of daily abundance of flycatchers at Long Point, banding totals gave comparable results for the overall seasonal patterns of migration.

Peak days were usually under-represented in the banding data, however, and seasonal patterns based on banding data tended to be somewhat less concentrated around the peak period than were those based on daily totals (Figs. 1d, 5). A more standardized daily banding procedure would probably overcome this discrepancy, at locations where it is feasible.

There were marked differences in abundance of Least Flycatchers between years, particularly in the fall (Fig. 4, Table 2). Although some of this variability is probably due to the effects of weather on the numbers of migrants at Long Point, it appears unlikely, for example, that such factors could entirely account for the consistently high numbers of adults in July 1967 and the consistently low numbers in July 1966. Clearly, many factors must influence the numbers of migrants occurring at the coastal concentration points such as Long Point. In addition to the direct effects of local and regional weather, these may conceivably include the effects of year-to-year changes in the timing, rate, and route of migration in response to conditions on the breeding grounds or elsewhere, effects of changed conditions at the count site itself (e.g., abundant versus scarce food supply), and changes in the size of the migrant population. Figures 1a–c and 4a–c are derived from a standardized procedure and I consider it highly unlikely that the major differences between years represent consistent errors from year-to-year. This conclusion is supported by the fact that in some instances other *Empidonax* did not vary in parallel with Least Flycatchers (unpublished data).

A remarkable feature of the annual cycle of the Least Flycatcher is the short time which the adults spend on the breeding grounds. Based on the 1966–1968 migrations, this amounts to an average of no more than 64 days, if we conservatively assume that Long Point is a 1-day flight to and from the breeding grounds. As pointed out elsewhere, adults must move southward almost immediately upon completion of their final nesting attempt (Hussell 1980). Early departure is related to the post-migratory timing of the molt of the flight feathers (Dwight 1900, Johnson 1963, Hussell 1980).

According to Johnson (1963), postjuvenal molt occurs on the breeding grounds and late phases are probably completed during migration; it involves the body plumage almost exclusively. Presumably, active molt in immature migrants at Long Point represented the late phases of the postjuvenal molt and this interpretation is consistent with the decline in molt scores as the season progressed. Johnson (1963) says that the adult postnuptial molt takes place on the wintering grounds and is apparently complete. Body plumage molt recorded at Long Point in adults during fall migration presumably represents the early stages of this molt. Unfortunately, the Long Point data provide information only on the extent of active molt and not on the stage of body molt; so the marked decline in body molt scores of adults during the fall migration is difficult to interpret. Possibly, commencement of molt tends to be delayed in later migrants, which may originate from more northern breeding grounds

or may have completed nesting later than the earlier migrants. Lack of molt in spring migrants confirms that the prenuptial molt, which takes place from mid-February to mid-May on the wintering grounds (Johnson 1963), is complete before arrival on the breeding grounds.

SUMMARY

Spring migration of Least Flycatchers at Long Point, Ontario in 1966–1968 peaked in mid-May, with a median date of 18 May and fifth and ninety-fifth percentiles on 11 May and 1 June. Males preceded females by an estimated 6 days in the spring, but there was no evidence of differences in timing of migration between sexes in the fall.

Fall migration of adults took place in July and early August, with the median in 1966–1968 on 22 July and the middle 90% of migrants occurring between 11 July and 13 August. Adults spent an average of no more than 64 days on the breeding grounds.

The peak fall migration of immatures was usually in the last days of August. In 1966–1968 the median date for immature migrants was 29 August and the fifth and ninety-fifth percentiles were on 17 August and 13 September. Fall migration of immatures in southern Ontario averaged at least a month later than that of the adults; it was 38 days later in 1966–1968.

There was essentially no molt of body plumage in spring migrants, but many adult and immature fall migrants were molting body feathers.

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