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IDENTIFICATION OF JUVENILE LINCOLN'S AND SWAMP SPARROWS

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Lincoln's and Swamp sparrows (*Melospiza lincolnii* and *M. georgiana*) are sympatric over much of their breeding range in boreal regions of Canada and the northeastern United States. Yet few banders routinely handle juveniles of both species and become familiar with their diagnostic characteristics. Several authors have acknowledged the difficulties in discriminating between *lincolnii* and *georgiana* in juvenal plumage (e.g., Bent 1968, Dwight 1900, Forbush 1929, Godfrey 1966, Peterson 1980, Sutton 1935, Swinebroad and Crebbs 1965), but no systematic attempt to evaluate distinguishing characters has been made. Individuals in first basic and subsequent plumages can be identified on the basis of conspicuous plumage differences, but juvenal plumages are highly variable, and the two species form what appears to be a continuum. In the absence of well-defined classification criteria, the potential for misidentification is large.

Various characters have been suggested to differentiate between juvenile Lincoln's and Swamp sparrows. These include the presence of throat and chin streaking in *lincolnii* and its absence in *georgiana* (Dwight 1900, Forbush 1929, Swinebroad and Crebbs 1965), the distinctly darker crown pattern of *georgiana* (Bent 1968, Dwight 1900, Forbush 1929, Graber 1955, Roberts 1932, Swinebroad and Crebbs 1965), the richer chestnut wing edgings of *georgiana* (Dwight 1900, Godfrey 1966, Roberts 1932), the grayish vs. yellow color of the upper mandible lining in *lincolnii* vs. *georgiana* (Forbush 1929, Godfrey 1966), and the ninth (outermost) primary being longer than the fourth in *lincolnii,* shorter in *georgiana* (Forbush 1929, Godfrey 1966, Ridgway 1901). To determine the reliability of these and other characters, I examined a series of known-identity individuals of both species from the same locality (285 banded birds, 24 specimens from the Canadian National Museum of Natural Sciences). This paper proposes a classification that should eliminate ambiguity in identifying these species in juvenal plumage.

STUDY AREA AND METHODS

I conducted fieldwork during 1983 and 1984 at North Point, 27 km north-northeast of Moosonee, on the southwest coast of James Bay, Ontario (51°29′N, 80°27′W). I opened 8–15 mist nets on suitable days in thickets of willow (*Salix* spp.) and alder (*Alnus rugosa*) and the shrubby borders of cattail (*Typha latifolia*) marshes immediately inland from the extensive graminoid-dominated supertidal marshes that characterize this coastline. Lincoln's and Swamp sparrows are segregated by breeding habitat in the region. Lincoln's Sparrows occupy inland fens (at least 1

km from the study site) with stunted tamarack (*Larix laricina*), black spruce (*Picea mariana*), and low willow-alder patches. Swamp Sparrows breed along brushy margins of coastal freshwater marshes. During post-fledging dispersal and southward migration (late July through mid-September), both species are abundant in wet coastal thickets.

I banded 834 individuals of the 2 species, which were either in full juvenal plumage or various stages of the first prebasic molt. Juveniles with incompletely grown remiges are not included in the following analysis. I collected data on 3 characters that seemed likely to be useful in discriminating between the species: wing length, wing formula, and mouth color. Wing length has been shown to be a reliable indicator of identity of other similar species (e.g., Lanyon and Bull 1967, Phillips et al. 1966). I measured the natural wing chord of the right wing to the nearest 1.0 mm with a stainless steel wing rule. Wing formulae have also been employed as critical characters in identifying similar species (e.g., Phillips et al. 1966, see examples in Svensson 1984). I measured the difference in length between primaries 9 and 4 of the right wing to the nearest 0.1 mm with dial calipers. This involved measuring the distance between the tips of primaries 9 and 4 in the closed wing, rather than the total length of each. Birds with broken or misshapen primaries were not measured. In 1984, I subjectively scored color of the roof of the mouth on a scale of 1–6, grading from bright yellow to gray. These 6 categories have been grouped into 3 classes (bright yellow and pale yellow, yellow-white and white, yellowish-gray and gray) in the analysis.

Prebasic molt was scored during both years on a scale of 0 to 5 (0 = all feathers old, 5 = all feathers new and fully grown), separately for the head, body, and greater coverts. This molt typically begins in the ventral tract and produces the distinctive first basic plumage. Once out of the basal sheath, incoming breast and side feathers, which may be concealed by unmolted and overlapping juvenal feathers, unambiguously reveal species identity. They are pinkish-buff or grayish-buff with narrow, black streakings in *lincolnii* (Dwight 1900) and olivaceous wood-brown with obscure brown streaking or spotting (Dwight 1900) or no markings (pers. obs.) in *georgiana*. For the analysis of species differences, I used only individuals of known identity (n = 285), i.e., those with a body molt score of 3 or greater (incoming feathers erupted from sheath and at least one-third grown). This eliminates some birds in body molt class 2 (feathers emerged from sheath and up to one-third grown) that were positively identifiable, but it excludes many more that were not (i.e., feathers barely emergent, color and pattern not evident). I assigned species identities to all remaining banded individuals (n = 549) with body molt scores of 2 or less, based primarily on my confidence in the wing formula criterion (primary 9 greater or less than primary 4), in conjunction with other plumage characters.

I collected a series of 9 *lincolnii* and 15 *georgiana,* representing a range of plumage variability, and including individuals that were especially difficult to identify. These were frozen and deposited in the National

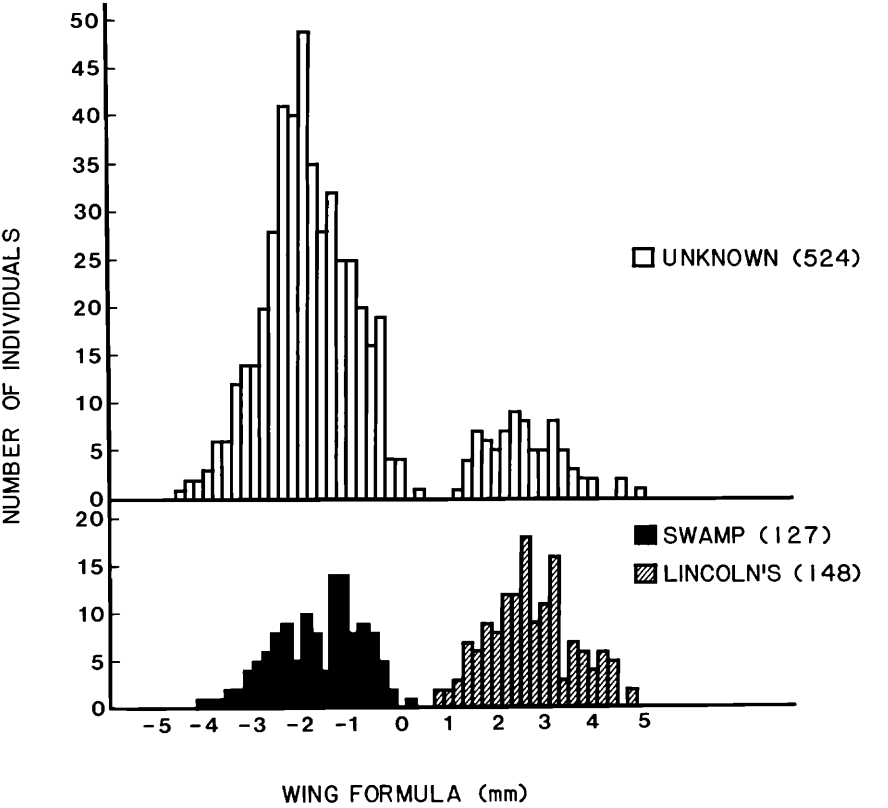

FIGURE 1. Distribution of wing formula measurements for known- (1a) and unknown-identity (1b) birds. Vertical bars represent 0.2 mm increments. Numbers in parentheses are sample sizes.

Museum of Natural Sciences in Ottawa, Ontario for preparation as study skins and were subsequently available for examination. The following were measured with dial calipers to the nearest 0.1 mm: culmen length from mid-nares to tip, culmen width at mid-nares, tarsal length, and distance between the tips of the longest (innermost) and shortest (outermost) rectrices. Tail length was measured to the nearest 0.5 mm using dividers. I subjectively evaluated 3 plumage characters on a scale of 0–3 (0 = absent, 3 = heavy or prominent): chin and throat streaking, breast and side streaking, and median crown stripe. I also scored the percent of black feathers on the crown to the nearest 10%.

RESULTS AND DISCUSSION

Wing formula.—Measurements plotted in Figure 1a were calculated with the wing formula from the sample of known-identity birds. The mean wing formula of Lincoln's Sparrows is significantly greater than

TABLE 1. Wing length and wing formula (9th minus 4th primary length) for known- and assigned-identity juvenile Lincoln's and Swamp sparrows.

Species	Sample	Wing length (mm)			Wing formula (mm)		
		n	$\bar{x} \pm SE$	Range	*n*	$\bar{x} \pm SE$	Range
Lincoln's	1[a]	153	58.4 ± 0.16	53–63	148	+2.67 ± 0.08	+0.7–4.8
	2[b]	82	58.4 ± 0.19	54–61	82	+2.98 ± 0.12	0.0–5.1
Swamp	1[a]	132	57.3 ± 0.18	53–62	127	−1.76 ± 0.08	−4.1–0.2
	2[b]	467	57.3 ± 0.09	52–62	442	−1.87 ± 0.04	−4.6–0.0

[a] Birds of known identity.
[b] Birds of assigned identity.

that of Swamp Sparrows (Table 1, $t = 39.74$, df = 273, $P < 0.001$). In fact, there was no overlap between the species. Only 1 Swamp Sparrow had its 9th primary longer than its 4th (0.2 mm), while all Lincoln's Sparrows had 9th primaries longer than the 4th by at least 0.7 mm. Thus, using 0 mm as the point of reference, 99.6% of individuals in this known-identity sample can be correctly classified. An absolute separation is achieved if a midpoint between the extreme values of 0.2 and 0.7 mm (e.g., 0.5 mm) is used as the criterion. However, such a degree of accuracy is unreasonable for most banders (see below). Therefore, the relevant criterion for identifying juvenile *lincolnii* and *georgiana* on the basis of wing formula should be: *lincolnii*—9th primary greater in length than 4th; *georgiana*—9th primary shorter than 4th.

The distribution of this measurement for 524 birds of uncertain (assigned) identity (body molt score 2 or less) is given in Figure 1b. Again there was no overlap between the two groups. Using 0 mm as the reference, I may have misclassified 2 *georgiana* as *lincolnii*, according to the above criterion of 0.5 mm. One had primary 9 longer than 4 by 0.3 mm, the other had both primaries equal in length. However, this very small error rate (0.4%) suggests (1) that the 0 mm criterion is adequate for the great majority of cases, and (2) that the wing formula measurement is a reliable means of discriminating between juveniles of these two species.

TABLE 2. Differences in wing formula measurements between original and subsequent captures of Lincoln's and Swamp sparrows, including both known- and assigned-identity birds.

		2 captures			≥3 captures		
		n	$\bar{x} \pm SE$	Range	*n*[a]	$\bar{x} \pm SE$	Range
Lincoln's	1983	24	0.33 ± 0.05	0–0.9	18 (9)	0.40 ± 0.06	0.1–1.1
	1984	7	0.36 ± 0.11	0–0.7	9 (4)	0.14 ± 0.04	0–0.6
Swamp	1983	22	0.26 ± 0.04	0–0.6	17 (8)	0.34 ± 0.09	0–1.0
	1984	19	0.27 ± 0.04	0–0.6	16 (8)	0.22 ± 0.06	0–0.8

[a] Number of recaptures (number of individuals).

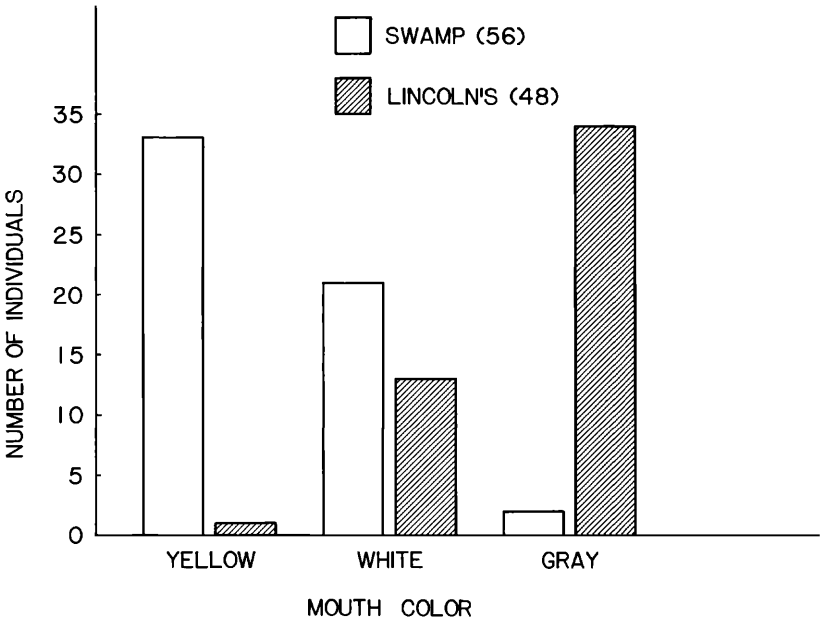

FIGURE 2. Distribution of mouth color scores for known-identity birds. Numbers in parentheses are sample sizes.

Wing formula is admittedly difficult to measure in the field, and a level of accuracy to 0.1 mm may not be feasible for most banders and in any case cannot be reliably repeated. Table 2 shows the repeatability of my measurements on 101 recaptured birds. Overall, mean differences in wing formula measurements between original and subsequent captures were 0.33 mm ± 0.03 SE for Lincoln's Sparrows (n = 44 birds, 58 recaptures) and 0.27 mm ± 0.03 SE for Swamp Sparrows (n = 57 birds, 74 recaptures). There were no significant differences in measurements between birds captured twice and those captured three or more times. This character is clearly subject to considerable measurement error, but with practice and precision dial calipers, most banders should be able to achieve consistent accuracy to 0.5 mm or so. However, visual inspection of relative lengths of primaries 9 and 4 will suffice in more than 99% of cases, based on my samples. For birds with wing formula values between 0 and 0.5 mm, other characters (see below) should be used in conjunction.

Mouth color.—The distribution of mouth color classes is shown in Figure 2. This character is reliable for discriminating between juvenile *lincolnii* and *georgiana* only at its 2 extremes, yellow and gray. Based on this criterion alone, 5% of birds with gray mouths would be misidentified as Swamp Sparrows, and 3% of yellow-mouthed birds would be incorrectly classified as Lincoln's Sparrows. However, the intermediate category (white) accounts for 37% of *georgiana* and 26% of *lincolnii* in this

sample. Thus only 58% and 71% of Swamp and Lincoln's sparrows, respectively, can be correctly identified on the basis of mouth color, and this character should not be used alone to differentiate between the species. However, yellow or gray mouth color can be used as strong corroborative evidence in combination with wing formula, particularly if values of the latter are between 0–0.5 mm.

Wing length.—Mean wing chords for the known-identity sample are significantly different (Table 1, $t = -4.67$, df = 283, $P < 0.001$), but the nearly complete overlap indicates that this measurement is not useful for identification of the species. The wide range in wing length probably reflects sexual dimorphism. Although I could not determine the sex of banded birds, mean wing lengths of the 24 specimens were: *lincolnii*—male: 60.4 ± 0.87 SE ($n = 7$), female: 58.0 mm ± 0.0 SE ($n = 2$); *georgiana*—male: 58.0 mm ± 0.43 SE ($n = 7$), female: 56.9 mm ± 0.4 SE ($n = 8$). Godfrey (1966) reported mean wing lengths for adult specimens as: *lincolnii*—male: 63.5 mm, female: 58.9 mm; *georgiana*—male: 60.7 mm, female: 57.6 mm. Mean wing chords for the unknown sample are again significantly different for the 2 groups (Table 1, $t = 4.96$, df = 547, $P < 0.001$), but this character clearly does not allow discrimination between juvenile Lincoln's and Swamp sparrows.

Specimens.—None of the mensural characters provides a clear basis for differentiating between the species (Table 3), but results are inconclusive due to the small sample size. Several qualitative trends in plumage characters are apparent in Figures 3 and 4, which illustrate both the range of variability within each species and the close between-species similarities. Throat and chin streaking is not a valid character for identification (Fig. 3). All *lincolnii* I examined showed some streaking; 8 of the 14 *georgiana* lacked streaking, but 6 had light to moderate amounts. Breast and side streaking tends to be heavier in *lincolnii,* but there is much variation (Fig. 3). Swamp Sparrows have consistently darker chestnut wing edgings, but this character is too relative and subjective to serve as an identification criterion. Crown pattern (Fig. 4) appears to be the most reliable plumage feature, although there is some overlap. Swamp Sparrows consistently, but not invariably, have a more solid and blacker crown with less buff and gray streaking than Lincoln's Sparrows. I have never examined a *lincolnii* with a largely solid black cap, but *georgiana* regularly show the streaky black, brown, and buffy-gray crowns typical of *lincolnii.* Both species have a median crown stripe of buff-brown or buff-gray that is often more distinct in *georgiana* because of the marked contrast with its black cap. In short, crown pattern is highly variable in juvenile Swamp Sparrows, but is a useful corroborative character at the black end of its range.

Song Sparrows.—All published descriptions of juvenile Lincoln's and Swamp sparrows compare them to congeneric Song Sparrows (*Melospiza melodia*), since juvenal plumages of the three are very similar. However, banders should encounter little difficulty in discriminating between Song Sparrows and the other two *Melospiza* species. Juvenile Song Sparrows

TABLE 3. Mensural data on juvenile specimens of Lincoln's and Swamp sparrows.

Species	*n*	Culmen length from mid-nares (mm) $\bar{x} \pm$ SE (range)	Culmen width at mid-nares (mm) $\bar{x} \pm$ SE (range)	Tarsus length (mm) $\bar{x} \pm$ SE (range)	Tail length (mm) $\bar{x} \pm$ SE (range)	Tail formula (mm) $\bar{x} \pm$ SE (range)	% black in crown $\bar{x} \pm$ SE (range)
Lincoln's	9	7.7 ± 0.15 (7.3–8.7)	4.1 ± 0.07 (3.7–4.3)	20.9 ± 0.22 (20.2–21.7)	55.5 ± 0.25 (54.5–56.0)	5.7 ± 0.23 (5.0–6.6)	42 ± 1.47 (40–50)
Swamp	15	7.7 ± 0.05 (7.4–8.1)	4.0 ± 0.03 (3.9–4.2)	21.5 ± 0.10 (20.9–22.3)	55.3 ± 0.43 (52.5–58.5)	7.8 ± 0.22 (6.3–9.2)	57 ± 4.42 (30–80)

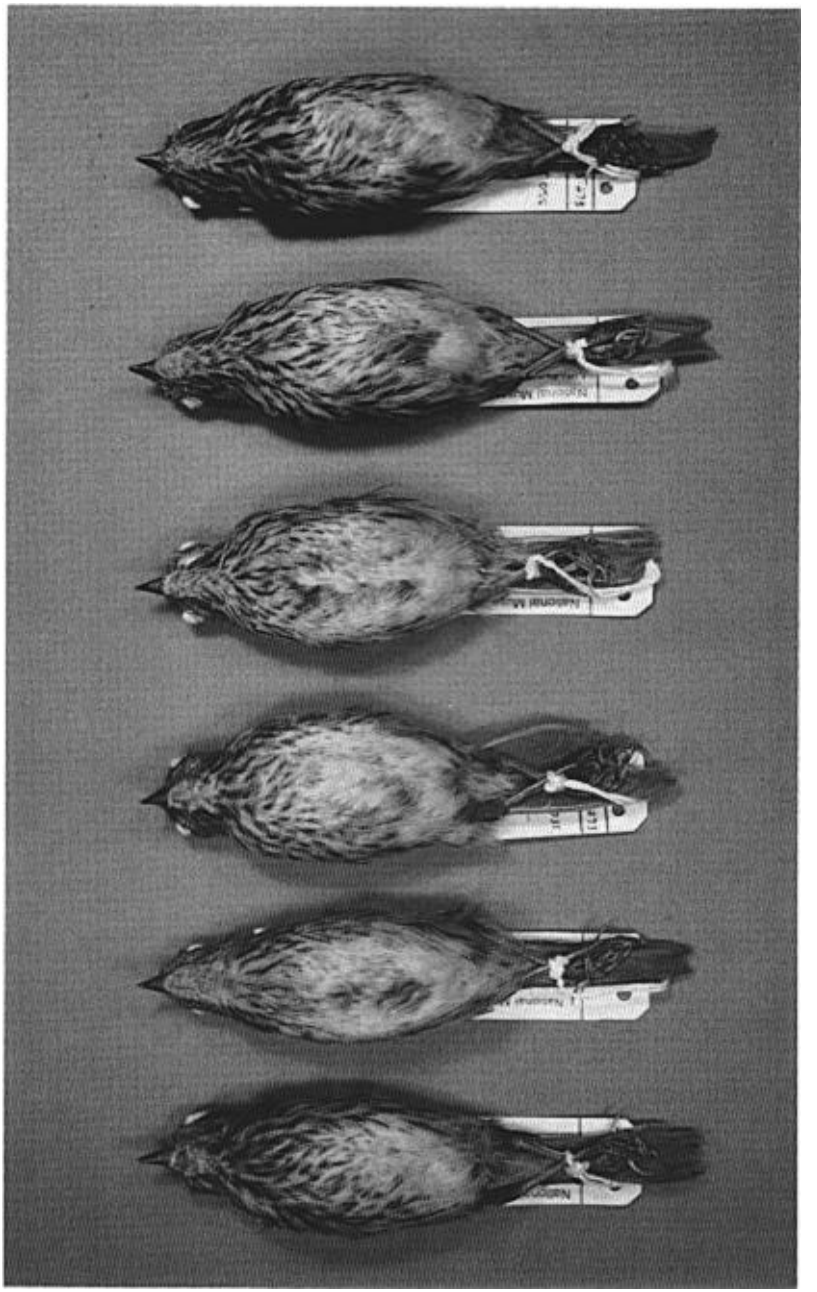

FIGURE 3. Ventral aspects of juvenile specimens of Lincoln's and Swamp sparrows from North Point. The 3 birds at left are *georgiana*, the 3 at right *lincolnii*.

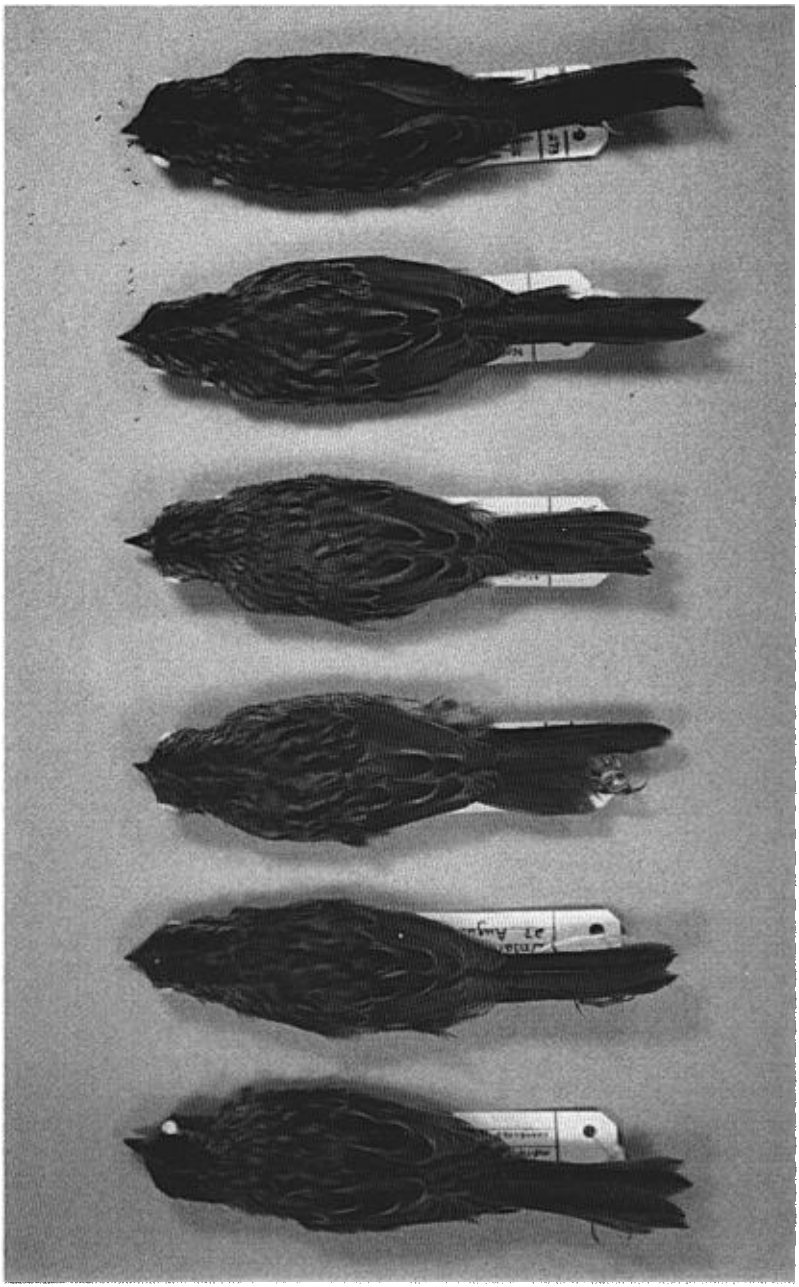

FIGURE 4. Dorsal aspects of juvenile Lincoln's and Swamp sparrow specimens from North Point. The 3 birds at left are *georgiana*, the 3 at right *lincolnii*.

are unmistakably larger, particularly in bill thickness (depth and width; e.g., Sutton 1935, pers. obs.), and tail length (Forbush 1929, Godfrey 1966, pers. obs.). The mean tail length of 23 specimens in juvenal and first basic plumage from northern Minnesota (Bell Museum of Natural History, *juddi* subspecies, which also breeds at North Point) was 64.7 mm ± 0.49 SE (range = 61.0–70.0, compare to Table 3). The malar stripe is conspicuously white in *melodia,* but is buffy or buffy-white in *lincolnii* and *georgiana* (North American Bird-Banding Manual, U.S. Fish and Wildlife Service 1977, pers. obs.). I did not collect wing formula or mouth color data on juvenile Song Sparrows at North Point, although Forbush (1929) and Godfrey (1966) suggest that these are useful characters. Corroborative measurements from the 34 individuals I banded include wing length (mean = 61.7 mm ± 0.28 SE, range = 60–66 mm, compare to Table 1) and body weight (mean = 19.1 g ± 0.32 SE, range = 16.5–26.4 g). A random sample of 35 *lincolnii* and 35 *georgiana* had mean weights of 15.7 g ± 0.19 SE (range = 13.8–18.4 g) and 15.0 g ± 0.16 SE (range = 13.5–17.0 g), respectively. Despite overlap in wing lengths and weights, the combination of tail length, bill thickness, and malar stripe color should enable nearly complete discrimination between juvenile Song Sparrows and Lincoln's or Swamp sparrows.

PROPOSED KEY TO *MELOSPIZA* SPECIES IN JUVENAL PLUMAGE

(applicable only to birds with full-grown flight feathers)

1A. Tail 60 mm or longer, malar stripe white ..... Song Sparrow
1B. Tail shorter than 60 mm, malar stripe buffy or buffy-white ..... See 2
2A. Color and pattern of incoming first basic breast and side feathers clearly evident ..... See 3
2B. First prebasic molt not yet in progress, or color and pattern of incoming first basic breast and side feathers not evident ..... See 4
3A. Incoming first basic breast and side feathers buffy with narrow, well-defined black streaking ..... Lincoln's Sparrow
3B. Incoming first basic feathers of breast and sides brownish and unmarked or with obscure dark streaking ..... Swamp Sparrow
4A. Primaries 9 and 4 not equal in length ..... See 5
4B. Primaries 9 and 4 equal in length ..... See 6
5A. Primary 9 longer than primary 4 ..... Lincoln's Sparrow
5B. Primary 9 shorter than primary 4 ..... Swamp Sparrow
6A. Color of roof of mouth grayish or yellow ..... See 7
6B. Color of roof of mouth whitish ..... See 8
7A. Color of roof of mouth grayish ..... Lincoln's Sparrow
7B. Color of roof of mouth yellow ..... Swamp Sparrow
8A. Crown largely solid brownish-black or black ..... Swamp Sparrow
8B. Crown streaked with brown, black, and buffy-gray ..... Unknown

(Note: Couplets 6–8 should be used to corroborate identification of birds that key out under couplet 5, especially those with primary 9 longer than 4 by 0–0.5 mm. If doubt exists, identity = unknown).

SUMMARY

Because of continuous variation in plumage characters, identification of juvenile Lincoln's and Swamp sparrows is impossible on the basis of

qualitative plumage differences. In attempting to discriminate between the species, banders should first carefully examine the breast and sides for the presence of incoming basic feathers. Once erupted 1–2 mm from the sheath, these clearly differentiate *lincolnii* from *georgiana*. For birds not advanced to this stage of the prebasic molt, a virtually unambiguous separation is achieved using a wing formula criterion, i.e., relative lengths of the 9th and 4th primaries. In my samples, all Lincoln's Sparrows had the 9th primary *longer* than the 4th, while 99% of Swamp Sparrows had the 9th primary *shorter* than the 4th. Color of the upper mandible lining (roof of the mouth) is a reliable character only at its two extremes, yellow (*georgiana*) and gray (*lincolnii*). Intermediate birds, i.e., those with whitish mouth color, should be identified only on the basis of wing formula. Banders should use both wing formula and mouth color in attempting to identify juveniles of either species. Plumage characters should be used only as corroborative evidence. Banders who handle juveniles of both species should be aware that geographic variation may affect the reliability of these criteria.

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