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ABSTRACT

Measurements of the widths of the notched tips of primaries 10 and 9 (P10 and P9) on Eastern Kingbirds (*Tyrannus tyrannus*) were evaluated to assess reliability in identifying adult male and adult female birds in the hand. Width measurements at 5, 9, 10 and 15 mm from the tip of P10 and at 5, 9 and 10 mm from the tip of P9 were analyzed. Depending on measure, 70.0-95.6% of males could be recognized at greater than 95% reliability, while only 54.2-74.5% of females could be recognized reliably. This lesser percentage for females appeared due primarily to more widely ranging male measurements overlapping into the female range. The most applicable and reliable measurement to separate adult male from adult female was the width of P9 5 mm from the tip. It identified 95.6% of the males at 98.5% reliability and 74.5% of the females at 97.2% reliability. Among juvenile kingbirds, these same P10 and P9 tip measurements exhibited considerable overlap as to not reliably separate male from female.

INTRODUCTION

When juvenile Eastern Kingbirds leave the northeastern United States by September for wintering in South America, where their preformative molt occurs, they are separated easily from adults by their juvenal plumage which is fresh, still unworn and brownish with little or no crown patch. Their juvenal P10/P9 tips are not notched and are generally recognizable from the notching in the basic or formative primaries of the adults with the exception of a few adult females whose extent of notching is so slight as to resemble the wing tips of some juveniles.

At the same time of their departure from their breeding ground, adults are easily separable from the juveniles by having grayer rather than brownish plumage in various degrees of obvious wear, a distinctive crown patch and, except for a very few females, distinct notching of the outer two primaries. When both age classes return in May from South America, all have renewed their primaries which are now notched and their basic or formative flight feathers show slight or no wear.

Rea (1969) illustrates the shapes of the five outer primary tips of Eastern Kingbirds, distinguishing juvenile male, juvenile female, adult female, and adult male in his Figures 9a, 9b, 12 and 13, respectively. He describes the outer two primaries (P10 and P9) of the adult female as slightly notched; while in the male, P10 is distinctly notched 8 mm or more from the tip. Pyle (1997) illustrates (Figure 179) typical adult male and adult female P10 patterns, and applies the 8-mm rule to both P10 and P9 to separate males from females. Rea (1969) illustrates slight differences in P10 shape in juvenile males and females, while Pyle (1997) shows one pattern for both juvenile sexes, though indicates slight differences may exist between males and females.

In trying to apply these differences in the shape of the tip of P10 in the field, I have found that variability in the length of and narrowness of the tip and the angle of the notch can sometimes cause difficulty in deciding whether an individual bird fits the male or female pattern. To attempt better quantitative separation of male from female, I examined museum specimens and measured the width of P10 at 5, 9, 10, and 15 mm from the tip, and of P9 at 5, 9, and 10 mm. I measured the wing chord length and recorded data on age/sex, date, and location on the specimen labels.

METHODS

In order to take width measurements at 5, 10, and 15 mm from the primary tips, I modified a dial caliper as illustrated in Figure 1a by attaching with pressure sensitive tape a piece of stiffened paper measuring about 5x50 mm cut from an ordinary index card, in effect extending the length of the left jaw of the caliper. Four lines were drawn on the jaw extender, one each at 0, 5, 10, and 15 mm from the tip of the jaw. Being right handed, I manipulated the caliper in my right hand, held the specimen in the left hand exposing its left wing from which I took measurements.

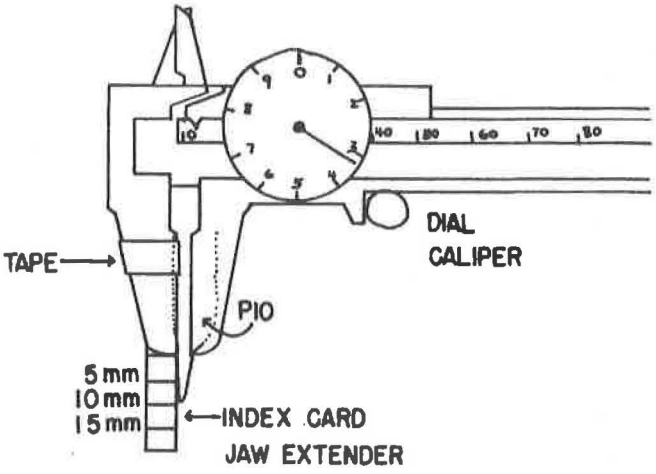

Fig. 1a. Dial caliper as modified with extender on left jaw to measure primary tip width of Eastern Kingbirds at 5, 10, and 15 mm. It is shown here superimposed over P10, measuring at 10 mm from the primary tip.

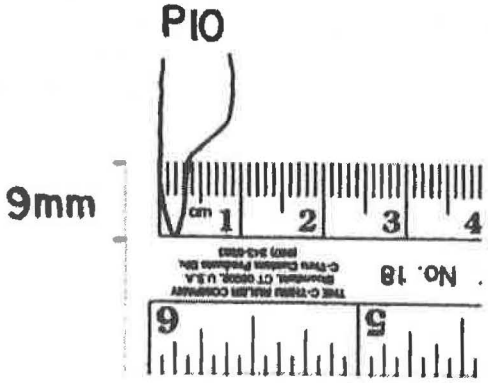

Fig. 1b. No. 18 clear plastic rule used to measure P10 and P9 widths at 9 mm from the primary tip.

While this modified caliper sufficed for museum work, it did not appear sturdy enough to survive field conditions, so a more field-worthy alternative was sought. I settled on a clear plastic 150 mm, 6" rule commonly found in stores that sell office products. It was model No. 18 manufactured by The C-Thru Custom Products Div. of The C-Thru Ruler Company of Bloomfield, CT, which was graduated at 1-mm intervals and could be estimated to 0.1 mm (see Figure 1b). Some banders carry such a rule for taking measurements, and it proved more convenient to use than the modified caliper. It so happened that its metric scale is 9 mm wide, allowing width measurements at 9 mm as shown in Figure 1b. Wing chord measurements were made with a rigid stainless steel rule without an endstop, also 150 mm long, graduated to 1 mm, and read to the nearest mm on the right wing.

I measured 25 Eastern Kingbird specimens at the New York State Museum (NYSM) in Albany, 23 from the Cornell University Museum of Vertebrates (CUMV) collection on loan to me at NYSM, and 100 specimens on loan from the American Museum of Natural History (AMNH). The 148 specimens included 71 adult males, 47 adult females, 10 juvenile males, 17 juvenile females, one juvenile of unknown sex and two specimens of unknown sex or age. Eighty-five percent of the specimens were from New York State, 8.2% from four New England states, and 6.8% from New Jersey, Maryland, West Virginia and Ohio. Collection dates were as follows: adult males, 1 May to an unspecified date in Oct; adult females, 7 May-28 Aug; juvenile males 4 Jul-14 Sep; and juvenile females 4 Jul-16 Sep.

As used here, the term "adult" refers to after-hatching-year birds with basic or formative outer primaries, while "juvenile" represents a hatching-year bird with juvenal outer primaries.

RESULTS

Data Summation - Table 1 summarizes the wingtip width and wing chord measurements of the four age/sex classes. A spreadsheet was made of all the width measurements for each of the seven primary tip criteria in Table 1 (excluding wing chord) divided into male and female measurements. That spreadsheet was examined visually to determine

Table 1. Summary of wingtip width and wing chord measurements of male (M) and female (F) Eastern Kingbird specimens where P10 and P9 refer to outer primaries 10 and 9; and /5, /9, /10 and /15 refer to the distances from the tips of these primaries where width measurements were taken in mm.

Age/Sex Class		P10/5	P10/9	P10/10	P10/15	P9/5	P9/9	P9/10	Wing Chord, mm
Ad. M	Ave.	2.42	3.29	4.16	6.43	2.91	5.31	5.99	118.2
	Range	1.8-3.0	2.3-5.7	2.59-6.0	5.4-7.5	2.01-4.4	3.3-7.0	4.78-7.2	112-124
	N	70	69	70	70	70	69	70	71
Ad. F	Ave.	3.21	5.19	5.93	7.16	4.46	6.41	6.68	112.6
	Range	2.3-3.75	4.0-6.0	4.72-6.2	6.12-7.6	3.35-5.5	5.3-7.7	5.8-7.5	107-116
	N	47	47	47	47	47	47	47	47
Juv. M	Ave.	4.71	6.04	6.37	7.05	5.76	6.70	7.01	112.6
	Range	4.16-5.3	5.5-6.7	5.73-7.1	6.33-7.9	5.2-6.3	5.8-7.5	6.38-7.8	105-117
	N	10	10	10	10	10	10	10	8
Juv. F	Ave.	5.29	6.14	6.54	7.22	5.91	6.91	7.10	109.4
	Range	4.73-6.4	5.0-7.0	5.76-7.6	6.5-7.87	5.35-6.8	6.2-7.8	5.0-7.0	102-112
	N	17	17	17	17	17	17	17	14

Table 2. Summary of primary tip widths for separating adult male (M) and adult female (F) Eastern Kingbirds where P10 and P9 refer to outer primaries 10 and 9; and /5, /9, /10 and /15 refer to the distances from the tips of these primaries where width measurements were taken.

Criterion	Width	Identifies	Reliability, %
1) P10/5	≤ 2.5 mm	70.0% of M sample	96.1
	2.6-3.0 mm	Overlap zone contains 53.7% M, 46.3% F; Accounts for 34.7% of total sample	–
	≥ 3.1 mm	54.2% of F sample	100.0
2) P10/9	< 3.8 mm	85.3% of M sample	100.0
	4.0-6.0 mm	Overlap zone contains 19.0% M, 81.0% F; Accounts for 50.0% of total sample	–
3) P10/10	≤ 4.6 mm	81.2% of M sample	100.0
	4.7-5.8 mm	Overlap zone contains 30.2% M, 69.8% F; Accounts for 36.8% of total sample	–
	≥ 5.9 mm	36.2% of F sample	94.4
4) P10/15	≤ 6.0 mm	20.3% of M sample	100.0
	> 6.0 mm	Overlap zone contains 54.4% M, 45.6% F; Accounts for 88.0% of total sample	–
5) P9/5	≤ 3.5 mm	95.6% of M sample	98.5
	3.6-4.1 mm	Overlap zone contains 21.4% M, 78.6% F; Accounts for 12.0% of total sample	–
	≥ 4.2 mm	74.5% of F sample	97.2
6) P9/9	< 5.7 mm	79.4% of M sample	96.4
	5.8-7.0 mm	Overlap zone contains 25.9% M, 74.1% F; Accounts for 50.0% of total sample	–
7) P9/10	< 5.9 mm	41.4% of M sample	96.7
	6.0-7.5mm	Overlap zone contains 47.1% M, 52.9% F; Accounts for 72.6% of total sample	–

where natural break points between male and female measurements occurred, as well as where regions of overlap occurred, and those criteria are summarized in Table 2.

By way of explanation, using the first entry of P10/5 in Table 2, it means that 5 mm from the tip of P10, a width measurement of 2.5 mm or less accounted for 70.0% of all the males measured, and 96.1% of the birds meeting that 2.5-mm criterion were males and 3.9% were females, defined here as 96.1% "Reliability," far column to the right. This 96.1% reliability meets the Bird Banding Laboratory's (BBL) standard of 95% or greater for use as an acceptable age/sex criterion. At a width of 3.1 mm or more, the measurement was 100% reliable in recognizing a female, and this applied to 54.2% of the females measured. The overlap range of 2.6-3.0 mm accounted for 34.7% of the specimens measured and was 53.7% male, 46.3% female.

Specimen Labeling – While conducting this study it became apparent that some people who had reviewed these specimens previously did not always agree with some of the original age/sex designations on the specimen labels, some dating back to 1864. This problem pertaining to sex determination, and some of its possible causes, is addressed by Clench (1976) and Parkes (1989). Among NYSM specimens, someone had changed one male to female and two females to male, with which I agreed, based on tip shape and measurements. Among CUMV specimens, some one had changed "imm." to "ad." on a female, based on worn plumage. Among AMNH specimens, a labeled "adult male" was an obvious juvenile, based on its very fresh and unworn brownish plumage lacking an adult crown patch; someone changed an adult male to female on the label, and I designated some additional changes based on tip shape/measurements and wing chord length. In total, two females were grouped and analyzed as male and nine males were treated as females among the 148 specimens.

DISCUSSION

The results in Tables 1 and 2 show that adult males tended to have narrower primary tips, especially on P10, and the narrow tips were longer than in females. But it became apparent while examining these birds that there was variability in the notching pattern not only between males and females, but within each sex class. In Figure 2 I have depicted what I saw as the extremes in the shapes of the tip of P10. Males, 2a and 2b, showed variability in the taper of the notching from steep in 2a to gradual in 2b. This variability is what caused me difficulty in applying the 8-mm criterion described by Rea (1969) and Pyle (1997) that notches of <8 mm are adult female and >8 mm are adult male. The problem became one of deciding where to place the rule to define the notch; hence, I resorted to the width measurements described here.

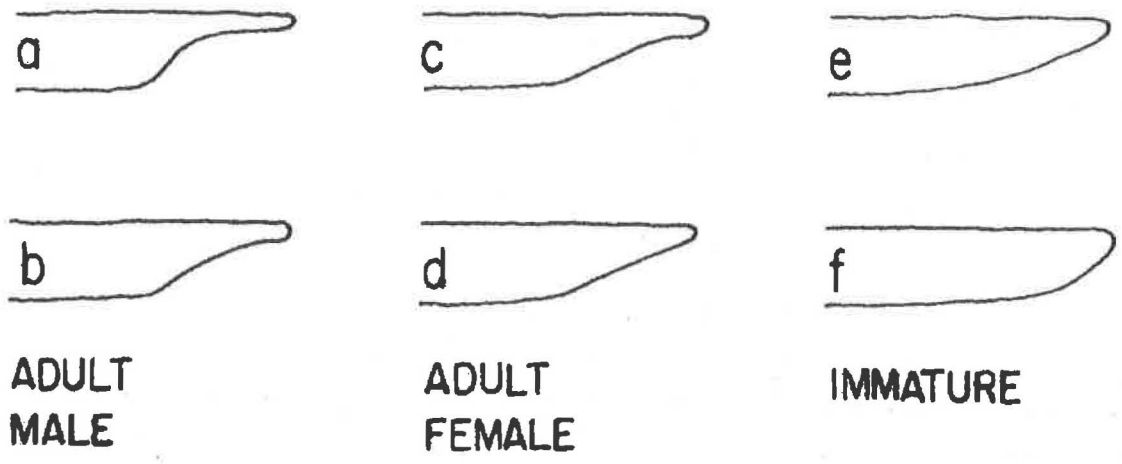

Fig. 2a-f. Range of angle of taper of P10 notch in adult male and adult female Eastern Kingbirds; and variation in tip shape of juveniles lacking notching.

Adult female tips were wider and more gradually tapered, 2c; and varied to the point of possessing almost no notch, 2d. As a result, visual inspection alone of the tip shape might confuse a 2b male with a 2c female. Juveniles, 2e and f, showed less degree of variation, sometimes resembling the 2d shape of an adult female, but there should be no reason to confuse the two because at the time on the breeding ground when the juvenile has a shape resembling that of the female, the fresh brownish juvenal plumage is distinguished easily from the grayer, worn adult plumage.

Based on the results in Table 2, P9 appeared to be a better indicator than P10 at separating the sexes. The most applicable and reliable measurement was the width of P9 at 5 mm from the tip (Criterion 5). It identified 95.6% of the adult males at 98.5% reliability and 74.5% of the females at 97.2% reliability. P10 measurements were moderately successful at identifying adult males, but identified females in a very limited fashion with only 54.2% recognizable using Criterion 1. This reduced reliability in recognizing females was due to some male measurements overlapping into the female range. Similarly, measurements made with the plastic rule 9 mm from the tip reliably recognized moderately high percentages of adult males (Criteria 2 and 6), but failed at reliably identifying females, because, as above with P10 measurements, some male measurements overlapped into the female range.

Given the advantage of the P9/5 measurement over all other measurements as a means of separating adult males from females, both the plastic rule and the caliper can be modified quite simply to allow them to be used to take this measurement. A very fine line may be scribed on the plastic rule 5 mm from its edge, and it so happens that this line coincides with the top of the "cm" notation at 5 mm in Figure 2b. Similarly, and more preferably due to its greater accuracy, the caliper may be scribed with a very fine line 5 mm from the tip of the jaws. To take the P9/5 measurement with the caliper, one would only need to insert into the open caliper jaws the P9 tip up to the 5 mm mark and adjust the width of the jaw opening to record the width. This simplified procedure eliminates the need for a fragile jaw extender as used here for museum work.

While reflecting on why some males had narrower and longer P10 tips with steeper angles of notching than did other males which tended to appear more female (wider, shorter tips and more gradual angle of notching), it caused me to wonder if this is age related, with the longer, spikier tips being definitive basic primaries belonging to after-second-year (ASY) birds, while those with more gradual angles of notching were formative primaries characterizing second-year (SY) birds. If SY male primary tips (Figure 2b) more nearly resembled those of ASY females (Figure 2c), it would possibly explain the overlapping of some male measurements into the female range, noted above.

It would require a field study with return banded birds of known age to resolve this question. And even if the hypothesis that shapes are age related proved correct, resulting in some known SY males measuring in the female range, it would not improve upon the reliability of recognizing females by measurements alone. During the peak of the breeding season, the presence of a brood patch would resolve the female identity issue; but when newly arrived on the breeding grounds and not yet in full breeding condition and then on wintering grounds outside the breeding season, brood patch would not be available and sexual identity would rely on use of measurements.

ACKNOWLEDGMENTS

I thank Joseph Bopp, Collections Manager at NYSM, for allowing me access to the museum's collection and for facilitating loans of specimens from AMNH and CUMV for my use; and to Paul Sweet and Christine Blake at AMNH and Charles Dardia at CUMV for generously supplying the specimens within their care. Peter Pyle supplied valuable, welcomed comments that improved the manuscript. I acknowledge also Gale Smith, fellow bander, who one day some years ago at Island Beach State Park, NJ, came to my net lane asking me to confirm the sex of an Eastern Kingbird he had in hand. While I knew how it should be done by primary tip shape, I had doubts about a definitive conclusion based on the shape on this bird, and thus this study was conceived.

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News, Notes, Comments

Spotted Towhee Band Size Revisited

The suggested band sizes for Spotted Towhees (*Pipilo maculatus*) are 1A-2 (Pyle 1997). It has been my impression that most banders, including myself, have found that the first recommended band size, 1A, is sometimes too small and band size 2 is a better fit. Thus, at all of my banding stations banders are required to use a leg gauge to determine the appropriate band size to use on Spotted Towhees.

Colwell (2002, 2003) suggested that Spotted Towhees could be assigned a band size based on sex and wing length. Band size 1A tends to fit females and birds with shorter wing length, while band size 2 tends to fit males and birds with longer wing length. The recommendation was that the band size for Spotted Towhees be stated as it is for Eastern Towhees: male : 2 - 1A; female : 1A - 2 (Pyle 1997). My initial impression was that this recommendation did not seem to fit with the Spotted Towhees that I captured in southern California. Thus, I decided to test this hypothesis. I also wanted to test and see if sex or wing length might be a useful predictor of band size as Colwell (2002) data showed.

I used birds captured from 2001 to 2006 at Zuma Canyon for this analysis. The Santa Monica Mountains is an east-west range located just north of greater Los Angeles in southern California. Zuma Canyon is one of numerous north-south canyons that drain south into the Pacific Ocean. This year-round constant-effort banding station is located in the parking lot of the trail head into Zuma Canyon in the Santa Monica Mountains National Recreation Area (NRA) at the end of Bonsall Avenue. The site (34°02'55" N, 118°48'44" W) is located about 1.5 km north of the mouth of Zuma Canyon, which is located at Zuma Beach. Surface water in the canyon in the vicinity of the nets is present only after heavy or persistent rains. The canyon is dry through most of the year.

All of my banders follow the same protocol described in Colwell (2002) and determine the proper band size for this species using an AVINET leg gauge. Based on geographical location, all birds are presumed to be of the subspecies *P. m. megalonyx*. (Pyle 1997).

I eliminated all birds for which there was missing information (sex or wing length) or the sex was listed as "unknown." Recaptured birds were not used in this analysis. The remaining 183 birds were used in this analysis (see Table 1).

Table 1. Number of Spotted Towhees banded using sizes 1A and 2 from 2001 to 2006 in Zuma Canyon.

Year	No. of Birds Using Band Size 1A	No. of Birds Using Band Size 2
2001	21	6
2002	20	37
2003	2	27
2004	9	18
2005	5	20
2006	6	16
Totals	**63 birds**	**120 birds**

I began by conducting a comparative re-analysis of Colwell's (2002, 2003) data (left side of Tables 2 and 3). There is almost a 4 mm difference in wing length between birds using 1A and 2 bands. A t-