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Simple technique for distinguishing Yellow-bellied Flycatchers from Cordilleran and Pacific-slope flycatchers

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ABSTRACT. Flycatchers of the genus *Empidonax* are readily misidentified in the field, in the hand, and even in museum collections. We describe a novel plumage feature that can be used to distinguish Yellow-bellied Flycatchers (*E. flaviventris*) from the two species that comprise the Western Flycatcher complex, Cordilleran Flycatchers (*E. occidentalis*) and Pacific-slope Flycatchers (*E. difficilis*). The length of the buffy fringing on the anterior edge of each secondary feather, visible on the folded wing, is significantly shorter in Yellow-bellied Flycatchers than in Western flycatchers, with minimal overlap. A definitive identification can be made using a simple formula that includes measurements of wing chord and the length of the buffy fringing along the outer edge of the first secondary (S1). This method provides definitive in-hand identification, and the difference in length of the buffy fringing on the secondaries is also a useful field mark for visual identification. Testing our method with 113 museum specimens that had been identified *a priori* based on locality, we correctly identified 112 specimens. The exception was a specimen from Illinois that had been assumed to be a Yellow-bellied Flycatcher. However, based on our formula, it was a Western flycatcher and analysis of its mtDNA sequence confirmed this result, proving the utility of our method.

RESUMEN. **Técnica simple para distinguir al Mosquetero vientre amarillo de los mosqueteros cordillerano y californiano**

Los tiránidos del genero *Empidonax* son constantemente mal identificados en el campo, en mano, y aún en colecciones de museo. Describimos un novedoso carácter de plumaje que puede ser usados para distinguir al Mosquetero vientre amarillo (*E. flaviventris*) de las otras dos especies que comprenden el complejo Mosqueteros del oeste, el Mosquetero cordillerano (*E.* occidentalis) y el Mosquetero californiano (*E. difficilis*). El largo de la franja difusa en el borde anterior de cada pluma secundaria, visible cuando el ala está plegada, es significativamente más corta en el Mosquetero vientre amarillo que en los Mosqueteros del oeste, con un solapamiento mínimo. Una identificación definitiva puede hacerse usando una simple fórmula que incluye medidas del largo del ala y del largo de la franja difusa a lo largo del borde externo de la primera secundaria (S1). Este método provee identificación definitiva en mano, y la diferencia en el largo de la banda difusa en las secundarias es también una marca útil en el campo para la identificación visual. Al poner a prueba nuestro método con 113 especímenes de museo que han sido identificados *a priori* basándose en la localidad, hemos identificado correctamente a 112 especímenes. La excepción fue un espécimen de Illinois que se ha asumido que es un Mosquetero vientre amarillo. Aún así, basándonos en nuestra fórmula, se trataba de un Mosquetero cordillerano, y análisis de secuencias de mtDNA confirmaron este resultado, probando la utilidad del método.

Key words: Empidonax, misidentification, mtDNA, vagrant birds, Western flycatchers

Visual identification of flycatchers in the genus *Empidonax* is notoriously difficult, particularly away from known breeding areas (Phillips et al. 1966, Kaufman 1990, Pyle 1997a, b). In one subclade of *Empidonax*, Yellow-bellied Flycatchers (*E. flaviventris*) and the two species that comprise the Western Flycatcher complex (Cordilleran Flycatcher, *E. occidentalis*, and Pacific-slope Flycatcher, *E. difficilis*; hereafter Western flycatchers) are especially challenging to distinguish (Heindel and Pyle 1999, Kaufman and Sibley 2002). The breeding ranges of these flycatchers overlap only in a small area of northeastern British Columbia, but their wintering distributions overlap broadly in Mexico. During migration, these species are likely to occur in central North America, and can potentially occur almost anywhere on the continent as vagrants, particularly in autumn (Howell and Webb 1995, AOU 1998, Heindel and Pyle 1999, Lowther 2000, Gross and Lowther 2011). Distinguishing Yellow-bellied Flycatchers from

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Western flycatchers is important for accurate monitoring of their population trends, distribution shifts, and phenology.

Characteristics that are useful in differentiating Yellow-bellied Flycatchers and Western flycatchers include eye-ring shape, degree of contrast on the wings, wing shape, overall plumage color, overall shape, and wing chord and tail length (DeSante et al. 1985, Pyle 1997a,b, Heindel and Pyle 1999). Unfortunately, none of these allows definitive identification. We describe a plumage feature, the extent of buffy fringing on the edges of the secondaries, that can be used for definitive differentiation of these taxa.

METHODS

We examined 40 Cordilleran Flycatchers, 40 Pacific-slope Flycatchers, and 33 Yellow-bellied Flycatchers from the Museum of Vertebrate Zoology (MVZ, University of California, Berkeley), Field Museum of Natural History (FMNH, Chicago, IL), and Museum of Southwestern Biology (MSB, University of New Mexico, Albuquerque), as listed in Table S1. Identification of these specimens had likely been assumed on the basis of collecting locality, for example, 16 of the Yellow-bellied Flycatchers had been salvaged in Illinois where Western flycatchers would have been unlikely vagrants. Most specimens were collected from July to September, but collection dates ranged from June to November. For each specimen, we measured wing chord (±1 mm) with a wing rule and the length of the buffy fringing on the outer secondary (S1), from its proximal edge to the tip of the feather, with digital calipers (Fig. 1, Appendix S1). We conducted a linear regression of the length of the buffy fringing as a function of wing chord. Using ANCOVA in R 2.13.1 (R Development Core Team 2011), we tested for possible differences in the relative length of buffy fringing (regression intercept) and its scaling relationship with wing chord (regression slope) between: (1) males and females, (2) Yellow-bellied Flycatchers and Western flycatchers, (3) after-hatch-year and hatch-year birds, and (4) Pacific-slope Flycatchers and Cordilleran Flycatchers.

Calculation of wing formula. We used the linear regression of buffy fringing length against wing chord to develop a two-parameter discriminant function to separate Yellow-bellied Flycatchers from Western flycatchers. This was simple because the slopes of the regression for each of these species were equal (0.32), although the intercepts were different. Accordingly, we used the residuals of a regression through the origin as an identification index, ID,

$$\mathrm{ID} = 0.32(\mathrm{WC}) - \mathrm{BF},$$

where BF is the length of the buffy fringing in millimeters along S1, and WC is the wing chord in millimeters. For one specimen (FMNH:Bird:472922) whose *a priori* species identification was in conflict with the identification index (ID), we attempted identification by sequencing mitochondrial DNA (mtDNA) for phylogenetic analysis (see Supplementary Appendix S1).

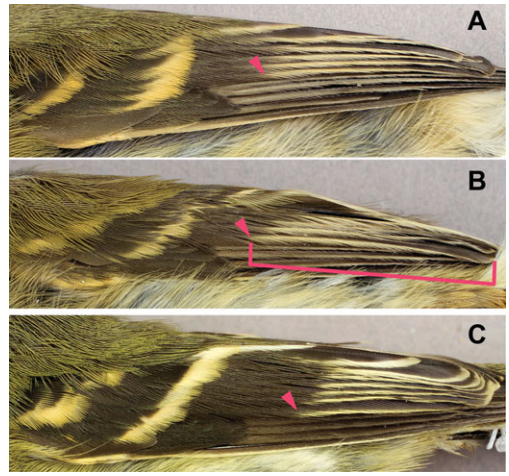

Fig. 1. Buffy fringing on the outermost secondary (S1) in (A) FMNH:Bird:472922, (B) MSB:Bird:15237 (Pacific-slope Flycatcher), and (C) MSB:Bird:30835 (Yellow-bellied Flycatcher). Triangles in each panel point to the start of the buffy fringing on the first secondary (S1). The bracket in (B) shows the extent of the measurement that we took, from the proximal edge of the buffy fringing on S1 to the tip of that feather.

RESULTS

In the regression of the length of buffy fringing on the secondaries against wing chord, Yellow-bellied Flycatchers and Western flycatchers had similar slopes, but significantly different intercepts ($F_{1,110} = 374$, $P = 0.0001$; Fig. 2). After accounting for wing chord, we found

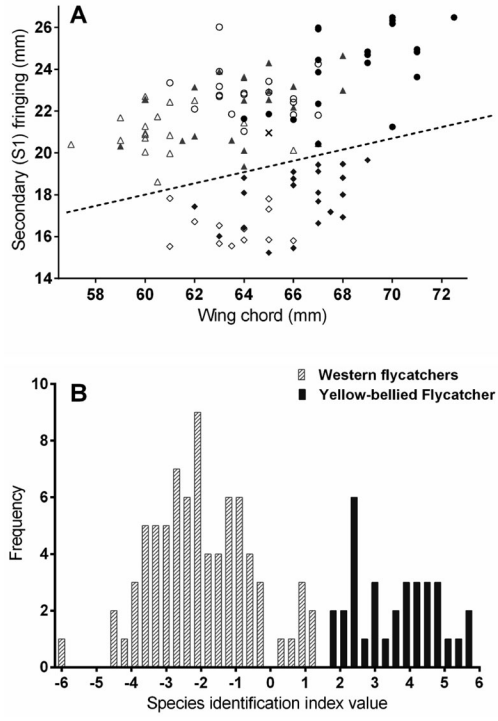

Fig. 2. (A) Length of buffy fringing on the outer most secondary (S1) as a function of wing chord, Western flycatchers ($y = 0.32x + 1.9$, $r^2 = 0.4$, $P = 0.001$) and Yellow-bellied Flycatchers ($y = 0.32x - 3.6$, $r^2 = 0.3$, $P = 0.01$). Cordilleran Flycatchers are represented by circles, females are open circles. Pacific-slope Flycatchers are represented by triangles, females are open triangles. Yellow-bellied Flycatchers are represented by diamonds, females are open diamonds. The black X represents FMNH:Bird:472922, which had been assumed to be a Yellow-bellied Flycatcher. (B) Distribution of the identification index (I) for Yellow-bellied Flycatchers (black) and Western flycatchers (hashed) based on Equation (1).

no difference in the length of buffy fringing on the secondaries between the two Western flycatchers, between sexes within any species, or between AHY and HY individuals. However, we did find a difference between Yellow-bellied Flycatchers and Western flycatchers, with Yellow-bellied Flycatchers having significantly less (S1) buffy fringing on the secondaries ($t_{83} = -17.2$, $P = 0.0001$). There was modest overlap (~1 mm) between Yellow-bellied Flycatchers and Western flycatchers in the length of buffy fringing on the secondaries (Table 1), but there was no overlap after accounting for wing length (Fig. 2). Accordingly, the largest value of ID for a Western flycatcher was 1.2, whereas the smallest value of ID for a Yellow-bellied Flycatcher was 1.7 (Fig. 2).

One specimen (FMNH:Bird:472922) from Illinois had been assumed to be a Yellow-bellied Flycatcher, but had an ID value of –0.16, placing it within the Western Flycatcher complex (Fig. 2). Other phenotypic characteristics of this specimen were also consistent with its being a Western flycatcher, and its mtDNA sequence matched previously published sequences of Pacific-slope Flycatchers (Fig. 3, see Supplementary Appendix S1 for details).

DISCUSSION

We found that the length of buffy fringing along the outer edge of S1 among Yellow-bellied Flycatchers and Western flycatchers was a reliable character for distinguishing Yellow-bellied Flycatchers from the Western flycatchers, but not for distinguishing Pacific-slope Flycatchers from Cordilleran Flycatchers.

We found that the amount of buffy fringing exhibited little overlap among species, with overlap up to ~1 mm occurring only among males (Table 1). The relationship between the amount of buffy fringing and the wing chord was sufficient to make a definitive identification (Fig. 2). We found no effect of calendar date, sex, or age on the ID of specimens collected from June to November, a series that included both fresh juvenile plumaged birds and adults. Nonetheless, we urge caution in applying this formula to birds in spring and summer because our sampling did not include specimens from this time frame and patterns of plumage wear can be unpredictable.

Our identification index will be most useful when wing chords and the length of the buffy fringing on the outer secondary can be measured on museum specimens or birds in the hand. We believe that the method will also prove useful for visual identification in the field or from photographs (Fig. 4). Observers should assess the distance between the pale tips on the distal end of the greater coverts (i.e., the lower wing bar) and the proximal end of the buffy fringing along the secondaries. This distance is noticeably longer in Yellow-bellied Flycatchers due to the lesser extent of buffy fringing on the secondaries (Fig. 1).

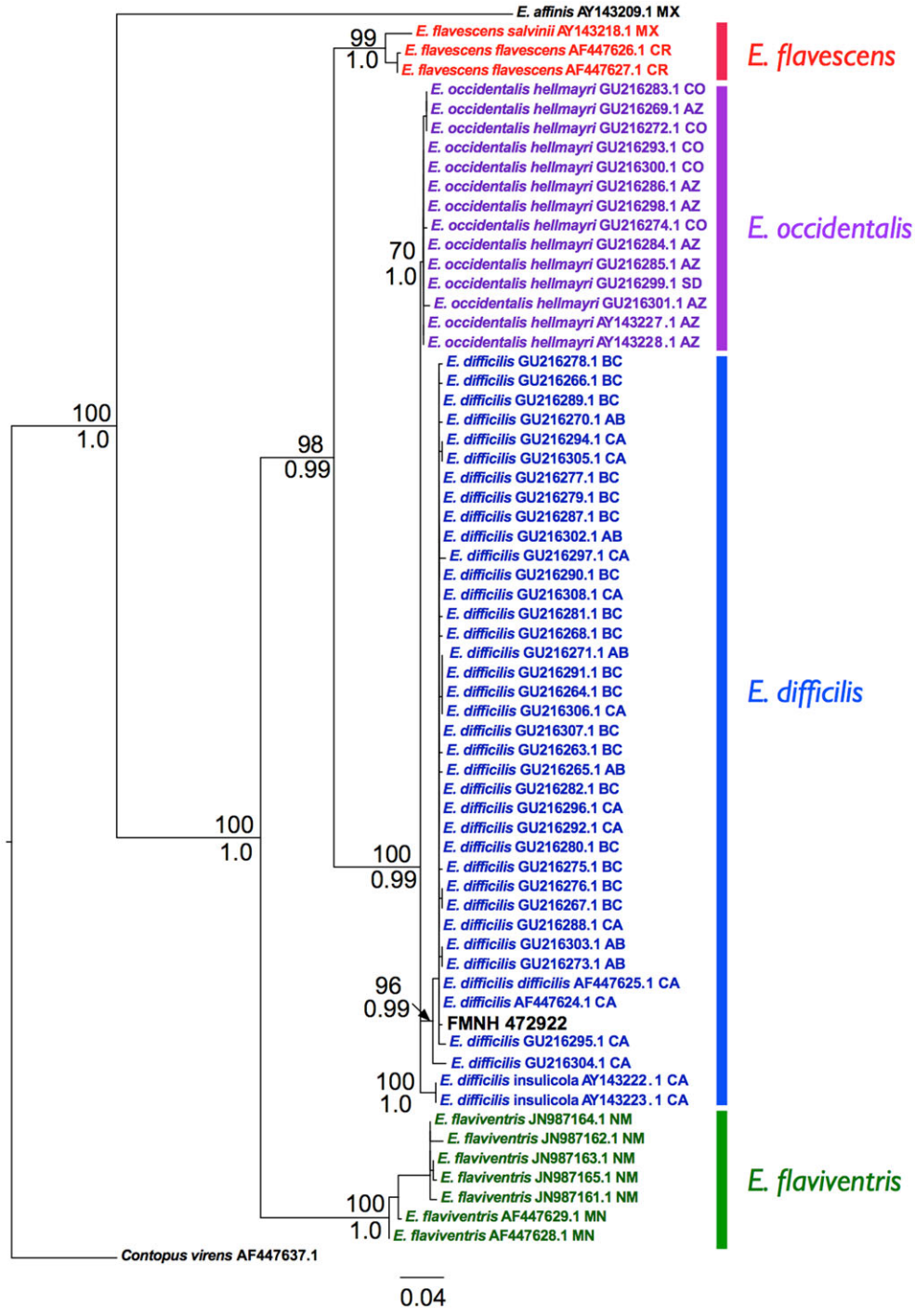

Fig. 3. Phylogeny of the "yellow-bellied" *Empidonax* species complex based on 1041 bp of the mitochondrial gene ND2. Note that FMNH:Bird:472922 is grouped with Pacific-slope Flycatcher (*E. difficilis*). Each sequence is labeled with its taxon name from GenBank, its GenBank accession number, and sampling location (AB = Alberta, AZ = Arizona, BC = British Columbia, CA = California, CO = Colorado, CR = Costa Rica, MN = Minnesota, MX = Mexico, NM = New Mexico, and SD = South Dakota).

Table 1. Length of buffy fringing on the outer most secondary feather (S1) and wing chord for each species and sex class[a].

Species	*N*	Mean S1 fringing (mm)	Range (mm)	SD	Mean wing chord (mm)	Range (mm)	SD
Cordilleran Flycatcher	38	23.5	20.4–26.5	1.7	66.4	61–72.5	2.9
Female	18	22.9	21.0–26.0	1.1	64.2	61–67	1.7
Male	20	24.1	20.4–26.5	2.0	68.5	64–72.5	2.3
Pacific-slope Flycatcher	40	21.7	18.6–24.7	1.5	62.5	57–68	2.8
Female	19	21.1	18.6–22.7	1.1	60.9	57–67	2.4
Male	21	22.3	19.4–24.7	1.6	64	59–68	2.3
Yellow-bellied Flycatcher	33	17.3	15.2–19.7	1.3	65.3	61–69	2.2
Female	12	16.4	15.5–17.8	0.8	63.5	61–66	1.6
Male	21	17.8	15.2–19.7	1.3	66.2	62–69	1.9

[a]Specimens without certain sex data were not included in this analysis.

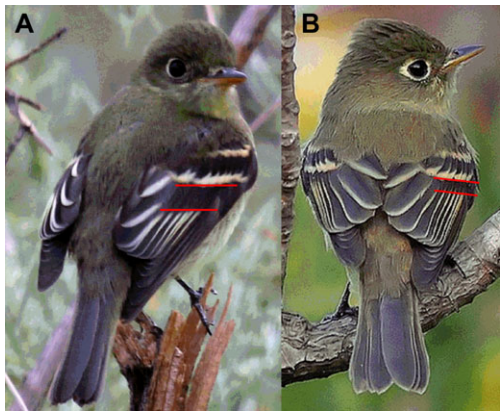

Fig. 4. Yellow-bellied Flycatcher. (A) Photo by N.D.P. and Pacific-slope Flycatcher; (B) photo by J. Ting on Flickr, demonstrating how the extent of buffy fringing on the secondaries can be useful for field identification. Lines depict the secondary "gap" that is produced by the distance from the distal end of the greater coverts (i.e., the lower wing bar) to the top of the fringing along the secondaries.

Our identification method was validated by the finding that FMNH:Bird:472922 belonged to the Western Flycatcher species complex. Its mtDNA matched published sequences of Pacific-slope Flycatchers that were divergent from those of Cordilleran Flycatchers (Fig. 3, Supplementary Appendix S1). Rush et al. (2009) found Pacific-slope and Cordilleran flycatchers were generally associated with divergent mtDNA haplotype clades, but with some mtDNA introgression. Considering that these two species recently diverged, overlap in distribution, and are geographically variable in genetics and vocalizations, it cannot be assumed that their mtDNA haplotypes provide certain species identification. We assigned FMNH:Bird:472922 to the Western Flycatcher complex, but refrain from more specific identification due to current uncertainty regarding species limits in this group (Lowther 2000, Rush et al. 2009). This specimen provides the first record of any bird from the Western Flycatcher complex in the state of Illinois (see additional details in Supplementary Information).

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SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article at the publisher's web site:

Supplementary Appendix S1

Table S1. Specimens used in the study, with measurement data, age, URL links to online specimen records, where applicable, and Genbank accession numbers. Specimens are held in the collections of the Museum of Vertebrate Zoology (MVZ), Field Museum of Natural History (FMNH), and Museum of Southwestern Biology (MSB). Specimens that did not have age data were aged by coloration of coverts, shape and wear of primary coverts, and shape of tail feathers following Pyle (1997a).

Table S2. Morphological measurements, in millimeters (mm), of FMNH:Bird:472922 compared to reported ranges for Yellow-bellied, Pacific-slope, and Cordilleran flycatchers from Pyle (1997a, b), and Heindel and Pyle (1999).

Table S3. Pairwise mean uncorrected p-distance among *Empidonax* species and FMNH:Bird:472922 based on 1041 bp of the mitochondrial gene ND2.

Supplementary Appendix S1

This supplement is intended to provide additional details on the molecular and morphological data that were used to develop and test our identification metric. We report all of the original measurement data for each specimen in Table S1. We intend this document to provide sufficient detail to support our identification of FMNH:Bird:472922 as a Western flycatcher.

Supplementary Methods

We conducted DNA sequencing and phylogenetic analysis to investigate the identity of the one bird that appeared to be misidentified by our identification metric, FMNH:Bird:472922. We extracted DNA from muscle tissue using the DNeasy Blood and Tissue Kit (Qiagen, Valencia, CA) following the manufacturer's protocol. Polymerase chain reaction (PCR) was used to amplify 1,041 base pairs (bp) of the mitochondrial gene ND2 using two overlapping primer pairs: L5219/H5766 and L5758/H6313 (Sorenson et al. 1999). Each 15 µl PCR reaction contained 1 µl template DNA, 1X PCR buffer (Invitrogen), 2.5 mM $MgCl_2$, 0.5 µm of each primer, and 0.75 units of Taq DNA polymerase. The thermal profile consisted of an initial 8 minute step at 94° C, followed by 35 cycles of 94°C for 30 sec, 50°C for 30 sec, and 72°C for 45 sec with a final 10 min extension at 72°C. A negative control was included in each PCR, although no contamination was detected. PCR products were stained with SYBR Safe (Invitrogen) and visualized on a 2% agarose gel. We purified PCR products using ExoSap-IT (USB, Cleveland, OH) and sequenced them in both directions using dye terminator cycle sequencing (Big Dye, ABI) on an ABI 3130 automated sequencer (Applied Biosystems, Foster

City, CA). Using the same methods, we sequenced five Yellow-bellied Flycatchers that were collected during fall migration at the western edge of the species' range (New Mexico) to increase our chances of sampling any significant genetic diversity that may exist within this species.

We aligned the ND2 sequence of FMNH:Bird:472922 (GenBank accession no. KJ154960) with sequences from the five New Mexico specimens of Yellow-bellied Flycatcher (GenBank accession no. JN987161.1-165.1) and previously published sequences for five *Empidonax* species that currently comprise the "yellow-bellied" clade: Yellow-bellied Flycatcher (*E. flaviventris*, 2 sequences), Pacific-slope Flycatcher (*E. difficilis*, 38 sequences), Cordilleran Flycatcher (*E. occidentalis*, 14 sequences), Yellowish Flycatcher (*E. flavescens*, 3 sequences), and Pine Flycatcher (*E. affinis*, 1 sequence). We used MEGA 5.05 (Tamura et al. 2011) to calculate uncorrected p-distances among sequences. We estimated a phylogeny for the ND2 sequence alignment with maximum likelihood (ML) in RaxML (Stamatkis et al. 2008) and Bayesian inference in MrBayes 3.2 (Ronquist et al. 2003). The optimal model of sequence evolution was determined to be GTR + G using jmodeltest2 (Darriba et al. 2012). ML analyses were conducted with 100 bootstrap replicates. Bayesian analyses were conducted as two MCMC runs of 10^6 generations each, sampling every 500 generations and discarding the first 10% of samples. The Eastern Wood-Pewee (*Contopus virens*, GenBank accession no. AF447637.1) was used as the outgroup.

Supplementary Results

One specimen from the Field Museum of Natural History (FMNH:Bird:472922) which was originally identified as a male Yellow-bellied Flycatcher and had been salvaged on 11 September 2010, at McCormick Place in Chicago, Illinois, had an identification (ID) value of -0.16, placing it well within the Western flycatcher complex. This specimen had longer buffy secondary fringing (20.9 mm) than any of the Yellow-bellied Flycatchers specimens examined in our study (longest = 19.7 mm). A detailed examination of FMNH:Bird:472922 revealed other plumage characteristics that were consistent with Western flycatcher, including olive/brown color of the mantle and head, a brownish wash across the breast, less yellow on the throat and belly, and a posterior extension to the eye-ring. Tail length and outer primary spacing were also consistent with Western flycatcher (Table S2).

MtDNA sequence analysis. Genetic distances and phylogenetic analysis revealed that FMNH:Bird:472922 is closely aligned with Pacific-slope Flycatcher. The mean genetic distance between FMNH:Bird:472922 and Pacific-slope Flycatcher was 0.2% (Table S3). In contrast, the mean distance between FMNH:Bird:472922 and the remaining *Empidonax* species ranged from 0.9% (Cordilleran Flycatcher) to 14.5% (Pine Flycatcher). FMNH:Bird:472922 was 9.2% divergent from Yellow-bellied Flycatcher. Both maximum likelihood and Bayesian analyses yielded identical topologies that grouped FMNH:Bird:472922 within a well-supported clade of continental samples of Pacific-slope Flycatcher.

Supplementary Discussion

Molecular data corroborated the identification (ID) by finding that FMNH:Bird:472922 belonged to the Western flycatcher species complex. Its mtDNA matched published sequences of Pacific-slope Flycatcher that were divergent from those of its sister species, the Cordilleran

Flycatcher (Table S3). The key published sequences for this analysis were those provided by Rush et al. (2009). Although Pacific-slope Flycatchers and Cordilleran Flycatchers appear to be readily identified by mtDNA, additional geographic sampling within these groups may reveal non-monophyly and haplotype sharing. Thus, we consider FMNH:Bird:472922 to belong to the Western flycatcher complex, and decline to make a more specific identification.

Additional morphological measurements of FNMH 472922, including WG-TL and primary spacing, provided corroborating evidence that this individual was a representative of Western flycatcher (Table S2). This record appears to represent the first record of any Western flycatcher for the state of Illinois (http://www.illinoisbirds.org/birds_of_illinois2.html#part2). The date of collection, 11 September 2010, matches the peak of this species' migration in the western states (Lowther 2000) and is similar to the timing of a Cordilleran Flycatcher that was banded in New York, 14-16 September 1995 (Halliwell 2000). However, these two records are from earlier in fall than most other eastern Western flycatcher records which span from November to January (Lowther 2000, LeGrand and Pippen 2003, Sullivan et al. 2009). It is likely that some Western flycatchers are overlooked during peak *Empidonax* migration in the east, hence the tendency for vagrants to be discovered in late fall and winter. This example highlights the importance of systematic salvage and specimen preparation efforts to build museum collections.

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Taxon	Museum and catalog no. and URL	Wing chord (mm)	Length of buffy fringing on S1 (mm)	Sex	Genbank access.	Age	Date
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:77882	64	22.86	F		Unk	8/26/1939
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:107154	67	21.81	F		HY	8/20/1908
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:111276	63	22.76	F		HY	6/17/1939
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:121908	61	23.355	F		AHY	7/24/1950
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:133179	67	24.26	F		AHY	6/13/1955
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:133180	66	21.825	F		HY	6/14/1955
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:134242	63.5	21.855	F		HY	6/1/1956
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:148354	65	23.425	F		HY	6/6/1962
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:148361	63	22.705	F		AHY	6/16/1962
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:148364	66	22.59	F		AHY	6/17/1962
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:148367	66	22.43	F		AHY	6/26/1962
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:152646	62	22.1	F		AHY	6/14/1964

E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:152654	63	26.02	F	HY	6/12/1964
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:152655	63	23.895	F	HY	6/13/1964
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:152656	64	22.795	F	HY	6/14/1964
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:152667	63	23.18	F	AHY	6/13/1964
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:162663	64	21.035	F	AHY	7/8/1973
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:162664	65	22.9	F	AHY	7/15/1973
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:65815	65	23.475	F?	HY	9/7/1934
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:143770	62	21.99	F?	HY	9/6/1961
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:6437	67	25.985	M	AHY	unknown
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:116474	71	24.955	M	HY	10/21/1946
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:125837	67	20.425	M	HY	9/1/1952
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:125838	66	21.595	M	AHY	9/8/1952
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:133177	71	24.83	M	AHY	6/16/1955
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:133178	70	21.25	M	AHY	6/11/1955
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:133182	72.5	26.485	M	AHY	6/12/1955
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:133183	70	26.185	M	AHY	6/11/1955
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:133184	69	24.85	M	HY	6/15/1955
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:134243	67	24.455	M	HY	6/1/1956
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:145950	67	22.355	M	AHY	7/7/1929

E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:148348	67	23.86	M	HY	6/4/1962
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:148349	69	24.31	M	HY	6/4/1962
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:148356	70	26.485	M	AHY	6/9/1962
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:150400	65	21.86	M	HY	6/16/1963
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:152631	70	26.34	M	HY	6/29/1964
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:152633	71	23.63	M	HY	6/6/1964
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:152641	69	24.695	M	AHY	6/17/1964
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:153326	67	25.92	M	HY	8/10/1964
E. occidentalis	http://arctos.database.museum/guid/MVZ:Bird:159488	64	21.64	M	AHY	7/2/1969
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:3038	66	20.13	F	AHY	8/18/1908
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:3040	60.5	21.74	F	AHY	8/18/1908
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:3852	60	22.71	F	AHY	8/4/1908
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:3886	60	22.55	F	AHY	8/10/1908
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:3888	60	20.95	F	AHY	8/11/1908
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:3892	62	22.51	F	AHY	8/13/1908
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:29719	60	20.71	F	HY	10/10/1918
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:33337	60	20.05	F	AHY	9/17/1906
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:33346	64	21.435	F	AHY	8/1/1906
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:46263	61	19.98	F	HY	9/27/1925

E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:46265	59	20.605	F	HY	10/19/1925
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:51356	60	20.88	F	HY	9/18/1927
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:74734	61	20.845	F	HY	9/18/1938
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:76215	57	20.4	F	AHY	8/22/1939
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:87484	60	21.28	F	HY	9/5/1942
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:89759	61	22.435	F	HY	8/11/1944
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:118521	59	21.69	F	HY	8/20/1949
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:122688	67	20.45	F	HY	9/1/1950
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:122693	60.5	18.625	F	HY	9/9/1950
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:15741	64	23.645	M	HY	8/5/1910
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:15742	64	22.51	M	HY	8/7/1910
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:27223	68	22.985	M	AHY	8/18/1916
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:29720	66	23.175	M	HY	9/20/1918
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:39819	61.5	20.585	M	HY	8/19/1919
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:54396	59	20.33	M	HY	9/28/1927
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:55312	65	22.96	M	AHY	10/23/1928
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:55314	65	22.545	M	AHY	11/20/1928
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:55315	65	24.31	M	AHY	11/24/1928
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:55316	63	23.895	M	AHY	11/26/1928

E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:55317	64	19.355	M		AHY	11/27/1928
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:55318	68	24.655	M		AHY	11/28/1928
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:87487	62	20.8	M		HY	9/17/1942
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:117233	62	23.15	M		HY	8/21/1947
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:117234	65	24.295	M		AHY	8/23/1947
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:122687	66	22.175	M		AHY	8/31/1950
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:122689	64	20.115	M		HY	9/8/1950
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:122690	60	22.58	M		AHY	8/25/1950
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:122692	63.5	20.605	M		HY	9/6/1950
E. difficilis	http://arctos.database.museum/guid/MVZ:Bird:122695	64	23.585	M		HY	9/15/1950
E. difficilis	FMNH:Bird:472922	65	20.96	M	KJ154960	HY	9/11/2010
E. flaviventris	http://arctos.database.museum/guid/MSB:Bird:4058	64	15.84	F		HY	9/9/1976
E. flaviventris	FMNH:Bird:21378	63.5	15.56	F		HY	9/1/1906
E. flaviventris	FMNH:Bird:21380	65	15.85	F		HY	9/20/1906
E. flaviventris	FMNH:Bird:25885	61	15.53	F		HY	9/2/1907
E. flaviventris	http://arctos.database.museum/guid/MSB:Bird:29831	63	16.53	F	JN987162.1	HY	9/25/2010
E. flaviventris	http://arctos.database.museum/guid/MSB:Bird:30836	66	15.81	F	JN987161.1	HY	9/18/2011
E. flaviventris	FMNH:Bird:46612	64	16.37	F		HY	8/29/1903
E. flaviventris	FMNH:Bird:153231	65	17.81	F		AHY	8/22/1945

E. flaviventris	FMNH:Bird:187279	65	17.31	F		AHY	8/26/1948
E. flaviventris	FMNH:Bird:187280	63	15.67	F		AHY	8/26/1948
E. flaviventris	FMNH:Bird:452407	61	17.83	F		HY	9/14/2006
E. flaviventris	FMNH:Bird:466856	62	16.72	F		AHY	9/2/2009
E. flaviventris	FMNH:Bird:21377	66	19.1	M		HY	9/1/1906
E. flaviventris	FMNH:Bird:21379	67.5	17.18	M		HY	8/13/1906
E. flaviventris	FMNH:Bird:25883	66	18.77	M		HY	9/2/1907
E. flaviventris	http://arctos.database.museum/guid/MSB:Bird:30835	62	17.44	M	JN987165.1	HY	9/9/2011
E. flaviventris	FMNH:Bird:46613	66	15.46	M		HY	8/31/1903
E. flaviventris	FMNH:Bird:52922	67	19.44	M		HY	9/6/1906
E. flaviventris	FMNH:Bird:52923	65	15.23	M		HY	9/6/1906
E. flaviventris	FMNH:Bird:67161	68	16.93	M		HY	8/25/1923
E. flaviventris	FMNH:Bird:102836	64	16.43	M		AHY	8/31/1941
E. flaviventris	FMNH:Bird:140703	67	18.1	M		AHY	7/31/1905
E. flaviventris	FMNH:Bird:187276	69	19.66	M		AHY	8/21/1948
E. flaviventris	FMNH:Bird:187277	68	18.01	M		AHY	8/19/1948
E. flaviventris	FMNH:Bird:187281	68	18.82	M		AHY	8/24/1948
E. flaviventris	FMNH:Bird:187282	64	18.09	M		AHY	8/19/1948
E. flaviventris	FMNH:Bird:208915	68	19.47	M		AHY	8/15/1950
E. flaviventris	FMNH:Bird:208917	67	17.69	M		AHY	8/15/1950

E. flaviventris	FMNH:Bird:325957	64	18.81	M	HY	9/29/1967
E. flaviventris	FMNH:Bird:325959	67	16.64	M	HY	9/18/1959
E. flaviventris	FMNH:Bird:362630	63	16.02	M	HY	8/20/1993
E. flaviventris	FMNH:Bird:461099	67	19.12	M	HY	8/24/2008
E. flaviventris	FMNH:Bird:466393	66	18.46	M	HY	8/31/2009

Table S2. Morphological measurements, in millimeters (mm), of FMNH:Bird:472922 compared to reported ranges for Yellow-bellied, Pacific-slope, and Cordilleran flycatchers from Pyle (1997a, b), and Heindel and Pyle (1999).

	Yellow-bellied Flycatcher	Pacific-slope Flycatcher	Cordilleran Flycatcher	FMNH:Bird:472922
WG-TL	12.2-18.7	6.0-13.3	7.2-14.9	6.5
Tail	46.0-55.0	50.0-63.0	50.0-63.0	58.5
P7-P6	2.9-4.9	1.2-3.0	1.2-3.0	1.4
P6-P5	4.1-5.5	4.2-6.2	4.2-6.2	4.8

Table S3. Pairwise mean uncorrected p-distance among *Empidonax* species and FMNH:Bird:472922 based on 1041 bp of the mitochondrial gene ND2.

	(1)	(2)	(3)	(4)	(5)
(1) FMNH:Bird:472922	-				
(2) *E. difficilis*	0.002	-			
(3) *E. occidentalis*	0.009	0.008	-		
(4) *E. flavescens*	0.051	0.050	0.046	-	
(5) *E. flaviventris*	0.092	0.094	0.093	0.082	-
(6) *E. affinis*	0.145	0.145	0.145	0.143	0.144