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Geographical variation in *Tachycineta* Swallows (Aves: Passeriformes: Hirundinidae), with description of a new subspecies from Colombia

Variación geográfica en golondrinas del género Tachycineta (Aves: Passeriformes: Hirundinidae), con la descripción de una nueva subespecie de Colombia

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Abstract

Dark-winged *Tachycineta* swallows occurring west of the Andes in Colombia have confounded observers for decades. With a view to assessing their taxonomic rank, geographical variations in voice, plumage and biometrics were studied as between western Colombian birds ("Magdalena Swallows") and all members of subgenus *Leucochelidon*, i.e. Mangrove Swallow *T. albilinea* of Central America, White-winged Swallow *T. albiventer* of East of the Andes, Chilean Swallow *T. meyeni* and White-rumped Swallow *T. leucorrhoa* of southern South America and Tumbes Swallow *T. stolzmanni* of western Ecuador and Peru. A 'yardstick' methodology was applied, measuring and comparing differentiation between species using up to 18 vocal variables across 4 vocalization types as well as 9 biometric characters. Chilean versus White-rumped Swallow are a closely-related pair of valid, sympatric species, whose measured differentiation was compared to that between Magdalena and other swallows to assess their taxonomic rank. Vocal and morphological characters gave conflicting results. The rising calls of Magdalena Swallow are diagnosable in multidimensional space from White-winged Swallow, with slower pace, less change in frequency and overall lower frequency. Also, vocal repertoire differed, with 'buzz' calls predominating in Magdalena Swallow but 'rising' calls being more common in White-winged. Measured vocal differentiation exceeded that between Chilean and White-rumped Swallows and differences in repertoire were consistent. In contrast, Magdalena Swallow was non-diagnosably differentiated in plumage and biometrics from White-winged Swallow. Magdalena Swallows usually have a darker, navy-blue mantle (this usually being aquamarine or green-blue in White-winged Swallow but variable), and reduced white markings on the secondaries and wing coverts (which are typically extensive in White-winged Swallow but variable in both, with overlap). Biometrics largely overlap but Magdalena Swallows have an average shorter tarsus and bill. The molecular biology of Magdalena Swallow is unknown. Reported pairwise molecular differentiations between other species in the genus in previous published studies were tested for correlations against measured differentiation in all vocal and biometric variables. Magdalena Swallow achieved higher differentiation in vocal variables which correlated with molecular differentiation but low differentiation in biometric variables which also correlated with molecular differentiation, again a conflicting outcome. Considering differences in voice, plumage and biometrics, the Magdalena Swallow is here described as a new subspecies. The occurrence of dark-winged White-winged Swallows in western Colombia has led to dubious claims of both Mangrove Swallow and Bahama Swallow *T. cyaneoviridis* in this region, based on sight records. A 'Colombia' specimen of Mangrove Swallow was found in this study. Together with an intermediate specimen (showing a pale lore), there is evidence of occasional vagrancy of Mangrove Swallow to northern Colombia. There is some geographical variation in biometrics and plumage among Eastern populations of *T. albiventer*, but vocal differentiation is weak. The type locality of *T. albiventer* is in Cayenne, French Guyana, whilst western Amazonian birds were once named as *aequatorialis* due to their paler blue dorsal and more extensive white wing markings, but these variations are non-diagnostic. Populations of White-winged Swallow in the Atlantic and Cerrado regions of Brazil are taxonomically undescribed. These have a greenish mantle coloration (a rare morphotype in Amazonia) and often have a longer tail and white tail tips or remiges. Measured biometric and vocal differentiation of this population closely misses requirements for subspecies rank, but study of a larger sample of Brazilian specimens should be considered.

Keywords Taxonomy, swallows, oscines, voice, biometrics, species limits, subspecies limits

Resumen

Las golondrinas *Tachycineta* con alas oscuras, que se encuentran al oeste de los Andes en Colombia, han confundido a los observadores de aves durante décadas. Con el fin de evaluar el estado taxonómico de esta población, se estudiaron las variaciones geográficas en voz, plumaje y biometría entre las aves del occidente de Colombia y todos los miembros del subgénero *Leucochelidon*, i.e., *T. albilinea* de Centroamérica, *T. albiventer* del Este de los Andes, *T. meyeni* y *T. leucorrhoa* del sur de Sudamérica y *T. stolzmanni* del oeste de Ecuador y Perú. Se aplicó una metodología con la medida y comparación de diferenciaciones entre poblaciones, estudiando hasta 18 variables vocales a través de 4 clases de vocalizaciones y además 9 variables biométricas. *Tachycineta meyeni* y *T. leucorrhoa* son especies válidas, relacionadas y simpátricas, cuya diferenciación se comparó con la diferenciación entre la Golondrina del Magdalena y otras golondrinas, para evaluar su estado taxonómico. Los análisis de caracteres vocales y morfológicos dieron resultados contradictorios. Las llamadas ascendentes de la Golondrina del Magdalena, se pueden diagnosticar en el espacio multidimensional a partir de *T. albiventer*, por su ritmo más lento, menores cambios en la frecuencia acústica y menor frecuencia acústica en general. La diferenciación vocal medida superó la de entre *Tachycineta meyeni* y *T. leucorrhoa*. Sin embargo, la Golondrina del Magdalena no se diferenciaba de manera diagnosticable ni en plumaje ni biometría a partir de *T. albiventer*. La Golondrina del Magdalena por lo general tiene la espalda oscura y azul marino (que suele ser azul verdoso en *T. albiventer*, pero variable), y manchas blancas reducidas en las secundarias y coberteras del ala (que suelen ser extensas en *T. albiventer*, pero variable en ambos, con superposición). La biometría se superpone en gran parte, pero la Golondrina del Magdalena en promedio tiene el tarso y pico más cortos. Se desconoce la biología molecular de la Golondrina del Magdalena. Se analizó posibles correlaciones entre la diferenciación molecular reportada en estudios publicados entre otras especies del género, contra diferenciaciones en todas las variables vocales y biométricas. La Golondrina del Magdalena logró una mayor diferenciación en variables vocales que se correlacionaban con la diferenciación molecular, pero una baja diferenciación en variables biométricas que también se correlacionaban con la diferenciación molecular, nuevamente un resultado conflictivo. Considerando las diferencias en plumaje, voz y biometría, se describe la Golondrina del Magdalena como una nueva subespecie. La presencia de golondrinas con alas oscuras en el occidente de Colombia, ha resultado en registros inciertos de *T. albilinea* y *T. cyaneoviridis* en esta región, basándose en avistamientos. En este estudio, se encontró un espécimen con etiqueta de 'Colombia' de *T. albilinea*. Junto con un espécimen intermedio (que muestra una mancha pálida en la ceja), hay evidencia de ocurrencia ocasional de esta especie en el norte de Colombia. Hay variación geográfica en la biometría y el plumaje entre las poblaciones orientales de *T. albiventer*, pero la diferenciación vocal es menor. La localidad del tipo de *T. albiventer* es en Cayena, Guyana Francesa, mientras que especímenes del occidente de las Amazonas fueron descritas antes como *aequatorialis*, debido a su dorsal más pálida y las manchas blancas en sus alas siendo más extensas, pero estas variaciones no son diagnósticas. Las poblaciones de *T. albiventer* en las regiones del Atlántico y del Cerrado de Brasil no están descritas taxonómicamente. Ellas tienen una coloración de espalda más verdosa (una morfología rara en la Amazonia y ausente en otras regiones) y a menudo, su cola es más larga y las puntas o rémiges de cola frecuentemente tienes márgenes blancos. Las diferencias en biométrica y voz de esa población actualmente no alcanzan los requisitos de reconocimiento de una subespecie, pero se debe considerar una muestra más grande de especímenes brasileños.

Parablas clave: Taxonomía, golondrina, oscines, voz, biometría, límites de especie, límites de subespecie

Introduction

Swallows (Hirundinidae) are among the most cherished and best studied birds, featuring in popular literature from Shakespeare and Aesop to modern times. Over two millennia ago, the overall morphology and nesting of swallows and their migratory appearance in Europe during the Summer were already documented (Aristotle c.350BC). These aerial insectivores are conspicuous and thrive in open country, modified habitats and near water bodies, often coming into contact with humans. Their ecology and behaviour are relatively well-known (e.g. Turner & Rose 1989); their phylogeny has more recently been studied, with near-comprehensive species-level sampling in the Neotropics (Whittingham *et al.* 2002, Dor *et al.* 2012, Sheldon *et al.* 2005, Cerasale *et al.* 2012). The family is remarkably cohesive, morphologically and ecologically.

In the Americas, the swallows were likely among the first of the avian families to be more comprehensively identified and described – and are therefore an unlikely candidate for a taxonomic description in the 21st century (although see Gedeon & Töpfer 2023, Bradley & Ikawa 2023). Most swallows are of limited interest to conservationists: no continental Neotropical swallow species are currently considered globally threatened (IUCN 2024), for example. Perhaps often being overlooked as 'trash species', swallows are not usually a focus of taxonomic studies these days in the Neotropics. One notable exception is the Tumbes Swallow *Tachycineta stolzmannni* (Philippi 1902). This was known only from the type series for decades (Hellmayr 1935) and was not recognized specifically until Robbins *et al.* (1997) rediscovered it and published on its voice and biometrics.

Members of the swallow genus *Tachycineta* Cabanis, 1850 are relatively slender and neat, with iridescent blue to green upperparts, white underparts and forked tails. Species are often associated with water (lakes, rivers). Most species are resident, some are partially migratory and several are restricted to particular geographical regions. Species in this genus differ from one another principally by mantle coloration and the presence or absence of a white rump, white lores, white wings and proportions.

Perhaps slipping between these cracks, unstudied properly for over a century since its distinctive plumage was first noted (Chapman 1917, Hellmayr 1935), is the dark-winged population of Swallows occurring throughout the Magdalena valley, upper Cauca/Sinú drainage and cienagas of western and northern Colombia (Figs. 1, 2, 18). This population has confused many observers: dubious records of numerous dark-winged *Tachycineta* species as vagrants have been claimed in northern Colombia, including of three predominantly Central, North American or Caribbean species (Mangrove Swallow *T. albilinea*, Tree Swallow *T. bicolor* and Bahama Swallow *T. cyaneoviridis*) (Gochfeld *et al.* 1980, Hilty & Brown 1986, Strewe 2006, Donegan *et al.* 2009, 2010a discussed below), as well as White-winged Swallow *T. albiventer*, which is considered resident (Hilty & Brown 1986, McMullan & Donegan 2014, Quiñones 2019, Hilty 2021).

Original descriptions and nomenclature

Molecular studies suggest that White-winged Swallow and Mangrove Swallow are part of a broader clade of white-rumped, bluish, largely Neotropical swallows, including Tumbes Swallow *T. stolzmanni* (Philippi 1902), a restricted-range endemic of drier habitats in southernmost Ecuador and north Peru, as well as two southern South American species, White-rumped Swallow *T. leucorrhoa* (Vieillot 1818) and Chilean Swallow *T. leucopyga* (Meyen 1834) (Dor *et al.* 2012, Whittingham *et al.* 2002, Cerasale *et al.* 2012, Brown 2019). Together, these conform subgenus *Leucochelidon* Brooke, 1974.

The names of species in subgenus *Leucochelidon* have been the subject of competing descriptions and challenges as regards nomenclature (Mlíkovský & Frahnert 2009). White-winged Swallow *T. albiventer* was originally described by Boddaert (1783, p. 32, para. 546(2)). The sole type specimen was held once in the Cabinet du Roi collection in Paris, which is no longer considered extant (see e.g. Steinheimer 2005, Donegan 2016). The specimen was illustrated by Daubenton (in Martinet *et al.* 1765-1783, vol. 6, pl. 546, no. 2) and described in detail but not named by Buffon (1779, vol. 6 p. 681) as the "Hirondelle à ventre blanc, de Cayenne". This is an unambiguous white-winged swallow with extensive wing markings. The collecting locality of Cayenne, French Guyana was one of the earlier Amazonian collecting localities used by those sourcing materials for European museums and is plausible for this species. Buffon and Daubenton's scholarly and lavishly illustrated works were originally published in French without accompanying Linnaean binominal or Latin names, which were added later in Boddaert's (1783) index. Boddaert cited "vol. 12 p. 451" of Buffon, which does not appear to be a correct citation based on digitized versions available today. Buffon's (1779) vol. 6 p. 681 has the same caption as Daubenton's plate and his description befits it. Brisson (1760, vol. 2, p. 493) was also referenced by Boddaert, although denoted with an interrogation mark "?". This citation must be excluded for purposes of assessing the type series under Article 72.4 of the Code, which excludes specimens that the author "doubtfully attributes to the taxon". Brisson's (1760) account is entitled "Hirundo dominicensis", which in that publication is a non-available name, due to the author not consistently using binominal nomenclature (as ruled in direction 105: ICZN 1963). The relevant account is of a Caribbean Martin *Progne dominicensis*, which would later be formally named by Gmelin (1789). Finally, Boddaert cites "Linn. Gen 117 o.". Linnaeus (1758, 1766) had no account corresponding to White-winged Swallows. References of this nature at the end of each account of Boddaert (1783) denoted where the species would be inserted in Linnaeus' (1766) index. Reference to Linnaeus' (1766, p. 343, section 117) is therefore merely a reference to his account of genus *Hirundo*, adding nothing to the type series. The bird in Daubenton's illustration is therefore the sole type, whose collection locality is Cayenne.

Gmelin (1789) later described *H. leucoptera* also based solely on Daubenton's illustration in Buffon (1779). That name was used for decades (e.g. Lawrence 1863), but it is an objective junior synonym of *H. albiventer* Boddaert, 1783. The name *Hirundo aequatorialis* Lawrence, 1867b is also widely treated as a subjective synonym of *albiventer* Boddaert, 1783. This was based on a specimen from the río Napo of Ecuador, a locality in western Amazonia. It was described based upon a classical Amazonian morphotype, which Lawrence (1867b) considered to be "lighter green, with no bluish shade, except slightly on the crown; the wings and rump are more conspicuously white, the latter having twice the extent of that color existing in *albiventris*". He also considered northern birds to be larger and broader-billed. Hellmayr (1935, vol. 13, pt. 8, pp. 71-73) did not recognize this subspecies taxonomically, noting that "*Birds from … Peruvian localities … have just as much white on the wings as a series from Eastern Brazil and Guiana and do not differ in any other respect, as far as I can see. The amount of white on the wings becoming greatly reduced with the progress of wear, particular care should be taken in using only specimens in comparable plumage*". Brooke (1974) inspected the type and concurred that it was a synonym.

Occurring close to the Colombia border from Panama north into Central America is the Mangrove Swallow *T. albilinea* (Lawrence 1867a). Lawrence's name (just) has priority over its subjective synonym *T. littorea* (Salvin 1863), whose publication dates were considered to be 27 April 1863 and 21 May 1863 respectively by Baird (1865, p. 300). Mangrove Swallow is considered the sister of White-winged Swallow in molecular studies

(Whittingham *et al.* 2002, Sheldon *et al.* 2005, Cerasale *et al.* 2012, Brown 2019), although in one study, the two were considered paraphyletic (Dor *et al.* 2012). In the original description, Mangrove Swallow was diagnosed from White-winged Swallow (for which the author used Gmelin's (1789) name *leucoptera*) by its less extensive white wing markings and white marking "on each side of the forehead from the nostrils to the upper eyelid" (i.e. loral).

Perhaps unsurprisingly for a group of aerial insectivores, which often perch in the open, this genus has been studied to date largely based on plumage characters. Some studies of specimens have included biometrics (e.g. Turner & Rose 1989, Robbins *et al.* 1997, Sykes *et al.* 2004, as set out in Appendix 4) but only Robbins *et al.* (1997) provided insights on voice.

Previous publications on the *Tachycineta* population of western and northern Colombia

Wyatt (1871, p. 323) first recorded White-winged Swallow from a definite locality west of the Andes, '*skimming over the Magdalena and lake of Paturia*'. One of his specimens survives and is in the BMNH (see Paratypes, 37). Chapman (1917, pp. 501-502) discussed a series from La Morelia (Caquetá, Amazon region of Colombia), noting that these were marked more extensively white in the wings than specimens from La Playa, Magdalena (paratypes 32-26 below). He considered that the variation could be racial, in which case *aequatorialis* would apply to Amazonian birds and the nominate subspecies would extend from the Guyanas into northern Colombia. With materials of both White-winged Swallows from east of the Andes and Mangrove Swallows from Central America under study, as well as a single specimen from west of the Andes in Colombia, Hellmayr (1935) commented on the reduced white wing markings of his Colombian specimen: "*A single example from the Magdalena River (La Playa) has by no means less white than certain Peruvian birds in similarly abraded condition, though it is of course quite possible that adequate material may show that the inhabitants of that region diverge in the direction of* [Mangrove Swallow] *[T.] albilinea*." Having noted the variation, he considered White-winged Swallow to occur west of the Andes, "*only in the Magdalena valley*".

The situation with the Colombian population of these swallows passed without further material comment for decades. For example, Meyer de Schauensee (1951, p. 877; 1964, p. 299) considered White-winged Swallow to occur in the Caribbean coast west to the río Atrato and in the Magdalena valley (as well as throughout Colombia East of the Andes) and Hilty & Brown (1986, p. 522, map 1092) mapped and described the same distribution, with a note considering Mangrove Swallow as "possible" in the north of the country.

Claims of Mangrove Swallow in Colombia originate with Gochfeld *et al.* (1980, p. 199), who studied birds at Isla Salamanca in northern Colombia on 24 December 1974 and 15 and 19 January 1977. The first two authors reported up to 40 *Tachycineta* sp. "*with green-blue backs and white rumps which were believed to be Mangrove Swallows Tachycineta albilinea, but the fine loral mark could not be discerned*" in 1977, with the third author reporting "*several probable Mangrove Swallows*" at the same locality in 1974. They discussed the possibility that other extralimital dark-winged swallows, Chilean *T. leucopyga* or White-rumped Swallows *T. leucorrhea* may be involved, but did not consider White-winged Swallow (nor report any white markings in the wings of these birds in their detailed account). Turner & Rose (1989, p.101-2) classified these records as 'unsubstantiated reports' of Mangrove Swallow in Colombia. Rodner *et al.* (2000) then listed Mangrove Swallow for Colombia based on sight records, citing Gochfeld *et al*. (1980), as did Salaman *et al*. (2001, p. 75), citing Turner & Rose (1989). The occurrence of White-winged Swallow west of the Andes and Mangrove Swallow as a vagrant species in northern Colombia was reflected in Salaman *et al*. (2007, p. 61; 2008, p. 59), Restall *et al*. (2006 p. 579), McMullan *et al*. (2010, p. 181; 2011, p. 181) and McMullan & Donegan (2014, p. 290).

The situation with reported Mangrove Swallows in Colombia was assessed in detail by Donegan *et al.* (2009, p. 82; 2010a, pp. 44-45; 2018a, p. 29). The former noted that records in the DATAves database (at Coveñas, Tolú Viejo by Daniel Piedrahita Thiriez) and assertions of possible occurrence in Colombia (in Turner & Rose 1989, Rodner *et al.* 2000, Salaman *et al.* 2001, 2007, 2008 and Restall *et al.* 2006, all ultimately based on Gochfeld *et al.* 1980), were unsupported by specimen or photographic evidence, calling for unconfirmed status. Donegan *et al.* (2010a, pp. 44-45) later addressed a contemporary claimed photographic record by Rob Scanlon and Carl Downing of Mangrove Swallow involving a bird with essentially no white wing markings (reproduced here in Fig. 18D). Following consultation with Álvaro Jaramillo and F. Gary Stiles, it was concluded that this was not a Mangrove Swallow but: "*an aberrant or molting White-winged Swallow Tachycineta albiventer*". It was considered that: "*the bird photographed has a trace of white on the wing. The individual is not of Tree Swallow T. bicolor or Mangrove Swallow T. albilinea due to its shade of its upperparts. The photographed individual more closely resembles Chilean Swallow T. leucopyga and White-rumped Swallow T. leucorrhoa but differs from the latter in lacking more extensive white loral markings and from both species in its more robust bill and the pattern of white on the neck*". In Donegan *et al.* (2018a), it was commented that: "*This genus presents an interesting puzzle in Colombia, muddied by noteworthy and recently-discovered intraspecific plumage variation* *in White-winged Swallow T. albiventer (Donegan et al. 2009, 2010[a]) that is presently under further review (Donegan MS). ... the detailed published observations of Gochfeld et al. (1980) ... stand as the basis for a hypothetical national record until a more detailed rebuttal or analysis is published…*".

Following Donegan *et al.* (2009, 2010a), Mangrove Swallow was treated as hypothetical or unconfirmed in South America and/or Colombia (Salaman *et al.* 2009, p. 56, 2010, p. 56; Donegan *et al.* 2015, 2016, 2018a, b; McMullan *et al.* 2018, p. 307; 2021, p. 343-344; Hilty 2021, p. 427; Echeverry-Galvis *et al.* 2022, p. 34; Remsen *et al.* 2024 and earlier editions, including before 2009). Ridgely & Tudor (2009, p. 522) considered Mangrove Swallow only "perhaps" to occur in northern Colombia. None of Del Hoyo & Collar (2016, p. 456), Avendaño *et al*. (2017, p. 68) nor Quiñones (2019) considered Mangrove Swallow to occur in Colombia at all.

Plumage variation in White-winged Swallows in Colombia was mentioned in McMullan & Donegan (2014, p. 290), who noted that "white on wings may be very limited or absent". Based on an earlier version of this manuscript, McMullan *et al*. (2018, p. 307; 2021, p. 343) then mapped populations west of the Andes in a distinct coloring scheme as an undescribed "ssp." or "ssp?", respectively, referring reduced white in the wings of this population and the latter illustrating an example of this subspecies. More recently, Echeverry-Galvis *et al*. (2022, p. 34) differed from their baseline of Avendaño *et al.* (2017) in reinstating Mangrove Swallow as hypothetical for their Colombia list, based upon an undocumented sight record at Turbo, Golfo de Urabá, Antioquia, reported in eBird (2024: checklist S22439123) by Peter Colasanti with no accompanying notes on the observation. The status of Mangrove Swallow in Colombia is discussed further in the Conclusions.

Separately, Strewe (2006) reported a sight record of a dark-mantled and dark-winged, fork-tailed juvenile *Tachycineta* in Colombia, which he identified as a vagrant of the endangered, extralimital Bahama Swallow *T. cyaneoviridis*, claiming a first national and South American record of that species. This was widely accepted as a sight record in the publications cited in this section.

Background to this paper

This present paper is the end-product of the MS referred to in Donegan *et al.* (2018a) and describes the dark-winged population mentioned by McMullan *et al*. (2018, 2021). Although I have previously observed and reported White-winged Swallow numerous times in western Colombia (e.g. Salaman *et al.* 1999, p. 37; Donegan *et al.* 2010b), the species was not a focus of studies until the situation was highlighted by records submitted when I was part of the team administering the Colombian bird checklist (Donegan *et al.* 2009, 2010a). An opportunity to study these swallows in detail arose during various *ad hoc* visits with bird observations in and around the lowland lakes of the Magdalena valley in dptos. Cundinamarca and Tolima from 2016 to 2024. Some of the localities included resident populations of *Tachycineta* swallows, allowing the study of numerous individuals, including apparently the first sound recordings of populations from west of the Andes and photographs of several birds. These observations took place in Colombia's interior where the occurrence of numerous vagrant Mangrove Swallows (or other species) including adults and juveniles at multiple sites would be implausible. At the same time, in the fourteen years since 2010 when I first started studyng these birds, an extraordinary database of photographic records has become available on eBird (2024).

Initial vocal studies based on a small sample revealed small differences between populations occurring west and east of the Andes. Searches on Biomap Alliance Participants (2006) revealed various specimens from west of the Andes. In the ICN-UN collection in 2017, F. Gary Stiles kindly investigated whether the plumage patterns observed in the field were confirmed in the Universidad Nacional specimens (see Fig. 17), kindly sharing data on the extent of marked secondaries on eastern versus western birds. All these findings suggested that an undescribed subspecies could be involved, leading to assertions of the existence of an undescribed taxon in McMullan *et al*. (2018, 2021) and development of this study.

In the remainder of paper, the term "Magdalena Swallow" refers to the resident *Tachycineta* population occurring west of the Andes in Colombia. "White-winged Swallow" refers to the population East of the Andes, *sensu stricto*, unless otherwise stated.

Previous work on the vocalizations of *Tachycineta* swallows and notes on vocal repertoire

Note: this section includes materials that might feature in an introduction (previous publications on the voice of *Tachycineta*) and methods, results or discussion (identification of vocal repertoire and different kinds of vocalizations among *Tachycineta* swallows, which have never before been studied in a comparative manner). These are combined in this initial section as a form of pre-study underlying the main study conducted here, since splitting such items out into different sections would unhelpfully disperse relevant information through the paper.

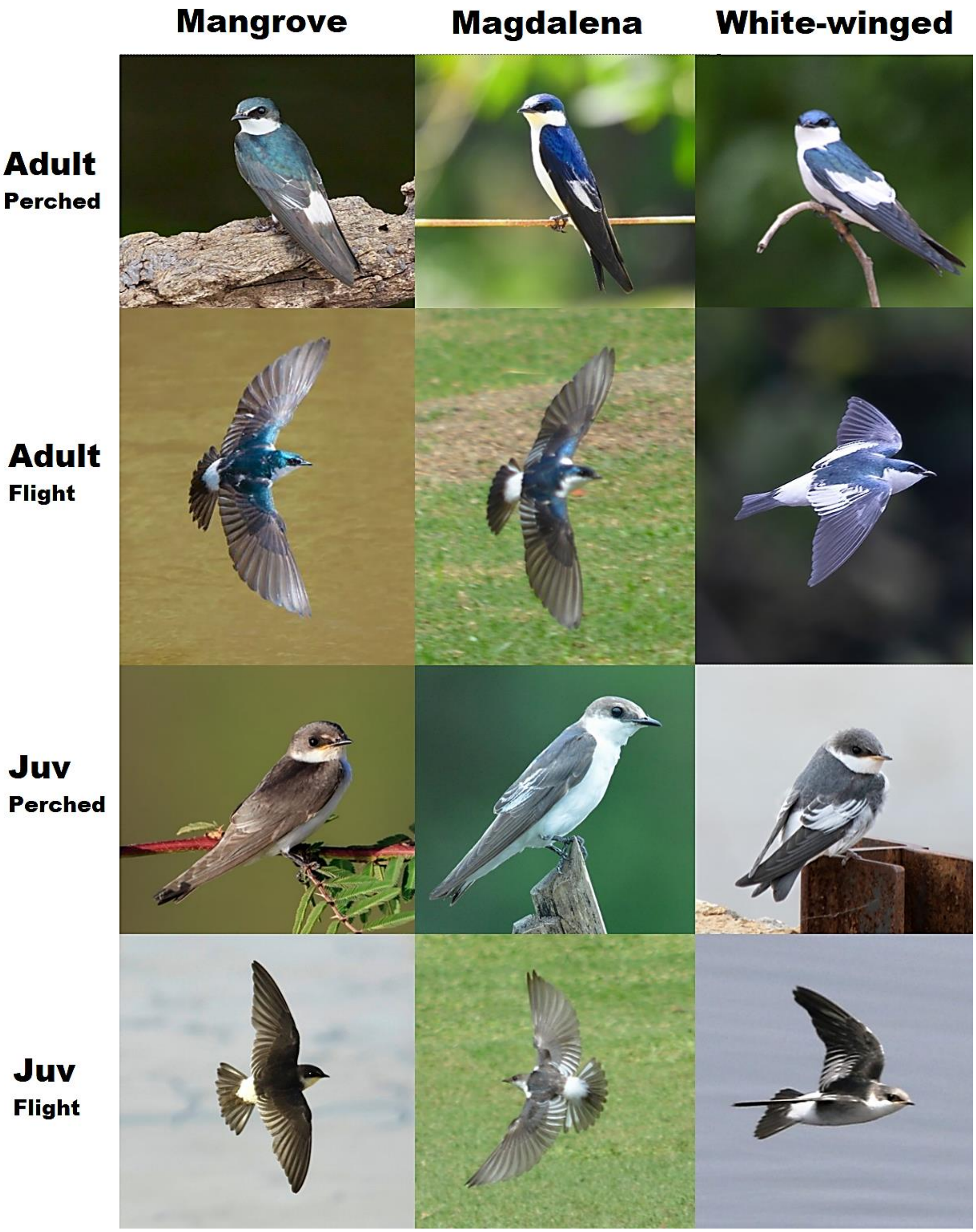

Figure 1. Typical individuals of Mangrove Swallow (left column), Magdalena Swallow (middle column) and White-winged Swallow (right column). In each case, adult perching (top, A), adult in flight (second row, B), juvenile perching (third row, C) and juvenile in flight (bottom row, D). Mangrove Swallows: A. New River waterway, Orange Walk, Belize (P. Tavares, 3 March 2015, ML38383891). B. rio Tárcoles, Costa Rica (Claudio Dias Timm, 6 March 2016). C. Crooked Tree Wildlife Sanctuary Belize (Judd Patterson / BirdsInFocus.com, 26 June 2019). D. Mirador Ciénaga Sisal, Hunucmá, Yucatán, Mexico (Erik I. Johnson/National Audubon Society, 26 July 2019, ML170725621). Magdalena Swallow. A. Vereda Lechugal Antioquia, Colombia (Edwin Múnera, 22 December 2022, ML518162381). B. El Peñón, Girardot, Cundinamarca (T. Donegan, 31 December 2021). C. Charca de Guarinocito, La Dorada, Caldas, Colombia (James Kamstra, 24 March 2023 ML 562520731). D. El Peñón, Girardot, Cundinamarca, Colombia (T. Donegan, 31 December 2021). White-winged Swallow. A. Río Guayabero, 3km W of La Macarena, Meta, Colombia (Blanca Huertas, 31 July 2023). B. Sani Lodge, Sucumbios, Ecuador (Paul Fenwick, 12 April 2023, ML592326731). C. Indaituba – Parque do Mirim, São Paulo, Brazil (André Zambolli, 17 October 2021, ML 380567531. D. Aranas Poconé, Mato Grosso, Brazil (Richard Greenhalgh, 3 September 2019, ML199395231).

Four main kinds of vocalizations can be identified, which are given by all or some of Magdalena Swallow, White-winged Swallow, Mangrove Swallow, White-rumped Swallow, Chilean Swallow and Tumbes Swallow: 'rising calls' (all species: Figs. 3-4), 'buzzes' (all species: Figs. 5-6), 'slow rising calls' (White-rumped and Chilean, examples within: Figs. 7A, C & D) and 'chatter' (White-rumped and Chilean: Fig. 7; more or less equivalent bouts being rare in Mangrove: Fig. 7E). Chips and whistles are also reported (Fig. 8), but they were rare in the sample.

The voices of White-winged Swallow, Mangrove Swallow, White-rumped Swallow, Chilean Swallow and Tumbes Swallow are all documented in sound libraries (see App. 1) and most of them have been described disparately in the field guide literature (as discussed below). However, no comparative framework has been developed that involves the identification or study of homologous vocalizations among different populations or species for this group. The only previous vocal study related to this sub-genus is that of Robbins *et al*. (1997) who, in advocating the split of Tumbes Swallow from Mangrove Swallow, published a sonogram of the main call of both species and made brief notes on how these differ. They described the flight vocalization of Tumbes Swallow as a 'single-noted buzzy call' and considered this to 'analogous to the flight calls of *T. albilinea*', which they described as more complex and differing in acoustic frequency.
Starting with the populations that are the main focus of this paper, there were no available sound recordings of Magdalena Swallow during the course of this study from 2010-2023 in online archives, at which point a few appeared. I therefore made particular efforts to obtain sound recordings of Magdalena Swallows during fieldwork. Neither Magdalena Swallows nor White-winged Swallows frequently vocalize; they are more usually mute when observed perched or in flight. Despite being among the more easily observed of South America's lowland species and tame to humans (e.g. when approached by river-boat or from the water's edge on a submerged post), there are few sound recordings. For example, eBird (2024) has just 47 sound recordings of White-winged Swallows compared to over 3,500 photographs, a low ratio even for *Tachycineta*.

In contrast, for the less widespread Chilean Swallow, there are almost double the number of sound recordings but fewer photographs. White-winged and Magdalena Swallows vocalize sporadically when flying over water or perching, but not often. When given, their vocalizations are aesthetically uninteresting churrs. Vocalizations tend not to occur even on flushing. In my observations, the most common event linked with voice was when an individual of the same species newly came into proximity of another. Perched birds will also sometimes repeat the main territorial call, but this is fairly unusual.

Both White-winged and Magdalena Swallows, and all of the other species in the subgenus studied here share two kinds of vocalizations, both of which are simple, short and involve rapid delivery of notes. Both calls sound to the naked ear as a buzz or rasp. Initially, these calls appear on sonograms as a short block of sound. However, on magnification by time, they can be seen as comprised of numerous, rapidly-repeated, individual notes.

The first and the most 'stereotypical' kind of vocalization (in terms of both consistency within species and measured between-species variation) is referred to here as the 'rising call' or 'fast rising call' (Figs. 3-4). This kind of call generally increases in acoustic frequency over time. It has been transcribed for White-winged Swallow as 'schrreet' (Sick 1993), 'zweeed' (Hilty & Brown 1986, Turner & Rose 1989), 'tree-eet?' (Ridgely & Tudor 2009), 'cheerr' (Honkala & Niiranen 2010), twe'e'e'd (Hilty 2003), 'wrreeeet' (Ridgely & Greenfield 2001, who considered this the 'most frequent call' of the species), 'a toneless, slightly rising "krch" or "wrch"' (van Perlo 2009) or a 'buzzy dzree' (Schulenberg *et al*. 2007). The same sort of call has been described for Mangrove Swallow as and as "dzreet, dzreet" (Ridgely 1976, Ridgely & Gwynne 1989) or 'jeet or jrrt" (Stiles & Skutch 1989) and for Tumbes Swallow as 'dzeet' (Ridgely & Greenfield 2001), or 'dree-eet' (Ridgely & Tudor 2009).

There are some variations between species which stand out. First, in a handful of White-winged Swallow recordings but more commonly in Chilean Swallow and White-rumped Swallow, the fast rising call can be more S-shaped (i.e. falling briefly, rising, and then falling again) (e.g. Fig 4B). The fast rising calls of Tumbes Swallow are so fast that, in many sonograms, it is not possible to discern individual notes, leading to Robbins *et al*. (1997) reasonably describing such calls as being comprised of a single note. However, on amplification of sonograms of stronger recordings, it is possible to discern repeated individual notes, at often over 100 notes/s.

The second kind of call given by all the species under study ('buzz': Figs. 5-6) is also fast but tends to have notes of broadly similar bandwidth, which are usually flat in frequency, or increase or decrease moderately in acoustic frequency over time. The buzz call was transcribed for White-winged Swallow as 'chewrr' by Sick (1993) or 'cherp' by Honkala & Niiranen (2010), for Mangrove Swallow as 'buzzier chirps' or 'burry chips' (Howell & Webb 1995) and for White-rumped Swallow as 'toneless, short "zzt"' (van Perlo 2009), for Chilean Swallow as 'a harsh, nasal buzzy "dzzk"' (Schulenberg *et al*. 2007). These calls or possibly the rising call were described by Turner & Rose (1989) for Mangrove, White-winged and White-rumped Swallows as a 'short harsh alarm'.

There are then various kinds of vocalizations which are given only by some of the species in this group. First, White-winged and Magdalena Swallows occasionally deliver slow whistles (Figs. 8A-E) but these are rare (<10% of recordings) and so they were not studied in detail.

Turning to Mangrove Swallow, its main call (as depicted in the sonogram in Robbins *et al.* 1997 and described above) is a rising call which is slower than that of all the other species. This call involves sequences of notes which sequentially increase in frequency and so they are structurally similar to the rising call of Magdalena and White-winged Swallow, albeit slower with thicker, variable and slower note shapes. They are indeed so slow that Howell & Webb (1995) reasonably transcribed these quite differently to the rising calls of other species, as 'varied chirping calls, 'chiri-chrit', 'chrit' or 'chriet'. These calls sound more like a chirrup than a rasp and can have greater variation in note shape than in the other two species. This species has never been recorded giving a faster rising call. It seems that in Mangrove Swallow, the functions of the two calls seen in Magdalena Swallow may be reversed or different, with the (slower) rising call being the main contact or flight call in Mangrove Swallow. However, since the two kinds of call map clearly to the two structurally similar calls of White-winged, the buzzes and rising calls of both species were here treated as homologous with one another and not in reverse.

Chilean Swallow and White-rumped Swallow, which are considered sisters of one another in molecular phylogenies (Whittingham *et al.* 2002, Sheldon *et al.* 2005, Dor *et al.* 2012, Brown 2019), both give fast rising calls and buzzes, but these are not the main vocalizations. Instead, these species share a more diverse vocal repertoire and seem to have a different ecology and vocal behaviour to the other species in the subgenus. The numerous available sound recordings of these two species are dominated by 'slow rising calls' and 'chatter' (Fig. 7; Table 3, App. 1). Chatters have been described for White-rumped Swallow as 'long soft tremulous notes, followed by others shorter and more hurried and sinking to a murmur' (Sclater & Hudson 1888), a 'broken warbling song', given 'continuously' (Wetmore 1926), 'a dawn song, uttered in flight like the famous daytime song of the Eurasian Skylark, *Aulada arvensis*' (Sick 1993), 'a long series of various warbling notes, given at slowish tempo' (Honkala & Niiranen 2010) or a 'jumble of "zzt" and "zr" notes and gurgling, rapidly descending "pri-ri-ri-row"' (Van Perlo 2009). For Chilean Swallow, these calls are described as 'three or four high-pitched gurgles followed by lower guttural sounds (Humphrey *et al.* 1970) or 'a varied, gurgling, liquid series lasting c. 2 s, sometimes prolonged if excited' (Jaramillo *et al.* 2003) or 'pri-ri-ri' (Van Perlo 2009). Chatter involves a series of short calls in sequence. Some of these calls are high or low trills; some involve repeated double notes; some involve alternating high and low notes with linear note-shape (typically towards the end of sequences); some involve up-down frequency modulations with no breaks between 'notes', just turning points; some are lower churrs or higher trills. Often, slow rising calls are given at the start of these sequences or as a prelude to or within them; sometimes, slow rising calls and fast rising calls are delivered as a phrase within these sequences. Chatter is not found in the other species, although some recordings of Mangrove Swallow included sequences of slower-delivered notes that could be considered roughly analogous (Fig. 7E).

Linked to their different vocal repertoire, these two species appear to have a different ecology from the others, being described as 'gregarious' outside the breeding season (Ridgely & Tudor 2009). In this aspect, they are unlike White-winged and Magdalena Swallows, which are typically (but not always) seen as loners or in pairs, with juveniles probably ceasing to associate with their parents within a few months after fledging.

Methods

In order to assess taxonomic rank of the Magdalena Swallow, a detailed study of voice, biometrics and plumage was undertaken, in which White-winged Swallow, Mangrove Swallow, White-rumped Swallow, Chilean Swallow and Tumbes Swallow were also studied. This was done with a view to assessing whether differentiation between the Magdalena Swallow and White-winged Swallow was less or greater than that observed between recognized species in this genus, i.e. applying a yardstick approach (cf. Isler *et al.* 1998, Helbig *et al.* 2002) to assess taxonomic rank. Statistical tests developed by Donegan (2018) were used to measure pairwise differentiation for continuous variable datasets in multidimensional space. These methods test the null hypothesis that the Magdalena Swallow is not differentiated from White-winged Swallows occurring East of the Andes (or other species in the group) then if disproven, measure any such differentiation.

Fieldwork

This study was first inspired by observable plumage differences between *Tachycineta* populations in the field in Colombia. I carried out five periods of casual fieldwork during 3-5 days each at three sites which supported good populations of these swallows, all of which include a large artificial lake and streams with adjacent woodland, scrub or trees. These were located in three municipalities and two departments of the middle Magdalena Valley of Colombia:

(a) Hacienda La Estancia, Melgar, Tolima (4°12'N, 74°41'W) (5 to 7 January 2016 and 29 December 2016 to 2 January 2017);
(b) El Imperio, Carmen de Apicalá, Tolima (4°09'N, 74°43'W) (23 to 28 December 2018); and

(c) El Peñon, Girardot, Cundinamarca (4°19'N, 74°46'W) (29 December 2021 to 2 January 2022 and 29 December 2023 to 2 January 2024).

Multiple photographs of birds in the field were taken and several sound recordings of the western population, being apparently the first ever recordings and indeed the only recordings of the most important 'rising song', were eventually made.

Voice

Although not renowned songsters, swallows are oscine Passerines, and so form part of the main songbird radiation of birds. In oscines, vocalizations are learnt and not innate (Kroodsma & Pickert 1984). Vocal differences are nonetheless evident between related allopatric populations of oscine birds (e.g. Cadena *et al.* 2007, Donegan & Avendaño 2010, Donegan 2014). Vocal differentiation often accompanies molecular differentiation in oscines (e.g. Cadena & Cuervo 2010, Gutiérrez-Pinto *et al.* 2012). Physiological factors such as gape muscle strength and bill mass will likely influence the vocal repertoire of oscines, e.g. their ability to trill at given speeds or deliver notes of certain lengths or frequencies (e.g. Podos *et al.* 2004), and vocal differentiation is considered relevant to species limits in all birds (e.g. Helbig *et al.* 2002, Tobias *et al.* 2010). Voice is also often driven by sexual selection and ecological and behavioural factors. Therefore, a vocal study is considered relevant to assessing differentiation and taxonomic rank of these swallows.

All the sound recordings in the xeno-canto and Macaulay (eBird 2024) libraries were studied of Magdalena Swallow (10 recordings comprising 7 previously unpublished recordings of the author, 1 archived recording and 2 recordings extracted from online videos); White-winged Swallow 90 recordings (86 excluding duplicates and continuations); Mangrove Swallow 68 (43) recordings; White-rumped Swallow 101 (98) recordings and Chilean Swallow 138 (135) recordings (see list in App. 1). Sonograms were generated using Raven Lite 2.0, expanded to show only a few seconds and up to *c*.8-12kHz of acoustic bandwidth, i.e. similar detail to that shown in Figs. 3-8.

After initial analyses showed that the Magdalena population was differentiated in voice from White-winged and Mangrove Swallows, other species which form part of the same clade in molecular studies (per Dor *et al.* 2012) being all members of subgenus *Leucochelidon* Brooke, 1974, were added to the study, namely Tumbes Swallow *Tachycineta stolzmanni*, White-rumped Swallow *Tachycineta leucorrhoa*, and Chilean Swallow *Tachycineta leucopyga*. White-rumped Swallow and Chilean Swallow in particular are considered closely-related, sister species and are sympatric (at least in part of their range at some times of year), so measured differentiation between these two would serve as a yardstick to assess taxonomic rank of the Magdalena Swallow.

Sound recordings were converted to .WAV format and sonograms were viewed using Raven Lite 2.0. The following variables were initially designed as a dataset for studying differentiation between Magdalena, White-winged and Mangrove Swallows; these variables were also measured for Tumbes, White-rumped and Chilean Swallows when taxonomic coverage of the study was expanded. Measures were taken and databased using Microsoft Excel for rising calls, buzzes, chatters and slow rising songs: (i) number of notes, (ii) length (s), (iii) speed (notes/s) (derived by dividing the number of notes by the length), (iv) maximum acoustic frequency at start (kHz), (v) maximum acoustic frequency at end (kHz), (vi) change in maximum acoustic frequency (by subtracting the maximum frequency at the start from that at the end) (kHz), (vii) minimum frequency at start (kHz), (viii) minimum frequency at end (kHz), (ix) frequency bandwidth at start (kHz) (by subtracting the minimum from maximum frequency at the start), and (x) frequency bandwidth at end (kHz) (by subtracting the minimum from maximum frequency at the end).

During sampling of White-rumped and Chilean Swallows when these were added, it became clear that their rising calls differed from Mangrove and White-winged in different ways and that the above set of vocal variables did not capture the full extent of between-species variation in the group. To ensure that differentiation between Chilean and White-rumped Swallow was not under-measured, the entire set of vocalizations was studied over again for all species, with several additional variables measured or calculated for rising songs and slow rising songs only, namely: (xi) maximum acoustic frequency at trough (kHz); (xii) maximum acoustic frequency at peak (kHz); (xiii) frequency variation between start and trough (xii)-(iv) (kHz); (xiv) frequency variation between trough and peak (xii)-(xi) (kHz); (xv) frequency variation between trough and peak (xii)-(xi) (kHz); (xvi) frequency variation between peak and end (xii)-(v) (kHz); (xvii) position of trough in frequency near start (measured in s, then expressed as a percentage of call length); (xviii) position of peak in frequency towards end (measured in s, then expressed as a percentage of call length).

Up to three vocalizations were selected for study per track, based on Isler *et al.* (1998). However, rather than necessarily taking the first three vocalizations in a track, these were selected based upon examples with stronger resolution on sonograms and with a view to maximising diversity of measured variables in selected vocalizations (i.e. including both longer and shorter, higher and lower or faster and slower examples). Additional calls from the same track were included in the analysis where more than one individual was vocalizing (identified where recordist notes or features of calls indicated this). For chatter, each bout of vocalization within a phrase was treated as a separate vocalization and, to ensure equal weighting of the diverse kinds of vocalizations in each bout of chatter (which generally exceeded between-recording diversity), instead of stopping at *n*=3, all the calls in a single bout were measured for each recording, usually *c*.6-7 vocalizations from a track (see Fig. 8). For slow rising calls and chatter of Chilean and White-rumped Swallow, sample sizes of approaching or over *n*=100 were attained using only or principally the xeno-canto collection and further sampling was not carried out of the eBird (2024) collection above such sample sizes. However, the whole set of recordings of these species was still used to collect data on buzzes and rising calls and to assess predominance of call types (Table 3).

Kinds of vocalizations found in <10% of recordings (whistles for White-winged, Magdalena and Tumbes Swallow and chatter for Mangrove Swallow) were not measured or analyzed quantitatively.

Biometrics

I measured biometric data from specimens of Magdalena and White-winged Swallows at the following collections:

1. Instituto Alexander von Humboldt, Villa de Leyva (IAVH).
2. Instituto de Ciencias Naturales, Universidad Nacional (ICN-UN).
3. Natural History Museum, Tring, UK (BMNH).
4. American Museum of Natural History, New York, USA (AMNH).

I am very grateful to the following museums, which were identified as potentially relevant using the Biomap Alliance Participants (2006) database. Their curators kindly supplied photographs and biometric data on specimens in their collections or allowed visits to facilitate the same:

5. Universidad Industrial de Santander, Bucaramanga, Colombia (UIS).
6. Museo de Ciencias Naturales de la Salle, un proyecto cultural del ITM Institución Universitaria (formerly Colegio San José), Medellín, Colombia (CSJ).
7. Colección Ornitológica Phelps, Caracas, Venezuela (COP).
8. Carnegie Museum of Natural History, Pittsburgh, New York, USA (CM).
9. Cornell University Museum of Vertebrates, Ithaca, New York, USA (CUMV).
10. United States National Museum (Smithsonian), Washington, USA (USNM).
11. Field Museum of Natural History, Chicago, USA (FMNH).
12. Florida Museum of Natural History, Gainesville, Florida, USA (UF).
13. Museum of Vertebrate Zoology, Berkeley, California, USA (MVZ).
14. World Museum, Liverpool, Vertebrate Zoology collection, UK (NML-VZ)
15. Muséum d'Histoire Naturelle de Neuchâtel, Switzerland (MHNN).
16. Forschungsinstitut und Naturmuseum Senckenberg, Germany (SMF).

The following were measured: maximum wing length (mm), tail length (mm), tail fork (mm, but not all specimens), tarsus length (mm), bill length (to cranium) (mm), unfeathered bill length (to relevant part of culmen) (mm), bill width at nostrils (mm) and bill depth at nostrils (mm). Data on mass (g) was taken from specimen labels, where available. Biometric data for other species in Turner & Rose (1989), Robbins *et al.* (1997) and Sykes *et al.* (2004) were considered and compared. Due to the specimens inspected including numerous unsexed individuals and taking into account apparently low intraspecific sexual selection where this could be observed (see App. 4) and moderate sample sizes, the biometric dataset as a whole was used for statistical analyses instead of comparing e.g. males versus males only.

Plumages

The eBird (2024) photographic database expanded greatly during the period of the study; all photographs in that collection of White-winged Swallow were inspected and compared. Plumages were also studied in collections.

Within White-winged Swallow dataset

To investigate intraspecific variation within White-winged Swallow and regional variations versus Magdalena Swallow, the data set for voice (rising calls only) and biometrics was further partitioned into: (i) llanos of Colombia and northern Venezuela; (ii) Guyanan shield (sites north of the Amazon and Orinoco and east of the llanos in Venezuela, French Guyana, Guyana and Suriname, including topotypical *albiventer*); (iii) southern and western Amazonia (in Brazil, Colombia, Ecuador, Peru and Bolivia, including topotypical *aequatorialis*); and (iv) Atlantic-Cerrado (Brazil). See Fig. 2. Two Maracaibo basin recordings became available shortly prior to publication. The definition of each of these regions was based upon type localities of described names and traditionally associated biogeographic regions as well as preliminary observations on possible geographical variations. Each of those four populations versus one another and Magdalena Swallow were then subject to the same analyses as described below.

Statistical tests

The following statistical tests were applied on a pairwise basis to vocal and biometric data, using methods set out in Donegan (2018), using a Microsoft Excel spreadsheet (Donegan 2021) for rapid assessment of multiple pairwise statistical tests across multiple populations.

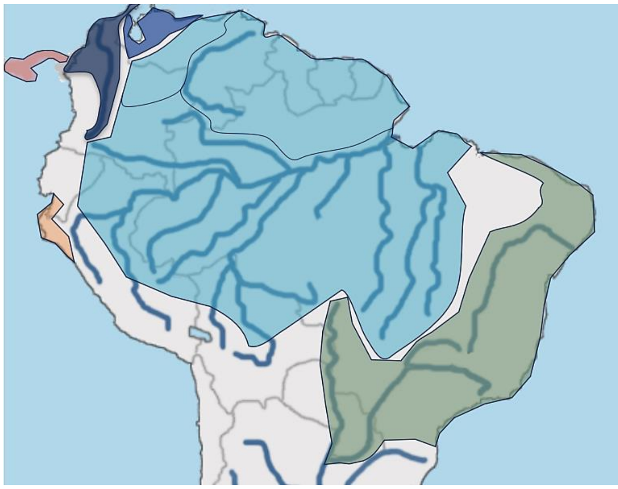

Figure 2. Simplified distribution map, showing major rivers in South America and distribution of some of the species and populations discussed in this paper. Ochraceous red: Mangrove Swallow *T. albilinea* (whose range is more extensive than shown in Central America). Light orange: Tumbes Swallow *T. stolzmanni*. Dark blue, mid-blue, aquamarine blue and green, all White-winged Swallow *T. albiventer* populations, with different shades broadly reflecting dominant mantle coloration in each region. Dark blue: Magdalena Swallow. Mid-blue: Maracaibo population (zone of intermediates). Aquamarine blue: W & S Amazonia, Llanos-Venezuela (top left) and Guyanan shield (top right) populations, with lines demarking each of these, as used to separate the sample in this study. Green: Atlantic-Cerrado population.

In the various formulae set out below, $\bar{x}_1$ and s_1 are the sample mean and standard deviation of Population 1; $\bar{x}_2$ and s_2 refer to the same parameters in Population 2; and the *t* value uses a one-sided confidence interval at the percentage specified for the relevant population and variable, with t_1 referring to Population 1 and t_2 referring to Population 2.

First, Welch's (unequal variance) *t*-test at $p<0.05$ was applied to all comparisons. This was chosen since it makes no assumptions about whether the standard deviation of one population differs from that of the other. A Bonferroni correction was first applied separately, based on the number of variables studied for each class of vocalization. After removing variables showing strong correlations (see below), there were 15 variables studied for rising calls, 14 variables for slow rising calls and 9 for buzzes and chatter; and 8 biometric variables. Applying Bonferroni resulted in more exacting statistical significance tests of $p<(0.05/15)=0.00333$, $p<(0.05/14)=0.000357$ and $p<(0.05/9)=0.00556$ and $p<(0.05/8)=0.00625$, respectively to show statistical significance.

Statistical significance (Level 1 under Donegan 2018's scheme) does not inform the extent of differentiation between populations; since very small differences can still meet a test of statistical significance if sample sizes are large enough. The differences between means of populations were measured for each variable in standard deviations (so-called effect sizes), controlling for sample size using *t*-distribution values, to produce 'differentiation coefficients' (per Donegan 2018) for each vocal variable and each cross-wide population comparison, as follows:

$$p<0.05/n_v \square |(\bar{x}_1 - \bar{x}_2)| / ¼[\, s_1\,(t_{1\,@\,97.5\%}) + s_2\,(t_{2\,@\,97.5\%})]$$

Using this calculation of 'controlled effect sizes', a measure of 2 indicates that the mean of one population falls outside 95% of the other population (of Hubbs & Perlmutter's (1942) subspecies concepts or Donegan 2018's "Level 2"), which approximates to the traditional '75%' rule for subspecies in ornithology (Amadon 1949, Patten & Unitt 2002) and a measure of 4 indicates diagnosability for the variable in question (i.e. satisfaction of Isler *et al.*'s (1998) diagnosability test, but in multidimensional space). Only those pairwise comparisons which were statistically significant are scored; all non-significant pairwise comparisons are scored as zero.

For species-level analyses, these tests were applied to each of 18 vocal variables for rising song and 10 vocal variables for buzz across 15 pairwise combinations of all *Tachycineta* species in the study and Magdalena Swallow (420 pairwise population/vocal variable comparisons). In addition, there were 18 vocal variables studied between White-rumped and Chilean Swallows for slow rising call and 10 vocal variables for chatter, a total of 428 pairwise comparisons. This was then repeated for the 'within White-winged Swallow' database, with 18 vocal variables for rising song and 10 vocal variables for buzz across 10 pairwise comparisons (280 pairwise comparisons). A grand total of 700 measured pairwise comparisons were therefore undertaken between different species or populations for different vocal variables (with some of these results then excluded for some analytical purposes, including the formula below, due to correlations).

Subspecies and species rank were evaluated using Donegan's (2018) proposed universal formula:

$$\sqrt{}\,(\textstyle\sum\,[p<0.05/n_v \square |(\bar{x}_1 - \bar{x}_2)| / ¼\,[\, s_1\,(t_{1\,@\,97.5\%}) + s_2\,(t_{2\,@\,97.5\%})]]^2)$$
$$\leq$$
$$\sqrt{}\,(\textstyle\sum\,[p<0.05/n_v \square |(\bar{x}_3 - \bar{x}_4)| / ¼\,[\, s_3\,(t_{3\,@\,97.5\%}) + s_4\,(t_{4\,@\,97.5\%})]]^2)$$

where:

p: the probability using Welch's unequal variance *t*-test.

n_v: the number of continuous variables used in the study, applying a Bonferroni correction.

Numbers 1 and 2 as subscripts refer to samples of two closely related "good" species, Species 1 and Species 2 (here, Chilean Swallow vs. White-rumped Swallow, respectively).

Numbers 3 and 4 as subscripts refer to the two allopatric populations, Population 3 (i.e. Magdalena Swallow) and Population 4 (others), under test for species rank.

$\bar{x}_1$, $\bar{x}_2$, $\bar{x}_3$ and $\bar{x}_4$ are the sample means of Species 1, Species 2, Population 3 and Population 4, respectively.

s_1, s_2, s_3 and s_4 are the SDs of Species 1, Species 2, Population 3 and Population 4, respectively.

The t value uses a one-sided confidence interval at the percentage specified for the relevant population and variable, with t_1, t_2, t_3 and t_4, referring to Species 1, Species 2, Population 3 and Population 4 respectively.

This method is preferable to other more subjective approaches or those which involve hard cut-offs, which only apply weightings to pairwise variations above particular thresholds, such as 0.2, or 5 (e.g. Tobias *et al.* 2010) or 4 (e.g. Isler *et al.* 1998). Unlike those other methods, this approach takes into account all statistically significant variation and subjects these to Euclidian summation to measure the extent to which the two populations can be differentiated in multidimensional space. Also, unlike those methods, all non-statistically significant variation is ignored (Donegan 2018).

Diagnosability is shown in multi-dimensional space if two populations attain a minimum score of 4, reflecting 4 standard deviations' differentiation and passing of Isler *et al.*'s (1998) test for the whole data set. Donegan (2018) showed that a measure of around 7 on this scale for voice was equivalent to that attained by some populations that met Isler *et al.* (1998)'s test of three diagnosable vocal characters for species rank in antbirds (Thamnophilidae). However, no universal score for species rank was proposed, since the degree of differentiation between sympatric species differs between bird families and in some cases genera, and so needs assessing separately for each group. This study is the first application of this system to vocal differentiation in Hirundinidae.

Finally, as a counterpoint, an attempt at scoring populations under the Tobias *et al.* (2010) methodology was attempted, despite the multiple shortcomings of this method compared to the above tests (Donegan 2018, Rheindt & Ng 2021, Winker 2021).

The development of this study and addition of further taxa and multiple variables led to an unusual hazard as regards potential correlation of variables. It is widely accepted that, where variables are correlated in a study like this, one of the variables should be excluded to avoid double-counting of differentiation (Isler & Whitney 2007, Donegan 2018). However, in practice, I have found high correlations among vocal variables to be unusual. In this study, the design of an initial study to compare Magdalena, White-winged and Mangrove Swallows only, then expansion of that study to include three other species, and its further expansion to measure new variables which better captured variation in those additional species, led to an unusual number of variables, particularly those related to acoustic frequency. To investigate and eliminate correlations, the entire data set for each kind of vocalization was combined in a Microsoft Excel spreadsheet and then Pearson's correlation coefficient was calculated on a matrix basis between all 18 or 10 variables (depending on the kind of vocalization). A threshold of $r>0.75$ was selected here, above which one of the variables was eliminated from aspects of the study measuring overall differentiation.

This resulted in the following variables being excluded from species-scoring for rising calls: (i) number of notes (correlates with song length, $r=0.89$); (ii) maximum frequency at start (correlates with maximum frequency of trough, $r=0.97$; and maximum bandwidth at start, $r=0.76$); (iii) change in frequency from start to end (correlates with change in frequency trough to peak, $r=0.79$). From buzzes and chatter, number of notes was excluded (correlates with song length in each case, $r=0.90$ and $r=0.83$ respectively). For slow rising calls, the following were excluded: (i) number of notes (correlates with song length, $r=0.75$); (ii) maximum frequency at start (correlates with maximum frequency of trough, $r=0.97$); (iii) maximum frequency at end (correlates with maximum frequency of peak, $r=0.88$); and (iv) change in frequency from start to end (correlates with change in frequency trough to peak, $r=0.77$). For biometrics, tail length was excluded (correlated with wing length, $r=0.75$). Where two variables were correlated, the variable to be excluded from analyses was chosen by summing the measured differentiation across all pairwise comparisons and eliminating the variable with the lower score.

The value of 0.75 is arbitrary, as are all proposed cut-off points in interpreting Pearson values. The figure of 0.75 was arrived at as a reasonable benchmark which appeared to identify variables that logically ought to be correlated with one another in the context of this particular study. The options of excluding all statistically significant correlations or the proposed 0.60 ('moderate positive') threshold were also considered, but those would have eviscerated the data set, resulting in key vocal variables which differentiate some species no longer being measured. The option of the 0.8 ('strong positive') threshold (as used by Isler & Whitney 2007 and Donegan *et al.* MS) would have resulted in greater disparities of exclusion of variables between different kinds of vocalizations and overlooked some logically supportable correlations. Although these exclusions were undertaken for purposes of overall species scoring, the measurements and pairwise scores for all variables (including correlated ones) are shown in Appendix 3 and all measured variables were subject to calculations of correlation against molecular differentiation (see next section).

Comparison with molecular differentiation

The molecular biology of Magdalena Swallow is unknown. To obtain greater insights on differentiations which might be more or less informative of molecular differentiation, the % pairwise molecular differentiation for each of Cytochrome b, ND2, ATPase 8, COII and combined results in Whittingham *et al*. (2002, p. 435, table 3) for 10 species pairs and overall molecular differentiation data from Cerasale *et al*. (2012, table 5) were made subject of Pearson correlation calculations lining up pairwise scores between the same species for each vocal variable, each set of vocalizations and overall vocal differentiation for rising calls and buzzes only (these being the only two kinds of calls with complete taxon coverage), as well as each biometric measure and overall biometric variation. Correlations were calculated on a matrix basis using Microsoft Excel. The identity of correlating variables and the differentiation in these variables among Magdalena and White-winged Swallows were then considered.

The COII results in Whittingham *et al*. (2002) seem to include glitches, since numerous pairwise situations returned the exact same value of 0.37, whilst Tumbes versus Mangrove Swallow reported an implausible score of 0. There were low correlations between COII and differentiation as measured in other molecular markers in the same study; the authors were unable to verify this data (F. Sheldon *in litt*. 2024). COII was therefore ignored as a marker for identifying vocal or biometric correlations.

Results: (a) Variation among *Tachycineta* spp. and Magdalena Swallow

Voice

Measurements of vocal variables across Magdalena Swallow, White-winged Swallow, Mangrove Swallow, Tumbes Swallow, White-rumped Swallow and Chilean Swallow are set out in App. 2, with full details of which variables were found to differ between each pair set out in App. 3. With one anomalous exception discussed below, all of these populations were found to be diagnosably differentiated from one another in multi-dimensional space by voice overall (Table 1, Apps. 2-3) and rising calls (Table 2A, Apps. 2-3), with broadly similar levels of differentiation (*c*.4-6.5 controlled effect sizes) between each of the populations under study (Fig. 14). Buzzes, slow rising calls and chatter showed mild but non-diagnosable differentiation between relevant populations (Tables 2B-D, Apps. 2-3).

Vocal differentiation between Magdalena Swallow and White-winged Swallow exceeded that observed between the related, sympatric pair White-rumped versus Chilean Swallow for the entire vocal set (5.15 vs 5.08), rising calls (4.46 vs 4.15) and buzzes (2.58 vs 1.44). Magdalena Swallow is also diagnosably differentiated in overall voice and rising song from the two other cis-Andean species, Mangrove Swallow and Tumbes Swallow. In both cases, differentiation of rising calls (4.76 and 5.28 respectively) exceeds that observed between White-rumped versus Chilean Swallow (4.15).

The kinds of variables in which these pairs differ are also noteworthy (see Apps. 2-3). Song speed was the most reliable differentiator between all species (with highest cumulative scoring in the sample as a whole). This variable had strong differentiation for rising songs in Magdalena vs White-winged Swallows, with differences in acoustic frequency variables also noted. In the comparator pair of Chilean vs White-rumped Swallows, most of the differences observed were in measures of acoustic frequency.

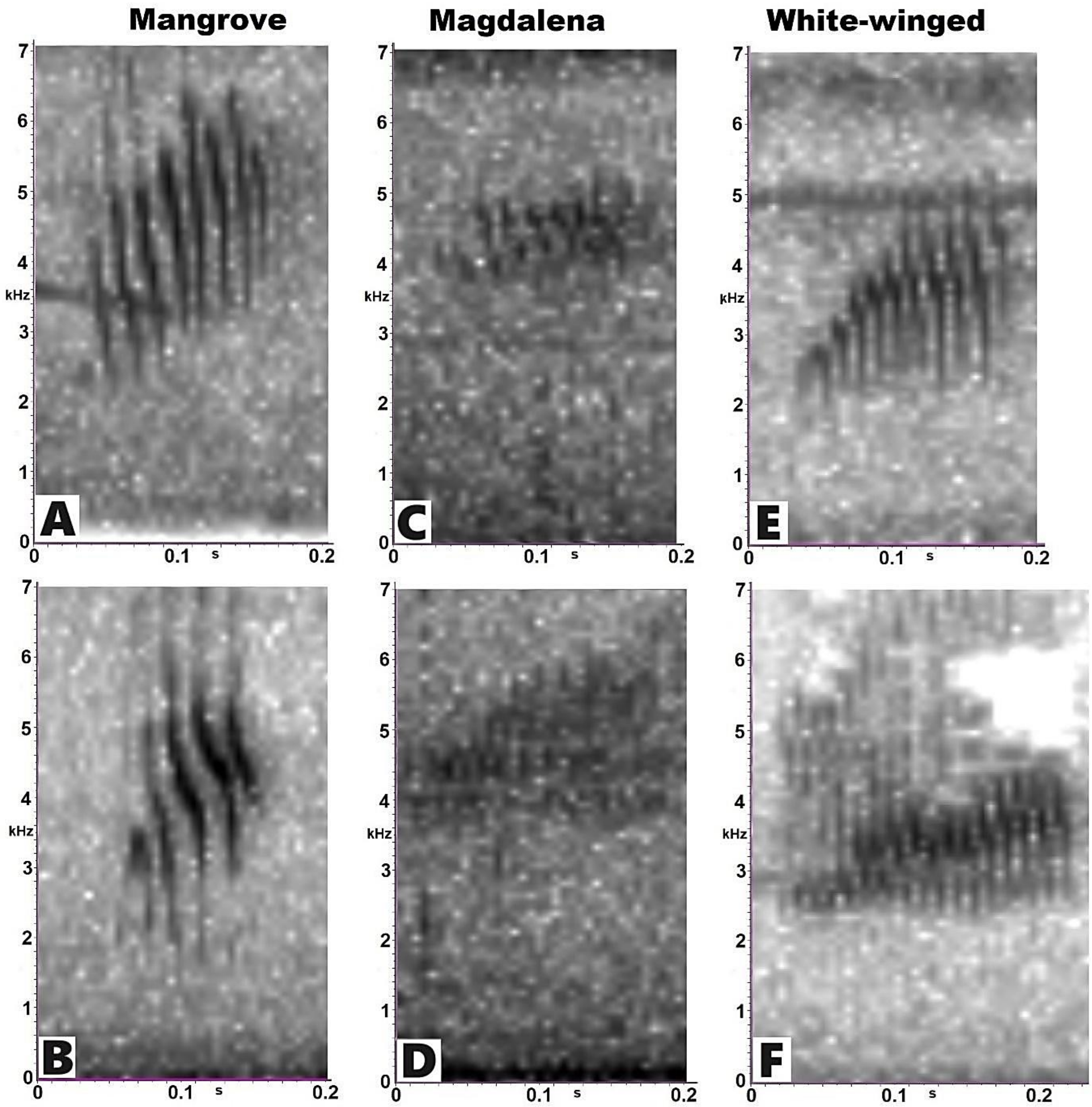

Figure 3. Sonograms of rising calls of Mangrove Swallow (left, A-B), Magdalena Swallow (middle, C-D) and White-winged Swallow (right, E-F). A. Ammo Dump Ponds, Colón, Panamá (Andrew Spencer, 24/03/2009: XC31778). B. Gamboa Rainforest Resort, Colón, Panamá (Nicholas Sly, 19/02/2013: ML541961041). C. Hacienda La Estancia, Melgar, Tolima, Colombia (Thomas Donegan, 06/01/2016: XC942997). D. As C (but 01/01/2017: XC942998). E. La Selva Jungle Lodge, North bank Río Napo, Sucumbíos, Ecuador (Niels Krabbe, 22/01/1992: XC243135=ML242118). F. Hato Corozal, Isla Ruende, Barinas, Venezuela (Paul A. Schwartz, 18/05/1964: ML66679).

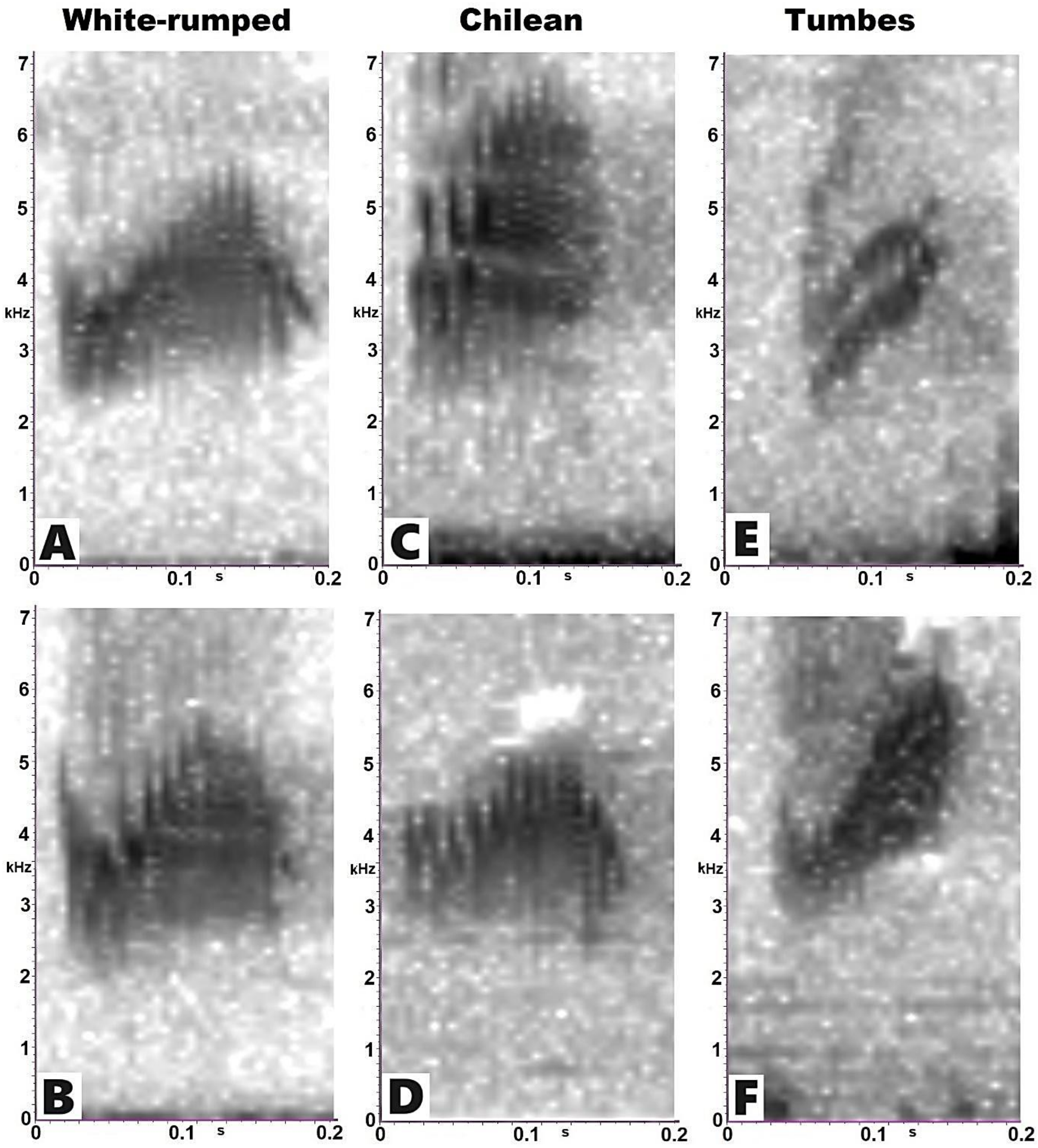

Figure 4. Sonograms of rising calls of White-rumped Swallow (left, A-B), Chilean Swallow (middle, C-D) and Tumbes Swallow (right, E-F). A. Madre de Deus de Minas, Minas Gerais, Brazil (Luiz Fernando Matos, 22/11/2020: XC656898). B. Mostardas area, Rio Grande do Sul, Brazil (Peter Boesman, 03/08/2005: ML295772 = XC230436). C. Virgen de las Misiones, Paso Córdova, Río Negro, Argentina (Natxo Areta, 02/05/2011: ML220393). D. Tapejara, Lagoa de Tamarana, Paraná, Brazil (Luiz Silva, 30/06/2021: ML351362831). E. Santuario Histórico Bosque de Pómac, Lambayeque, Peru (Fernando Angulo, 12/04/2007: XC12324). F. Río Alamor, La Ceiba, outside Zapotillo, Loja, Ecuador (Gary Rosenberg, 06/04/1992: ML73339=ML313324831).

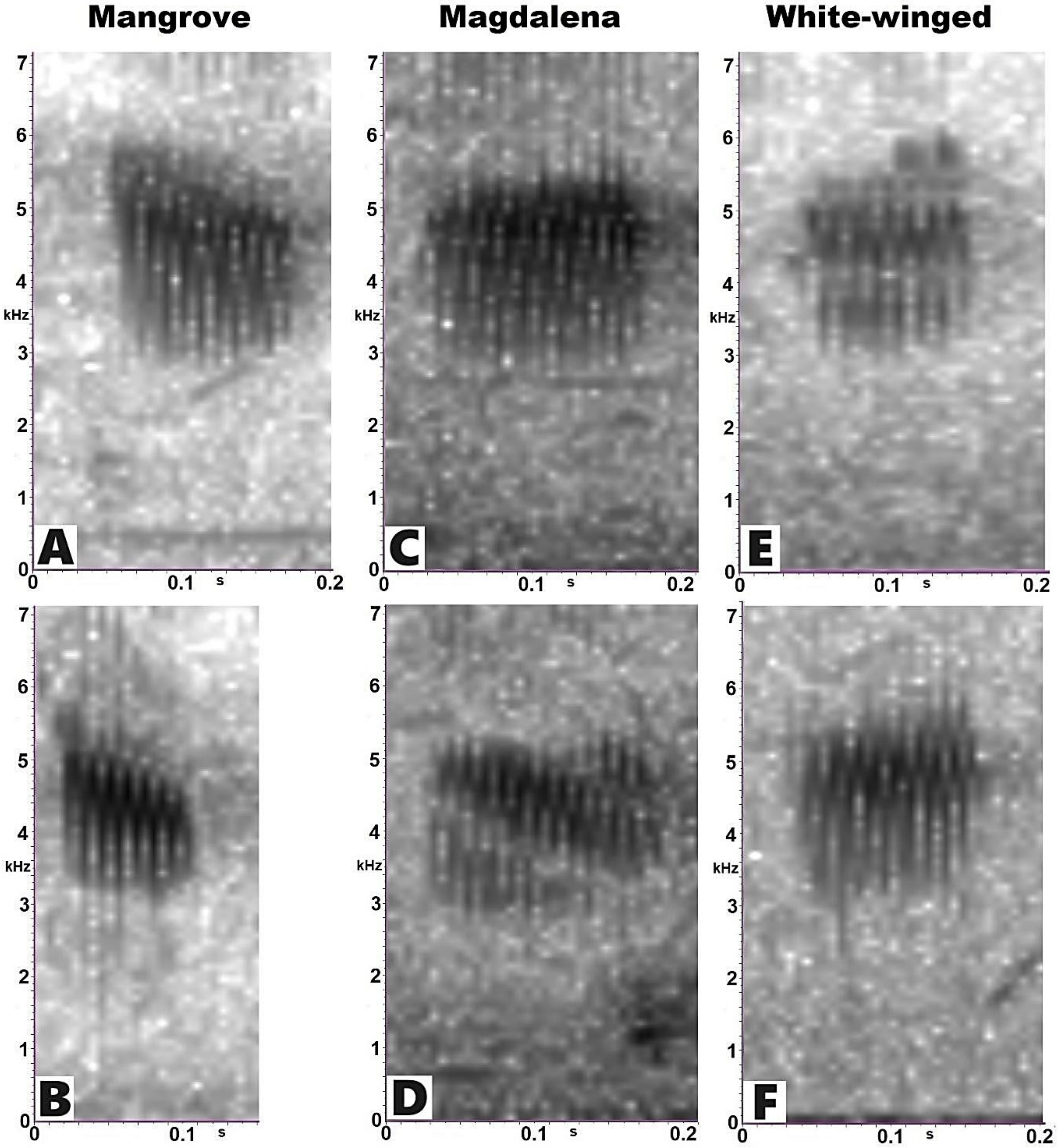

Figure 5. Sonograms of buzz calls of Mangrove Swallow (left, A-B), Magdalena Swallow (middle, C-D) and White-winged Swallow (right, E-F). A. & B. Hill Bank Field Station, Orange Walk, Belize (Rebecca Windsor, 18/04/2011: ML166513). C. & D. 2017 Hacienda La Estancia, Melgar, Tolima, Colombia (Thomas Donegan, 1/1/2017: XC942998). D features two birds vocalising simultaneously. E. São Gabriel da Cachoeira, Amazonas, Brazil (Jeremy Minns, 19/12/1998: XC211445). F. Orinoco River islands, Amazonas, Venezuela (Peter Boesman, 28/03/1997: XC230431=ML287886).

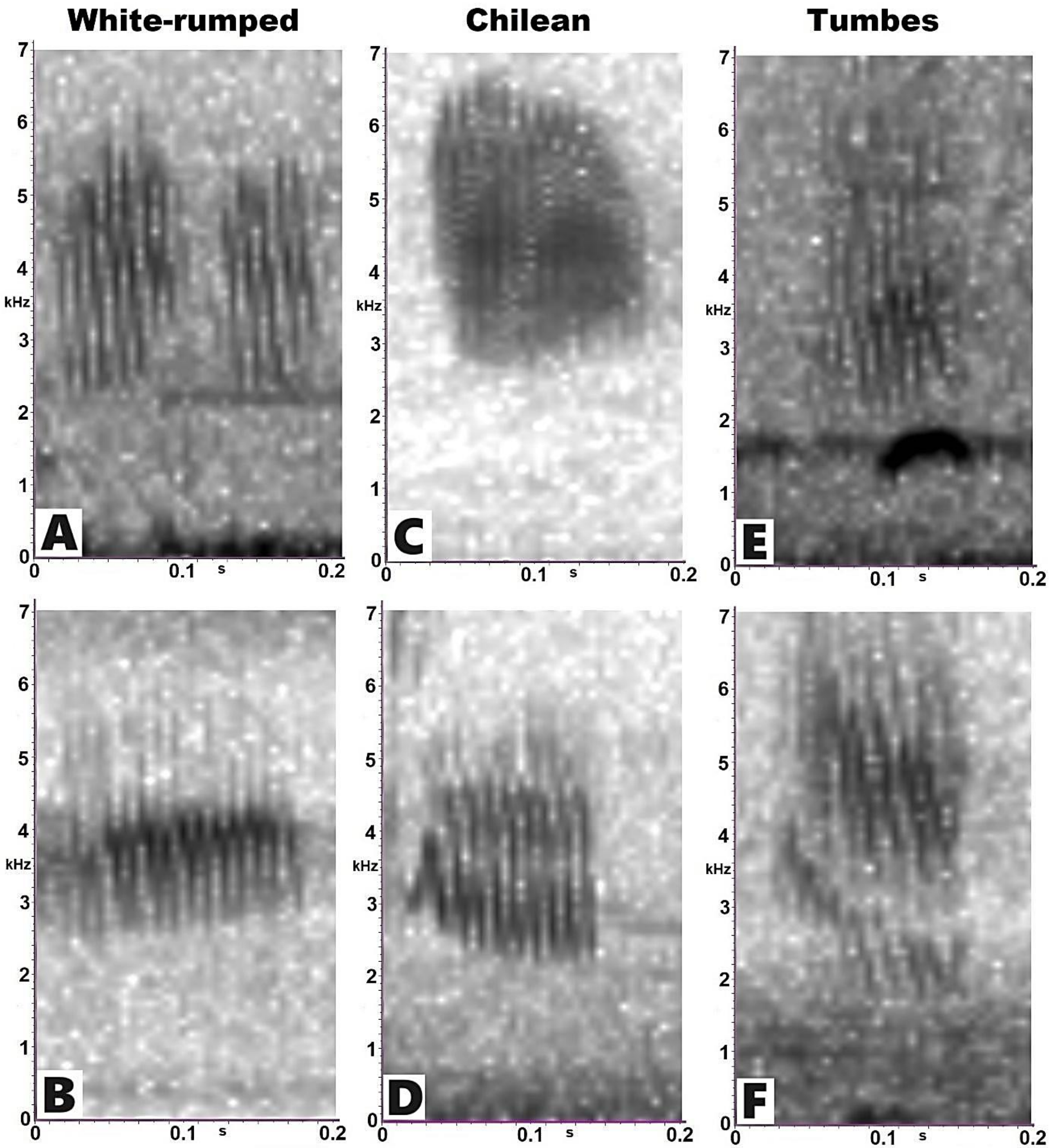

Figure 6. Sonograms of buzz calls of White-rumped Swallow (left, A-B), Chilean Swallow (middle, C-D) and Tumbes Swallow (right, E-F). A. RPPN Pontal da Barra, Pelotas, Rio Grande do Sul, Brazil (Fernando Jacobs, 25/11/2007: XC17398). B. MONA da Lagoa do Peri, Estrada Sertão do Peri, Santa Catarina, Brazil (Fernando Farias, 15/01/2021: ML298074601). C. Lago Alumine (El Puente), Villa Pehuenia, Neuquen, Argentina (Bernabé López-Lanús, 20/01/2005: XC46816). D. Los Muermos, Los Lagos, Chile (Eduardo Quintanilla, 25/09/2023: ML609774458). E. Río Alamor, La Ceiba, outside Zapotillo, Loja (Gary Rosenberg, 06/04/1992: ML73339=ML313324831). F. Piura, N of Sullana, Peru (Paul Coopmans, 02/1999: XC264784).

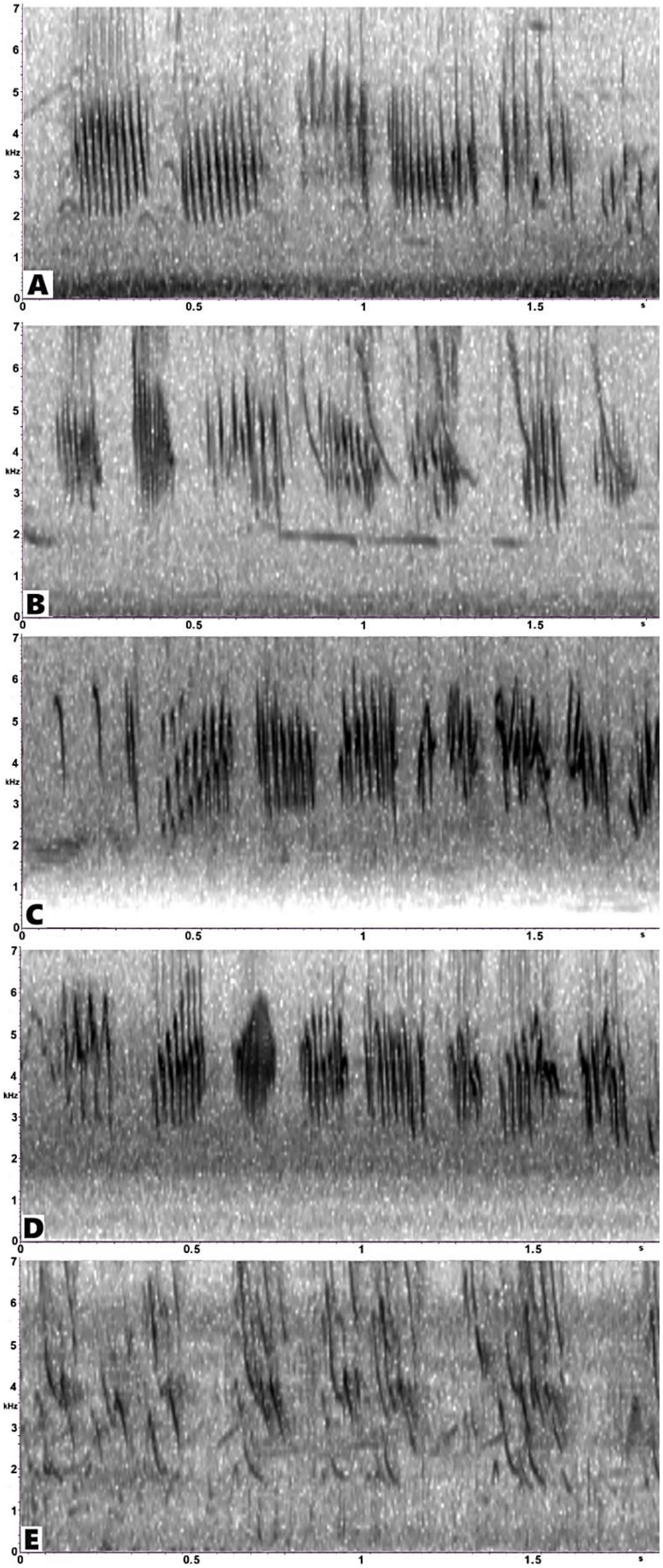

Figure 7. Chatter of White-rumped Swallow (A-B), Chilean Swallow (C-D) and unusual example of vocalizations similar to chatter in Mangrove Swallow (E). A. Puerto Piracuacito, Santa Fe, Argentina (Emilio Ariel Jordan, 03/11/2013: ML217742). B. Parque Nacional Serra da Canastra, São Roque de Minas, Minas Gerais, Brazil (Jeremy Minns, 30/10/2002: XC82410) (note an extract of a chatter approx. three times the length shown). C. Cueva del Mylodon, XII Región, Magellanes (Alvaro Jaramillo, 15/11/1999: XC60138). D. Termas de Chillan, VIII Región, Pinto, Ñuble, Chile (Peter Boesman, 01/12/2018: ML303627 = XC450171). E. Hill Bank Field Station, Orange Walk (Rebecca Windsor, 17/04/2011: ML166513).

Note A (second bout), C (after initial three chips) and D (second) all include examples of 'slow rising calls' towards the start. In D, the third call in the sequence is a (fast) rising call, in each case delivered within a 'Chatter' sequence.

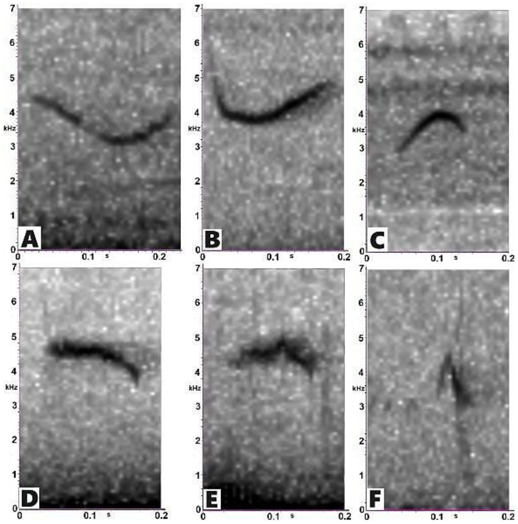

Figure 8. Whistles or call notes of Magdalena Swallow (A), White-winged Swallow (B-E) and a chip found within a Tumbes Swallow track (F). A. Malecón Puerta de Oro, Atlántico (Jason Vasallo, 06/01/2023: ML585771491). B. Hato Barley, Casanare, Colombia (Johnnier Arango, 27/10/2022: ML503990861). C. Serra do Ouro, Estação Ecológica de Murici, Murici, Alagoas, Brazil (Dante Buzzetti, 09/10/2002: XC504977). D. & E. Cachuela Esperanza, Beni, Bolivia (Joseph Tobias & Nathalie Seddon, 09/10/2005: XC74199). F. Santuario Historico Bosque de Pómac, Lambayeque, Peru (Daniel Lane, 06/08/2005: ML308401) (note: this kind of call requires confirmation; unclear if of this or another species).

Table 1. Overall vocal variation among *Tachycineta* Swallows across all vocalizations, measured in controlled effect sizes / diagnosability coefficients, following Donegan (2018). This shows the Euclidian summation of Tables 2A-D. A score of 4 or more, shown in bold and attained by all pairwise comparisons except one, reflects diagnosability in multidimensional space.

	White-winged	Mangrove	Tumbes	White-rumped	Chilean
Magdalena	**5.15**	**4.88**	**6.32**	**5.89**	**6.17**
White-winged		**5.39**	3.37	**5.50**	**6.65**
Mangrove			**5.10**	**4.63**	**5.28**
Tumbes				**4.84**	**5.60**
White-rumped					**5.08**

Table 2. Vocal variation in (A) rising calls, (B) buzzes, (C) slow rising calls and (D) chatter, among *Tachycineta* Swallows, measured in controlled effect sizes / diagnosability coefficients, following Donegan (2018). A score of 4 or more, shown in bold, reflects diagnosability in multidimensional space. Full details of each variable contributing to these scores is set out in App. 3. *n*=sample size for number of notes (NN).

A. Rising calls	White-winged (*n*=137)	Mangrove (*n*=96)	Tumbes (*n*=17)	White-rumped (*n*=72)	Chilean (*n*=35)
Magdalena (*n*=9)	**4.46**	**4.76**	**5.28**	**5.43**	**6.04**
White-winged (*n*=137)		**5.07**	3.03	**5.17**	**6.62**
Mangrove (*n*=96)			**4.67**	**4.63**	**5.17**
Tumbes (*n*=17)				**4.71**	**5.13**
White-rumped (*n*=72)					**4.15**

B. Buzzes	White-winged (*n*=52)	Mangrove (*n*=17)	Tumbes (*n*=11)	White-rumped (*n*=41)	Chilean (*n*=31)
Magdalena (*n*=29)	2.58	1.05	3.47	2.29	1.22
White-winged (*n*=52)		1.83	1.49	1.87	0.63
Mangrove (*n*=17)			2.04	0	0.92
Tumbes (*n*=11)				1.15	2.26
White-rumped (*n*=41)					1.44

C. Slow rising calls	Chilean (*n*=79)
White-rumped (*n*=71)	2.03

D. Chatter	Chilean (*n*=87)
White-rumped (*n*=91)	1.55

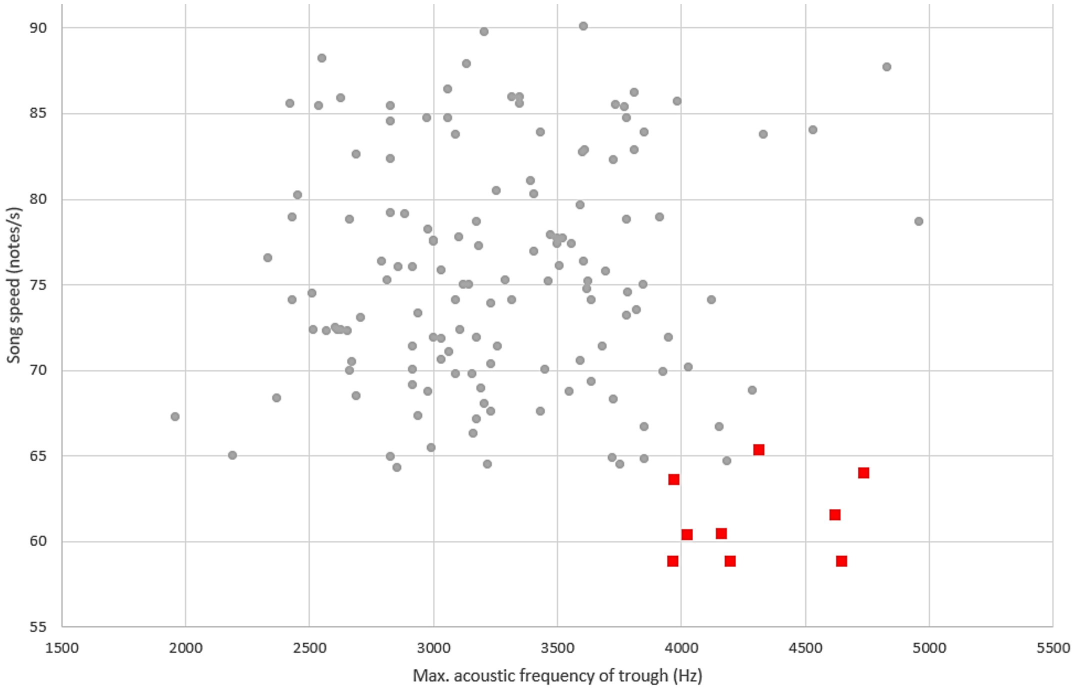

Figure 9. Scatter plot showing two most differentiated vocal variables for fast rising calls (max. acoustic frequency of trough (Hz) (score of 2.27, *x*-axis); and song speed (notes/s), score of 3.06, *y*-axis), as between White-winged Swallow (grey dots) and Magdalena Swallow (red squares).

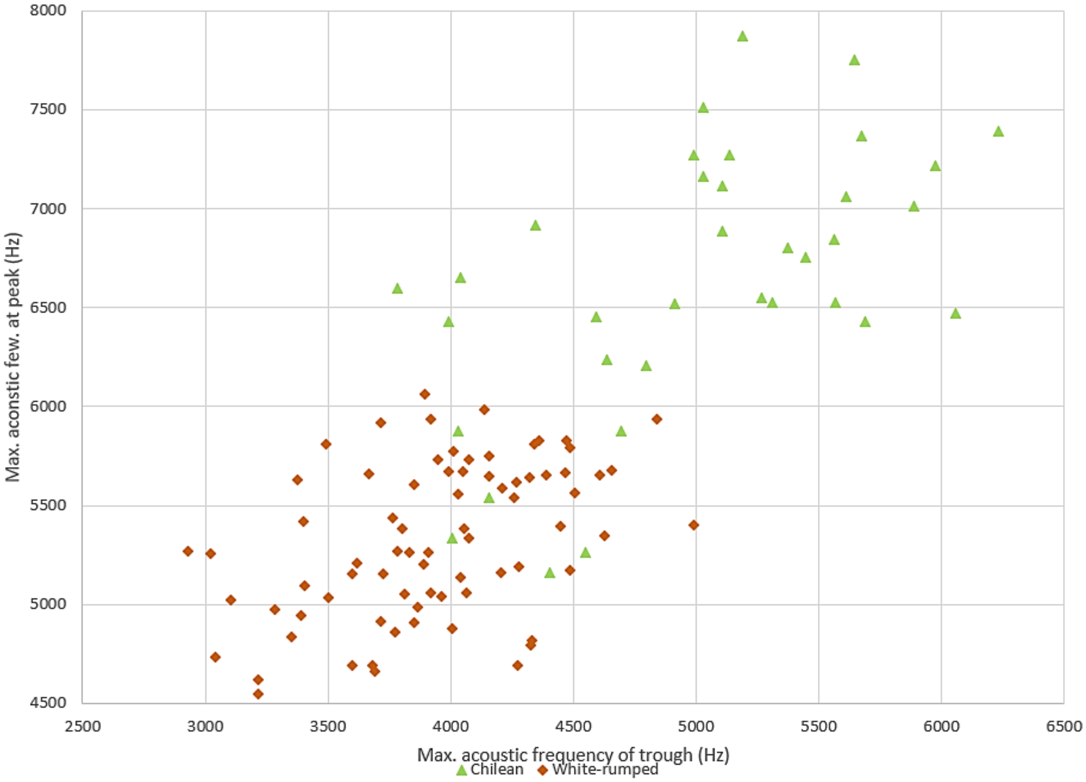

Figure 10. Scatter plot showing two most differentiated vocal variables for fast rising calls (max. acoustic frequency of trough (Hz) (score of 1.95, *x*-axis); and max. acoustic frequency of peak (Hz) (score of 2.47, *y*-axis), as between White-rumped Swallow (ochre rhomboids) and Chilean Swallow (green triangles). Note the reduced differentiation and greater extent of overlap as between these two recognized species for their most diagnosable vocal characters, compared to Magdalena vs White-winged Swallow in Fig. 9.

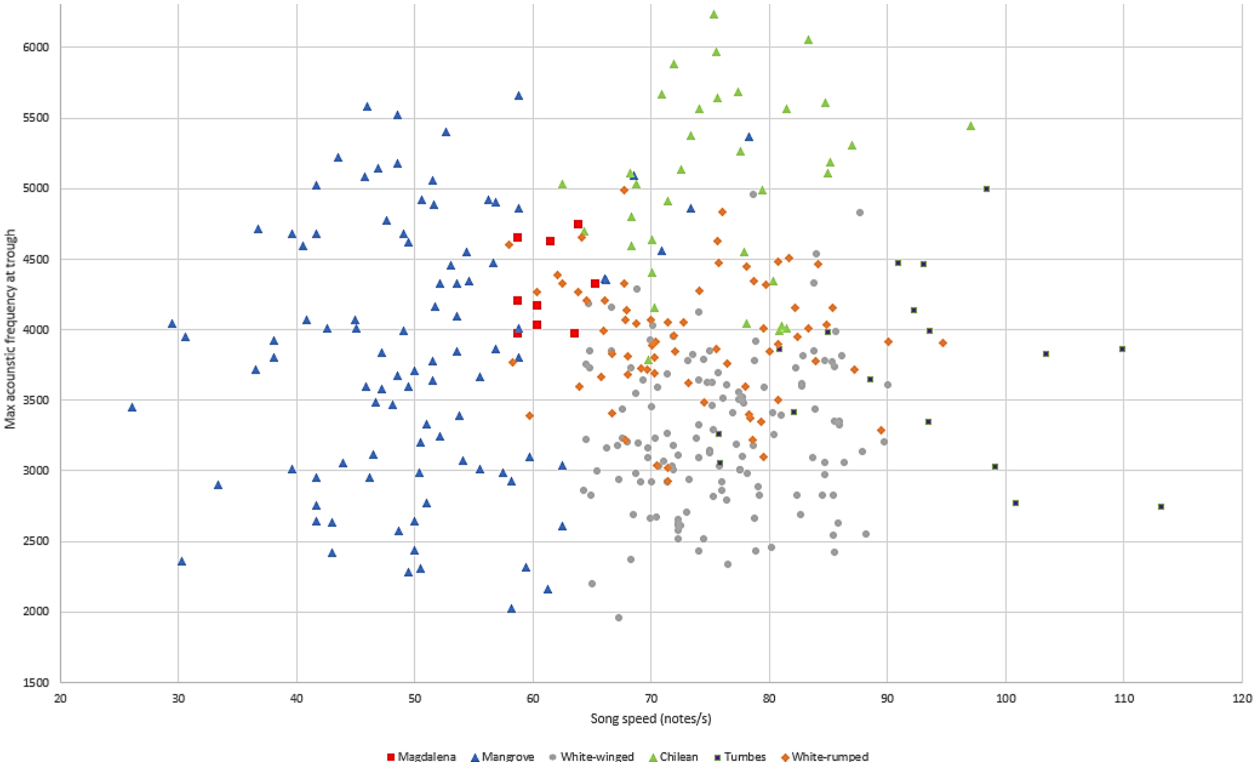

Figure 11. Scatter plot of the most varying acoustic frequency and speed variables for all taxa in the study: maximum acoustic frequency of trough (kHz) and song speed (notes/s), across all species. Note the axes are reversed compared to Fig. 9.

The only pairwise comparison for which the vocal sample did not demonstrate diagnosability in multi-dimensional space was that between White-winged Swallow and Tumbes Swallow. However, this may be a statistical anomaly, given the low sample size for Tumbes Swallow, Only the best quality recordings had sufficient resolution to allow measurement of its most distinguishable variable, song speed. If Bonferonni correction is removed from the analysis (an element of the method which particularly penalizes smaller sample sizes), this pair score over 4 for overall vocal differentiation. This pair are not even sisters in molecular studies (Dor *et al.* 2012, Brown 2019) and have strong plumage and biometric differentiation (see below).

In addition to quantitative and diagnosable differences in measured vocal variables, there were noteworthy differences in vocal repertoire among *Tachycineta* swallows. Table 3 shows the frequency of occurrence of each kind of vocalization studied here, expressed as a percentage based on the number of sound recordings inspected, in which at least one example of this kind of vocalization was found. As discussed in the Introduction, all species give rising calls and buzzes. However, in only three species (White-winged, Tumbes and Mangrove) is the rising call the most frequent vocalization. In White-rumped and Chilean Swallows, chatter and slow rising calls predominate, whilst in Magdalena Swallow buzzes predominate. Rising calls would nonetheless appear to be an important territorial or display call in all species. A 32% or 12% instance of fast rising calls in White-rumped Swallows or Chilean Swallows is likely to represent more or less similar frequency of occurrence over time as 65% in White-winged – a species which does not deliver chatters or slow rising calls at all and appears to be not as vocal or socially gregarious.

Several related populations show differences in vocal repertoire, either overall or in terms of the most common vocalization. The only and repeated exception is that of Tumbes versus White-winged.

Again, species rank would be supported for the Magdalena Swallow by considerations of vocal repertoire. Unusually, buzzes dominate as the most frequent vocalization of Magdalena Swallow, which is unique in the clade. The differentiation between White-winged and Magdalena Swallow is analogous to the situation between White-rumped and Chilean Swallows. White-rumped and Chilean Swallows also share the same overall vocal repertoire, but with chatter dominating in the former and slow rising calls in the latter.

Table 3. Vocal repertoire of *Tachycineta* Swallows. This table illustrates differences in vocal repertoire among species, identifying the predominant vocalization in each case, marked in bold. Note *n* is in most cases lower than the total number of catalogue serial numbers listed in App. 1, due to exclusion of recordings where: (i) there are duplication of recordings among archives; or (ii) archived recordings appear to be continuations of other recordings of the same individual. Numerous sound recordings include more than one kind of vocalization, meaning that the rows often add up to over 100%. The data do not necessarily mean that, e.g., 32% of White-winged Swallow vocalizations are actually fast rising calls. Probably, the frequency of such vocalizations is lower because chatter dominates all recordings. However, 35% of recordings include one or more such vocalizations. *n*=number of recordings inspected.

Taxon	Rising call	Buzz	Slow rising call	Chatter	Whistle
Magdalena Swallow (*n*=10)	30% (3)	**80% (8)**			10% (1)
White-winged Swallow (*n*=86)	**66% (57)**	49% (42)			9% (8)
Mangrove Swallow (*n*=43)	**95% (41)**	16% (7)		5% (2)	
Tumbes Swallow (*n*=7)	**71% (5)**	29% (2)			14% (1)
White-rumped Swallow (*n*=98)	32% (31)	16% (16)	34% (33)	**91% (89)**	
Chilean Swallow (*n*=135)	12% (16)	12% (16)	**77% (104)**	67% (90)	

Table 4. Differentiation in biometrics among *Tachycineta* Swallows as measured in controlled effect sizes / diagnosability coefficients, following Donegan (2018). A score of 4 or more, shown in bold, reflects diagnosability in multidimensional space. Full details of each variable contributing to these scores is set out in Appendix 5. *n*=sample size for wing length.

	White-winged (*n*=89)	Mangrove (*n*=34)	Tumbes (*n*=2)	White-rumped (*n*=20)	Chilean (*n*=14)
Magdalena (*n*=29)	1.75	3.06	**7.27**	**5.20**	**5.29**
White-winged (*n*=89)		**4.32**	**9.78**	**4.97**	**5.68**
Mangrove (*n*=34)			**6.26**	**6.62**	**5.77**
Tumbes (*n*=2)				**8.56**	**7.56**
White-rumped (*n*=20)					2.61

The predominance of buzzes versus rising calls in Magdalena Swallow is unlikely to be an artefact of sampling effort targeting these species, since none of the three archived recordings of Magdalena Swallow includes any rising calls, i.e. the only examples of rising calls were from my own recordings. Moreover, my relatively small study in the Magdalena valley resulted in an equal number of sound recordings containing buzzes, as that obtained from all archived sound recordings of White-winged Swallow by all sound recordists from the whole of Amazonia and was more than that in all archived sound recordings from the Atlantic region (see App. 2, section 6).

Biometrics

A list of specimens of Magdalena Swallow inspected is set out in App. 6. List of other specimens inspected is available from the author. Biometric data are set out in App. 4, with details of variables showing differentiation between each species pair shown in App. 5. Overall differentiation in biometrics between each species is summarized in Table 4.

Diagnosably distinct biometric differentiation was observed between all pairs of previously-recognized species, except Chilean vs White-rumped Swallow (2.61). The extent of variation is somewhat surprising because, in Hirundinidae, morphology is generally cohesive, driven by aerodynamic considerations (Evans 1998, Cuervo *et al.* 1996, Buchanan & Evans 2000, Rowe *et al.* 2001, Hasegawa & Arai 2020, 2021, 2022, Hasegawa 2023).

Magdalena Swallow was diagnosable neither from Mangrove Swallow (3.06) nor White-winged Swallow (1.56), implying an intermediate population which is neither the former nor the latter, but more closely related to White-winged Swallow.

The biometric differentiation between Magdalena Swallow and Mangrove Swallow exceeded that between Chilean and White-rumped. Biometric variation between Magdalena and White-winged Swallow was less than that between Chilean and White-rumped Swallows, an opposite outcome to the vocal study. The proposed statistical test for species rank was therefore failed for Magdalena Swallow when using biometric data.

Table 5. Plumage differences among *Tachycineta* species.

Taxon	White lores	White markings on tertials	White markings on secondaries	White markings on secondary covers	Mantle color	Striations on underparts
Magdalena Swallow	Absent	Usually present on distal edges, can extend to tip, but occasionally absent	Usually prominent on innermost average 4 secondaries only but variable, can be absent to more extensive	Usually absent or vestigial, but occasionally present.	Usually navy blue, some with slight aquamarine tones. One specimen is aquarmine green-blue on the mantle.	Absent or barely visible
White-winged Swallow	Absent	Present and usually extensive on distal and proximal edges and tip, but variable.	Usually extensive with all secondaries marked, but variable.	Usually extensive but variable, can be absent or vestigial.	Usually aquamarine green-blue, but variable including dirtier greens generally in Atlantic and Cerrado regions with some examples of this in Amazonia, and some navy blue birds in north-west of range.	Absent or barely visible
Mangrove Swallow	Present	Usually present, but occasionally absent	Absent or innermost only	Usually absent or vestigial	Grenish blue	Absent or barely visible
Tumbes Swallow	Weak	Tipped distal edge, can be reduced to absent	Absent or vestigial	Usually absent or vestigial	Navy to greenish blue	Present
White-rumped Swallow	Present	Absent or weak, tips only	Absent or weak, tips only	Usually absent or vestigial	Grenish blue	Absent, but mid-chest is slightly dusky
Chilean Swallow	Absent (except on one specimen)	Absent or vestigial, tips only	Absent or vestigial	Usually absent or vestigial	Navy blue	Absent but mid-chest is dusky or greyish, two-tone

Figure 12. Specimens showing adult examples of all the *Tachycineta* species and populations discussed in this paper. Left to right: (i) Mangrove Swallow *T. albilinea* (Lion Hill, South of Panama, BMNH 85.3.24.101); (ii) Tumbes Swallow *T. stolzmanni* (Eteru, Peru, male, BMNH 1901.4.25.7); (iii) Magdalena Swallow *T. albiventer magdalenae* ('South America', unsexed, BMNH 84.5.14.65); (iv) near-topotypical White-winged Swallow *T. a. albiventer* (Supernaam river, British Guyana, unsexed, BMNH 1922.3.5.3340); (v) White-winged Swallow Atlantic-Cerrado population (Ypanema, São Paulo, Brazil, male, BMNH 1904.7.8.45); (vi) White-rumped Swallow *T. leucorrhoa* (Argentina, female, BMNH 97.11.14.90); (vii) Chilean Swallow *T. leucopyga* (male, Espantillas, Argentina, BMNH 97.11.14.135). The dark underparts of Magdalena Swallow are unusual and seem likely due to dirt. Photographs by Thomas Donegan © Natural History Museum.

Plumage

Overall plumage variation between recognized species in this group generally is low (see Table 5; Fig. 12). Mangrove vs White-winged Swallow and White-rumped versus Chilean Swallow vary from each other in just one or two diagnosable characters in each case, with presence/absence of a white loral marking being the most reliable field marking in each case. Differences in mantle coloration and extent of white in the wing are also observed. However, I found one Chilean Swallow specimen with a white loral (BMNH 1946.49.472, Peulla, Todos los Santos, South Chile). This was collected well within the exclusive range of that species, so an unlikely hybrid and showing this feature to be non-diagnostic.

As regards the Magdalena Swallow, plumage characters were those which first inspired this study. Many individuals of the Magdalena Swallow have reduced or no white markings on the wing (examples in Figs. 1, 16-18, 20-22). Such markings are extensive in 'textbook' White-winged Swallows and the majority of birds can be identified on this basis. Principally, the differences are in the extent of white markings on the tertials, secondaries and wing coverts. In Magdalena Swallow, the greater coverts seldom include visible white markings; those birds which do have white edgings to such feathers generally have thinner edgings on fewer feathers compared to White-winged Swallows or do not have as extensively marked secondaries or tertials. In most Magdalena Swallows, the tertials are usually marked only on the distal margin (although in some cases it is more extensive). In contrast, in White-winged Swallows, most birds have extensively white tertials, including on both the distal and proximal sides and often with the entire tip and other exposed parts of these feathers being marked white (Figs. 11, 12, 16, 17). Fewer of the secondaries of Magdalena Swallow tend to be marked white and those which are marked tend to have less extensive markings also. Juveniles have brown base coloration in both Magdalena and White-winged Swallows, with similar wing markings to their respective adults (Figs. 1, 20-22).

Mantle coloration is almost universally navy-blue in Magdalena Swallow, with only a slight greenish tinge. In White-winged Swallows, blue-green shades predominate, although there is individual and geographical variation as discussed in Results – section (b), below.

Since Magdalena versus White-winged Swallow differ in extent of white on the wing and mantle coloration, but in each case non-diagnosably, this pair lacks a single presence/absence character for plumage which identifies the populations. As a result, they do not attain the same level of differentiation as that shown between 'good' species in the genus, a similar situation to that presented by biometrics.

Comparison of vocal and biometric with molecular differentiation

Pairwise comparisons for previously-recognized species showed moderate molecular (2-8%) and vocal variation (3-7 controlled effect sizes) (Figs. 13-14). The combined biometric dataset was a good correlate for molecular differentiation (Pearson *r*=0.64 versus all data; *r*=0.53 vs CytB, 0.76 vs ND2, *r*=0.75 vs ATPAse), with tarsus length correlating against CytB (*r*=0.66) and ND2 (*r*=0.64) and wing length against CytB (*r*=0.71). Overall vocal variation did not correlate with molecular variation, either based on the vocal dataset as a whole or on the vocal sample for buzzes or rising songs. For voice, the only correlations were between: (i) frequency variation from start to end of rising songs (FVSE: *r*=0.63 and *r*=0.72 vs all data in Whittingham *et al*. 2002 and Cerasale *et al.* 2012 respectively; *r*=0.71 vs Cytochrome B in Whittingham *et al*. 2002); and (ii) frequency variation from trough to peak of rising songs (FVTP: *r*=0.65 vs Cytochrome B in Whittingham *et al*. 2002).

For voice, the situation with FVSE likely arises because there are only two species in which frequency increases then decreases in frequency (Chilean and White-rumped), which are related to one another and both give lower scores as between one another than those of other species, but higher scores versus most of the other species. In contrast, in the other species, frequency generally only increases in rising songs but to different degrees.

A plot of FVSE vs molecular differentiation is shown in Fig. 13, overall vocal versus molecular variation in Fig. 14 and biometric versus molecular data in Fig. 15. These illustrate the contrasting results whereby Magdalena vs White-winged Swallow would be expected to have comparable molecular variation to good species in the group based on voice, but fall short as regards biometrics.

Species scoring

Under Tobias *et al.* (2010) criteria, Magdalena Swallow vs White-winged Swallow scores for plumage (2?: up to 1 for reduced white feathering in secondaries and tertials; up to 1 for mantle coloration, it being unclear how 75% differentiation is measured in this system for plumage); voice (4: 2 for speed and 2 for max. trough frequency); and biometrics: (1 for tarsus length). Total c.7, clearly a borderline case.

Results – (b) variation within White-winged Swallow

Voice

For voice, Magdalena Swallow stands out as the most different population within White-winged Swallow *sensu lato*. Comparing to differentiation of 4.46 of Magdalena vs White-winged Swallows as a whole, the most proximate llanos/Venezuela population held up at 4.81, W & S Amazonia scored higher at 6.15 and Guyana shield was lower and below the score for species rank at 2.96 (although with a smaller sample size) and Cerrado-Atlantic 5.55.

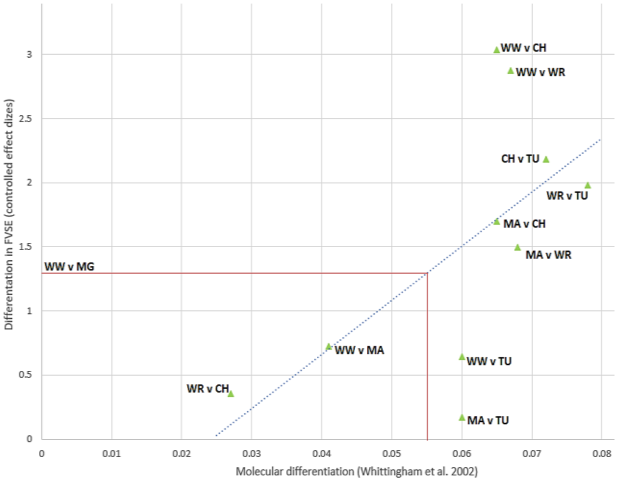

Figure 13. Scatter plot of pairwise overall molecular differentiation (per Cerasale *et al*. 2012, table 5) versus differentiation for acoustic frequency variation from start to end of rising call (FVSE). WW = White-winged Swallow; MA = Mangrove Swallow; TU = Tumbes Swallow; WR = White-rumped Swallow; CH = Chilean Swallow; MG = Magdalena Swallow. Blue dotted line is line of best fit. Red line shows FVSE for White-winged vs Magdalena Swallow and its intersection with the line of best fit.

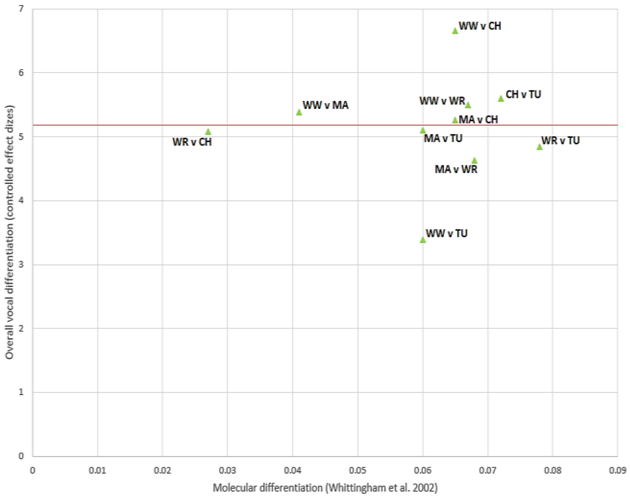

Figure 14. Scatter plot of pairwise overall molecular differentiation (per Cerasale *et al*. 2012, table 5) versus overall vocal variation as measured in controlled effect sizes. Acronyms as in Fig. 13. The red line shows vocal differentiation for White-winged vs Magdalena Swallow. These two variables were not correlated, so no line of best fit is shown.

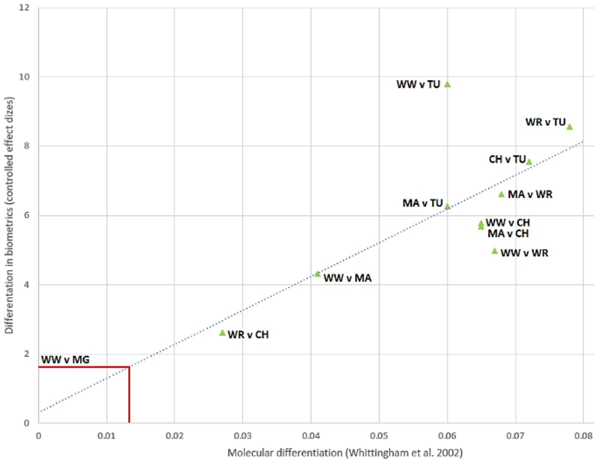

Figure 15. Scatter plot of pairwise overall molecular differentiation (per Cerasale *et al*. 2012, table 5) versus overall biometric differentiation in controlled effect sizes. Acronyms as in Fig. 13. Blue dotted line is line of best fit. Red line shows biometric variation for White-winged vs Magdalena Swallow and its intersection with the line of best fit, which contrasts with vocal results in Figs. 13-14.

Turning to Eastern populations, there is clearly geographical variation involved, but the differentiation is weak. Overall vocal differentiation among each pairwise comparison for Eastern populations was less than 2, which can be considered a bare minimum score for subspecies rank (Donegan 2018). Only marginal differences were observed between Guyanan and western Amazonian populations (1.49), resulting in weak vocal support for putative subspecies *aequatorialis*. Sample sizes for Maracaibo and Llanos-Venezuela are low (see Appendix 2), which likely results in zero scores for many variables; scores would be expected to attain greater definition with increased sample sizes. Amazonia versus Atlantic-Cerrado, which showed notable biometric and plumage differentiation (see below), scored only moderately for vocal variation.

Surprisingly, the most proximate (West Amazonia and Llanos) populations are more differentiated from Magdalena Swallow in voice. Guyana shield birds were closer. This leapfrog pattern might be a result of convergent evolution in different areas, or could suggest that limited contact via river deltas along the North coast of South America is more prevalent than contact across the Andes.

There are only two sound recordings from the Maracaibo basin, both from near-coastal localities in Falcón state. The first is a series of buzzes; the second is of buzzes with an unusual note shape (up-downstroke) and pace (50 notes/s), not seen in any other recording. The first recording is indistinguishable statistically from Magdalena Swallow, and has an overall decrease in frequency, which is more typical of that population and rarer east of the Andes (see App. 2). That the recording is a repeated buzz (the predominant kind of vocalization for Magdalena Swallow but rarer in White-winged: see Table 3) is also noteworthy.

Biometrics

Biometric variation between White-winged Swallow populations showed a different pattern (see App. 4 for details of measurements and App. 5 for differentiation of each variable between populations). The Atlantic-Cerrado population was the most distinct, with scores approaching 2 against most other populations, largely driven by its longer tail length. The llanos-Venezuela and Maracaibo populations scored zero against most other populations, likely due to low sample size. Magdalena Swallow showed moderate biometric variation compared to other populations, mostly in tarsus length but also wing and bill lengths (App. 5).

Plumage

Individual variation in wing markings of White-winged Swallow has been commented upon by Hellmayr (1935) and Turner & Rose (1989), who considered this largely a result of wear and abrasion. The white wing-margins of White-winged and, to a lesser extent Magdalena Swallow include mildly attenuated, extended barbs. Abrasion of these white barbs is clear in older specimens. However, this does not explain all morphological and geographical variation. An overall pattern of less extensive white wing markings in Magdalena Swallow is evident from specimens and photographic libraries. In White-winged Swallows, most birds include extensive white markings on both the inner and outer web of the tertials, although a small number of individuals are more like Magdalena Swallow with markings only on the distal margins. The number of secondaries and coverts which are marked and the extent of such markings also vary. Magdalena birds are predominantly non-extensively marked, with Eastern birds being predominantly extensively marked. No quantitative study of white wing markings was done here, since there is clearly overlap and no diagnosability would be shown.

Table 6. Vocal variation among populations of White-winged Swallows *Tachycineta albiventer*, measured in controlled effect sizes / diagnosability coefficients for rising songs only, following Donegan (2018). A score of 4 reflects diagnosability in multidimensional space. *n*=sample size for number of notes (NN).

A. Overall	**Maracaibo**	**Llanos-Venezuela**	**Guyana shield**	**W & S Amazonia**	**Atlantic-Cerrado**
Magdalena	0	**4.81**	2.96	**6.15**	**5.55**
Maracaibo		0	3.63	2.71	**4.17**
Llanos-Venezuela			0	0	0
Guyana shield				1.49	1.35
W & S Amazonia					0.85

B. Rising songs	**Maracaibo** (*n*=0)	**Llanos-Venezuela** (*n*=17)	**Guyana shield** (*n*=9)	**W & S Amazonia** (*n*=82)	**Atlantic-Cerrado** (*n*=40)
Magdalena (*n*=9)	/	4.48	2.46	5.24	3.76
Maracaibo (*n*=0)		/	/	/	/
Llanos-Venezuela (*n*=17)			0	0	0
Guyana shield (*n*=9)				1.49	0
W & S Amazonia (*n*=82)					0.85

C. Buzzes	**Maracaibo** (*n*=4)	**Llanos-Venezuela** (*n*=2)	**Guyana shield** (*n*=2)	**W & S Amazonia** (*n*=27)	**Atlantic-Cerrado** (*n*=21)
Magdalena (*n*=29)	0	1.25	1.17	2.28	2.89
Maracaibo (*n*=4)		0	3.63	2.71	**4.17**
Llanos-Venezuela (*n*=2)			0	0	0
Guyana shield (*n*=2)				0	1.35
W & S Amazonia (*n*=27)					0

Table 7. Biometric variation among populations of White-winged Swallows *Tachycineta albiventer*, measured in controlled effect sizes / diagnosability coefficients for rising songs only, following Donegan (2018). A score of 4 reflects diagnosability in multidimensional space. *n*=sample size, wing length.

	Maracaibo (*n*=2)	**Llanos-Venezuela** (*n*=11)	**Guyana shield** (*n*=22)	**W & S Amazonia** (*n*=42)	**Atlantic-Cerrado** (*n*=12)
Magdalena (*n*=29)	0	1.00	1.73	1.55	3.32
Maracaibo (*n*=2)		0	0	0	0
Llanos-Venezuela (*n*=11)			0	0	2.11
Guyana shield (*n*=22)				0	1.64
W & S Amazonia (*n*=42)					1.50

Another notable plumage feature which shows between-population and within-population variation is mantle coloration. In Magdalena Swallow, almost all individuals are a dark or navy shade of iridescent blue, with slight greenish tinges; one specimen had a green-blue mantle (AMNH 133912, Fig. 22(v)) and a few photographed birds show this coloration, but there is little individual variation.

Photographs of birds from the base of the Santa Marta mountains seem similar to other Colombian populations. Going clockwise around the Andes, the arid Guajira peninsula of northern Colombia and Maracaibo basin do not present ideal habitats for these riparian birds. There are few records from Guajira (only 5 photographs on eBird 2024, despite the inclusion of this region on many birding tours), most being taken on the pier by the mouth of the río Ranchería at Riohacha. The species seems to be a rare breeder or vagrant in this region.

Turning East from La Guajira in Colombia to Zulia, Falcón, Lara and Yarucuy states in northern Venezuela, coastal birds remain predominantly navy blue on the dorsal and lack strong white wing markings, but some examples have more extensive white wing markings. The single specimen from this region (AMNH 150572, Tucacas, Falcón) has a greenish-blue dorsal, but lacks strong white wing markings. In the Yaracuy valley, there are examples with plumage of classic Magdalena Swallow (e.g. ML334281761 in Chivacoa) but also of classic Eastern plumage in the southernmost part of the valley (e.g. ML618972248, near Sarare). The Merida Andes overall seem to form a barrier of sorts between these darker-mantled birds and the llanos-Venezuela population, which have consistently aquamarine blue mantles. However, this is porous barrier, with intergradation evident via the Táchira depression (Catatumbo region, see below) and likely through Yaracuy valley and across the Caribbean coast.

Near the Táchira depression, specimens are mixed but most have the classic plumage of Eastern (llanos) birds (e.g. ML578503761). I found 6 specimens from North of this depression in the Catatumbo region (Norte de Santander) and lowlands East of Perijá in Venezuela (see App. 6, 'Specimens from Táchira, Catatumbo and Maracaibo basin', nos. 1-6; Fig. 24). Three of them are juveniles. Of the three adults, two have more aquamarine mantles and extensive wing markings; one has reduced white in the wings and a bluish mantle. Of the juveniles, one has reduced white wing markings (Fig. 25(ii)) but the other two do not (Fig. 24). Birds along the coast are more predominantly of the Magdalena Swallow morphology, whilst those closer to the Táchira depression are mixed but predominantly of Eastern morphology (Figs. 24-25).

Looking further East, from the type locality of *albiventer* in French Guyana and throughout the Guyana shield to southern Amazonia, birds with an aquamarine mantle predominate, with extensive white wing markings, but some birds have more bluish-green mantles. Based on my studies of specimens at BMNH at AMNH, which have good series from (British) Guyana and western Amazonian localities in Colombia, Peru and Ecuador, dorsal coloration is not a diagnosable character for subspecies *aequatorialis*. I concur with Lawrence (1867b) that Amazonian birds generally have more extensive white wing markings and several specimens seem to have longer white flanges on the outer web of wing feathers than Guyanan birds on average, but populations overlap in these features.

In Amazonia, mantle coloration is more variable. Birds of the described morphology of subspecies *aequatorialis* have aquamarine blue/green mantles and extensive white wing markings; these morphotypes predominate. There are occasional examples in eBird (2024) from the western arc of Amazonia and the East slope in Colombia and Ecuador, of individuals with bluish dorsals approaching those of Magdalena Swallow (e.g. ML611314727 from South of the Táchira depression in Casanare) and also darker or muddier greens more typical of the Atlantic forest region (IAVH specimens, see next para.). This suggests limited contact with Magdalena Swallow around the Táchira depression or across the Andes, perhaps caused by wanderers.

Birds from the Atlantic and Cerrado regions have a different predominant mantle coloration, consistently being a more algal or dirty green shade, especially in the centre of the mantle (Figs. 12, 16). Some (but not all) specimens from this region also have narrow white markings on the tail tips and remiges. Birds of this morphology have been collected throughout the East coast of Brazil (from Pernambuco South to São Paulo and Paraná states and inland to Goiás and the Pantanal). Atlantic and Cerrado birds approach the mantle coloration (and also measurements) of sympatric White-rumped Swallow (Fig. 12). Birds with this algal green dorsal are occasionally found in Amazonia too, in smaller numbers (e.g. IAVH 2713, Guainía; IAVH 1161, Vaupés), and at least one Amazonian bird had a white tail tip (AMNH 116856, Morelia, Caquetá, Colombia), so this feature is not diagnostic for Atlantic populations either.

Six specimens from the rio Negro in AMNH all have darker, bluer mantles, although not as dark as Magdalena Swallows. Examples with bluer mantles can also be found in eastern Venezuela (e.g. BMNH 1903.12.12.28 Guanoco, Venezuela: Fig. 6).

Most specimens (at least a 75% or more basis) can be identified as having features of one of the three regions identified here based on mantle coloration: (i) (usually) blue-mantled West Colombia with reduced white wing markings, (ii) (usually) aquamarine-mantled Amazonia and (iii) greener-mantled Atlantic-Cerrado, which often have white tail tips. With care and experience, the marginally bluer-mantled aquamarine shades of the rio Negro and northern Venezuela population compared to other Amazonian birds can also be identified. However, none of these plumage characters is entirely diagnostic, suggesting contact.

Comparison with molecular variation

Dor *et al*. (2012) included four samples of Eastern White-winged Swallows, from Bolivia (2) and Peru (1) (W & S Amazonia region as defined here) and one from Venezuela (AMNH 2982: Rio Carapo, Guaiquinima Base Camp). Some genetic structure was observed, with the Venezuelan specimen (Guyanan shield region, as defined here) being embedded with Amazonian samples.

Figure 16. Specimens showing geographical variation in White-winged Swallow *Tachycineta albiventer* at BMNH © Natural History Museum. Left to right, typical individuals of Magdalena Swallow, northern Venezuela, Amazonian birds (three from Colombia, British Guyana and Peru) and Atlantic birds (Pernambuco, and two from SE Brazil). Note the navy blue of Magdalena Swallow, slightly darker blue (than other Eastern birds) of the northern Venezuelan specimen, lack of notable variation in Amazonian birds from Guyana to west Amazonia, and consistently greener dorsal of Atlantic birds. Left to right: (i) BMNH 84.5.14.65 ('South America', unsexed,); (ii) BMNH 1903.12.12.28 (Guanoco, Venezuela, female); (iii) BMNH 1950.64.51 (Plaza Bonita, region of Macarena, Colombia, female); (iv) 1922.3.5.3342 (Great Falls, Demerera river, British Guyana); (v) BMNH 98.10.20.124 (Iquitos, Upper Amazon, Peru); (vi) BMNH 1903.12.15.83 (Pernambuco, Brazil, unsexed); (vii) BMNH 1904.7.8.45 (Ypanema, São Paulo, Brazil); (viii) BMNH 1912.12.12.25 (Rio Jaquia, Guassu, SE Brazil, female). The dark underparts of Magdalena Swallow are unusual and seem likely due to dirt. Photographs by Thomas Donegan © Natural History Museum.

Brown (2019) studied specimens from Guyana (Guyana shield), Brazil (AMNH-DOT-14553; Amazonia as defined here), Bolivia (LSUMZ 12680; Amazonia as defined here) and Paraguay (UMMZ 227529: Atlantic-Cerrado as defined here). Different analyses yielded different tree topologies, although generally with low support.

Denser molecular sampling of White-winged Swallow, with samples of Magdalena Swallow, would be needed to shed further light on the vocal and plumage variations discussed in this section.

Conclusions and discussion

In summary, the Magdalena Swallow stands out from other populations in its voice, with statistically significant but moderate biometric variation and 75%+ plumage variation from Eastern birds. The Atlantic-Cerrado population shows moderate biometric differentiation and 75%+ plumage differentiation from other Eastern populations, but only moderate vocal differentiation. Amazonian, Guyanan and llanos birds show small differences in plumages and voice, but do not attain the levels of differentiation at which subspecies limits are usually recognized.

Reported vagrancy or occasional occurrence of White-winged Swallow to Curaçao (Voous 1985) and (presumed) Magdalena Swallow to Panama (Seutin 1998, Angehr *et al.* 2004) and once up to 2,600 m elevation of Bogotá in the East Andes of Colombia (eBird 2024) shows that these birds will occasionally wander both geographically and elevationally. This is an expected long-term survival strategy for a species linked so closely in its ecology to water, where resources may be ephemeral.

Occasional ongoing contact between Magdalena and White-winged Swallows seems to be maintained across the Táchira depression and Yaracuy valley and perhaps the northern coast of South America. This may explain the strong but non-diagnosable differentiation in plumages, the diversity in plumage of White-winged Swallow mantle coloration in Amazonia and appearance of broadly fringed white-wings in some Magdalena Swallows.

Description of Magdalena Swallow

Taking into account vocal, biometric and plumage differentiation, it seems clear that an undescribed swallow, which has probably been observed by hundreds of bird-watchers and ornithologists and whose plumage features have been noted for almost a century, has for too long remained undescribed. This paper aims to rectify its undescribed status, by naming:

Tachycineta albiventer magdalenae subsp. nov.

Magdalena Swallow
Golondrina del Magdalena

Wyatt (1871, p. 323) Lake of Paturia; Magdalena. Chapman (1917, pp. 501-502) "An abundant bird in the Magdalena Valley". Hellmayr (1935, p. 71, footnote) "A single example from the Magdalena River". Gochfeld *et al.* (1980, p. 199) "*Tachycineta* sp.". Turner & Rose (1989, p. 101, under Mangrove Swallow *T. albilinea*) "a few unsubstantiated reports from Colombia…". Strewe (2006) "*Tachycineta cyaneoviridis*". Donegan *et al.* (2009, p. 82), all materials within account discussing and entitled "Mangrove Swallow *Tachycineta albilinea*". Donegan *et al.* (2010a, pp. 44-45), within account discussing and entitled "Mangrove Swallow *Tachycineta albilinea*": "aberrant or molting White-winged Swallow *Tachycineta albiventer*" and plate in fig. 11: "putative aberrant or molting White-winged Swallow *Tachycineta albiventer*" (reproduced here as Fig. 18D). McMullan *et al.* (2018, p. 307) "*Tachycineta albiventer* ssp." ("white on wings may be very limited ….”). McMullan *et al.* (2021, p. 343) "*Tachycineta albiventer* ssp?" and right-hand plate, labelled "aves del norte y centro del país tienen mucho menos blanco".

Holotype

ICN-UN 3865, an adult female collected at Tocahagua, dpto. Atlántico, Colombia (20 m above sea level) by A. Dugand & J.I. Borrero on 14 January 1947. Field no. DB-540. Illustrated in Fig. 17, third from left. According to Paynter (1997), this is a small lake on the Atlántico/Bolivar border in northern Colombia, also known as Ciénaga de Tocaguá (coordinates 10°38'N, 75°11'W).

Diagnosis

Exhibits all characteristics of the genus *Tachycineta*, being a slender and neat-looking American swallow, with blue upperparts, white underparts, forked tail and associated with water. In particular, it forms part of subgenus *Leucochelidon* Brooke, 1974 due to its white rump, which contrasts markedly with the iridescent blue of the back and white edges to the middle and inner secondaries and predominantly South American distribution.

Compared to the nominate, allopatric White-winged Swallow *T. albiventer* found east of the Andes, its rising call is diagnosable by vocal variables in multidimensional space, being slower, having less of an increase in frequency through the call and being lower pitched (Tables 1-2; Apps. 2-3; Fig. 3). Also, buzzes (not rising songs as in White-winged) are the main and predominant kind of vocalizations (Table 3, Apps. 1-2). Most juveniles and adults of Magdalena Swallow can be distinguished from White-winged Swallow by their less extensive white wing patch, in particular absence of or reduced white markings in the tertials, secondaries and secondary coverts, almost universally navy-blue mantle coloration (versus typically aquamarine blue/green mantle in eastern birds, but variable) (Table 5; Figs. 1, 16, 17) and shorter average tarsus, wing and bill lengths (Table 4; Apps. 4, 5), but none of these is diagnostic.

Differs from Mangrove Swallow in lacking white lores and bluer (less turquoise) mantle shade (Figs. 1, 16), these being the only plumage differences identified by Baird (1865, p. 299). In juveniles of Mangrove Swallow, the lores have a burnt yellow coloration, which feature is absent in juveniles of Magdalena Swallow (Fig. 1). Magdalena Swallow has average longer bill, tail, tail fork and wings (Table 4; Apps. 4, 5), as well as faster and longer rising calls with more individual notes (Tables 1-3; Apps. 2-3; Fig. 3).

Diagnosable from all other species studied here by voice and plumage, as set out in Tables 1-5, Apps. 2-5 and Figs. 3-12.

Description of the holotype

Color nomenclature follows Munsell Color (1977, 2000), except for soft parts. Bill entirely black. Top of head azure blue (closest to 2.5B 3/2 but iridescent). No supercilium or eye stripe. Neck, mantle, lower rump and tail coverts iridescent navy blue with slight greenish tinge (2.5B 4/4 but iridescent) on exposed distal parts of feathers, with white (Gley 1 8/N) on concealed basal sections of feathers and a miniscule fringe of grey (Gley 1 3/N) in the interface between blue and white coloration visible on most feathers. (Exposed white feather bases in the neck area give the appearance of a white nuchal collar, probably due to stretching during skin preparation. This was probably invisible in life, since such features are not observed in the field or photographs of live birds.) Rump white (Gley 1 8/N) with numerous visible dark feather shafts (rachis) giving the impression of thin streaking in this region. Tail feathers are dusky (5Y 2.5/1) with slight bluish tinge. Tail forked (8.5 mm maximum difference between longest outer-tail feather and shortest central tail feather). Underparts and underwing coverts uniform white (Gley 1 8/N), from the lower lores and chin to vent. Carpal dusky (5Y 3/1) with white fringe. Underwing covers white. Wing coverts darker blue compared to the scapulars and mantle, with a small white mark on innermost greater covert. Primaries are uniform dusky (5Y 3/1), except for a thin white distal edge to the base of the innermost primary. Tertials and secondaries dusky, except as noted. White wing patch conformed of markings on distal (trailing) edge of secondaries and tertials as follows (numbering 9 as innermost tertial or most proximal secondary): moderate white distal margin on proximal tertial (9th secondary) extending to tip; moderate white margin on basal section of second and third tertials (8th and 7th secondaries), extending to a thin white fringe in the middle section to tip. Remaining secondaries compressed due to preparation of skin, 6th to 3rd secondaries marked with white distal margins extending to the tip, reduced on the second secondary and with a thin margin only on the basal outermost secondary. In the white, distal part of the secondaries, individual feather barbs become thicker and individually flanged, creating a moderate effect of additional volume. Measurements: wing chord 102 mm, tail 43 mm, tarsus 9.7 mm, bill from tip to cranium 11.3 mm, feathered bill 8.4 mm, bill width at nostrils 5.2 mm, bill depth at nostrils 3.1 mm.

Paratypes. See App. 6 and Figs. 16, 17, 20-23.

Variation in the series

As discussed under Results – Plumage, Magdalena Swallows vary in the extent of white in the wings. Some individuals have essentially no white markings at all (e.g. Figs. 1B. 18A-D, 20(ii), 20(iv, vi), 21(iii), 22(v)), whilst others have white edges to the greater covers and up to half of each tertial feather marked white (see Figs. 18G-I, 20(iv), 20(i)). A mid-point bird would have white fringes to the distal tertials, around half of the secondaries marked white distally but no markings on the outermost secondaries or wing coverts (Figs. 1A, 17(iii-iv), 18E-F, 20(i, v, vi), 21(ii, iv, v, vi, vii), 22(i-v)). Some birds with more marked tertials lack strong markings on the secondaries (Fig. 20(i)).

There are variations in mantle coloration. Juvenile specimens, and those photographed in the field, have a greyish-brown mantle and wing coloration (as is the case for White-winged Swallow) (Figs. 1C-D, 20(iv-vi), 21(vi-vii), 21(vi, vii), 22(v)). Such birds show overall reduced white markings in the secondaries compared to eastern juveniles (Fig. 1). As juveniles age, plumage briefly becomes a blackish, non-iridescent bluish color (e.g. ICN 20778: Fig. 17). Fully adult birds are beautiful shade of iridescent navy blue with a slight greenish tinge (Figs. 1-2, 17, 18, 20-22). The green or stronger aquamarine mantles, which dominate eastern populations (Figs. 1, 16, 17) were found in only one Magdalena Swallow specimen (Fig. 22(v)).

Figure 17. Two White-winged Swallows (left) and two Magdalena Swallows (right) including the holotype. Note darker or navy, less greenish-blue mantle, especially when viewed from side aspect (left) on Magdalena Swallow, and the reduced white wing markings of Magdalena Swallow (especially dorsally, top right). Instituto de Ciencias Naturales, Universidad Nacional, Bogotá (ICN). Left to right: (i) ICN 14785, Puerto Asís, Putumayo; (ii) ICN 3863, Tres Esquinas, Caquetá; (iii) ICN 3865, Tocahagua, Atlántico (holotype); (iv) ICN 20778, Islas del Rosario, Cartagena, Bolívar (a paratype). Photographs by Thomas Donegan.

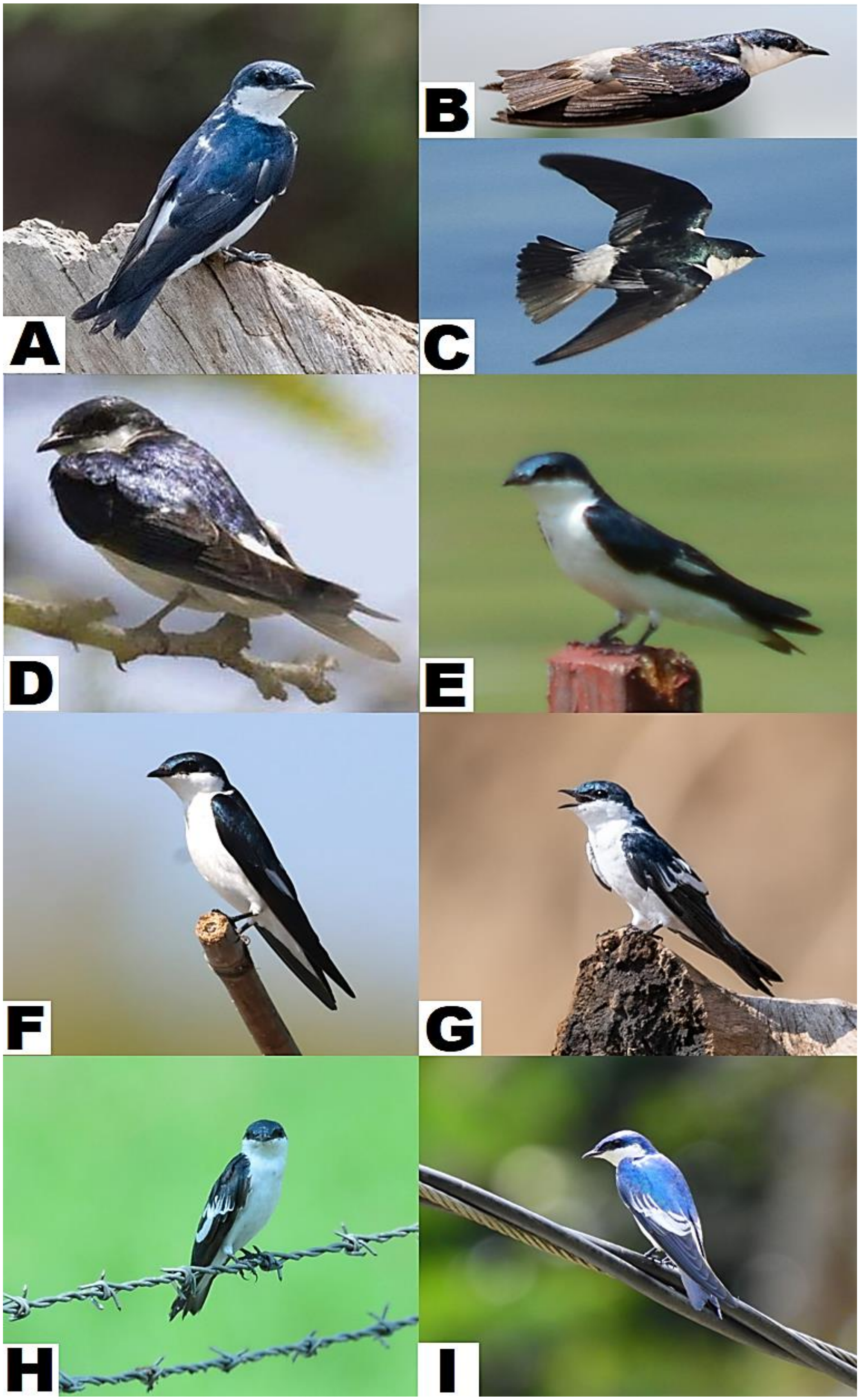

Figure 18. Collage of Magdalena Swallows, showing variation in wing markings. First, four birds with almost no white on the wing, two of them in flight. A. Reserva Costa Rica Antioquia, (Nestor Monsalve, 12 March 2023, ML551987511). B. Via Puerto Triunfo-Puerto Nare, Antioquia (Nestor Monsalve, 10 March 2023, ML545973881). C. Malecón Puerta de Oro, Atlántico (Jasan Vasallo, 6 January 2023, ML533164621). D. PNN Salamanca, Atlántico (R. Scanlon, March 2006. Mangoverde.com, previously published in Donegan *et al.* 2010a, pp.44-45). Next, three mid-range or 'typical' birds. E. El Peñón, Girardot, Cundinamarca (T. Donegan, 31 December 2021). F. Cienaga de Gambote Bolívar (Jorge Alcalá, 31 December 2022, ML519239713). G. Estación Cocorna, Antioquia (Nestor Monsalve, 10 March 2023, ML546288971). Finally, two highly marked birds with wing markings more similar to eastern populations. G. San Pablo, Tocaima, Cundinamarca (James Kamstra, 22 March 2023, ML562512161). H. Valdivia Rio El Pescado, Antioquia, Colombia (Edwin Múnera, 17 October 2022, ML498115911).

Etymology

The name *magdalenae* refers to the Magdalena valley and river, which characterizes most of the subspecies' range. The Magdalena river is in turn named after Mary of Magdalene, a confidant of Jesus of Nazareth who according to historical accounts lived over 2000 years ago in present-day Israel. Mary is said to have witnessed Jesus' crucifixion and to have wept; her tears may have inspired the naming of Colombia's mightiest western river. This name is based upon 'magdalena' as a supposed first declension feminine noun in Latin, declined in the genitive singular. It is non-variable with respect to the gender of the genus in which it is placed.

Distribution

See Fig. 2. Common in riparian habitats in the entire río Magdalena valley from its headwaters to the coast and northern lowlands of Colombia west of the Andes and uppermost rios Cauca/Sinú drainages. No confirmed records in the Cauca valley (except the uppermost part downstream from the Andes), but some recent sight records in north-west Chocó (eBird 2024). Uncommon in the Guajira peninsula. The Colombian part of its distribution is as mapped for "ssp." in McMullan *et al.* (2018, p. 307) and for "spp?" by McMullan *et al.* (2021, p. 343).

Although typically a low elevation resident species, the Magdalena Swallow wanders occasionally and was recently observed at 2,600 m elevation in Bogotá (eBird 2024). It might use man-made water bodies such as lakes and reservoirs as stepping stones to reach higher elevations. White-winged Swallows recorded as a vagrant in Panama (Seutin 1998, Angehr *et al.* 2004) are presumably referable to this subspecies.

Some specimens and photographs of birds in the Maracaibo basin are of the Magdalena Swallow phenotype, especially along the coast. The Táchira depression is here considered a region of intermediates with nominate populations.

Ecology

The new subspecies generally occurs at low elevations, near freshwater lakes, streams and slow-moving rivers. It is not usually found in fast-moving streams or rivers in their upper and more mountainous sections. White-winged Swallows have been considered an indicator species of forest main river channels and associated waterbodies (Mistry *et al.* 2008). They forage over water bodies and adjacent land. The new subspecies occurs on major rivers, including on the mighty Magdalena river itself throughout its entire length and the lower Cauca, Nechí and Sinú, as well as the complex of ciénagas in northern Colombia.

During my observations in Colombia, including in dptos. Cundinamarca, Tolima, Antioquia, Bolívar, Magdalena and Santander, *T. a. magdalenae* was usually observed perching at relatively low levels (up to c. 5 m from the ground) above relatively slow-moving parts of rivers (e.g. backwaters or eddies), lakes and ponds. Usually, birds are seen as singletons but sometimes two to four individuals would occur together, perhaps as pairs or family groups. Birds frequent natural perches, e.g. exposed branches of dead trees as well as man-made items, e.g. wires and metal or wooden installations such as boats and jetties. Individuals sally for insects, usually above the water. The new subspecies can be common in the right kind of modified freshwater habitats, so is not considered likely to be threatened or in decline. The availability of healthy slow-moving riparian habitats with adjacent tree growths or other perches and nesting sites would seem necessary for it to thrive.

The temporal activities of Magdalena Swallow were studied at some length, including in connection with repeated attempts to sound-record these birds, many of which had nil results. At dawn and before dusk, birds are not often visible and so may be at roost, possibly in nesting crevices or foliage. In Argentina, adult White-winged Swallows have been observed settling down for the night with a fully volant juvenile on small branches over a running stream (Winkler 2006). During the daytime, these swallows first tend to appear on one of their preferred perches at around 7:30 to 8 am. Only at El Imperio, where the resident pair frequented an exposed metal installation over a lake far away from potential predators, would the resident birds appear earlier and just after dawn.

White-winged Swallows are often considered to frequent a preferred perch. However, my observations of that species and Magdalena Swallow indicate a more complex behaviour. Pairs seem to claim a territory of 500 m or so linearly on a river or lake and will have as many as 3 or 4 preferred perches along that transect. Upon being disturbed or on foraging they may sally from and then alight back on the same perch or may alternatively fly further and land on a different one. Birds would stay close to water level and certainly below the level of any nearby canopy. In the mid-morning, from 9-11 or so, birds would forage by flying regularly over water using relatively short episodes of hawking, either starting and ending on the same perch or between one perch and another. At this time, it was more possible to obtain sound recordings, as birds seemed to call often in the air but also when perched, mostly with buzzes perhaps on successful catching of insect prey and especially when one bird came into close proximity to another. During these early to mid-morning hours, birds had high site fidelity towards this handful of preferred perches.

From late morning (c. 11am) onwards into the afternoon, swallows would still use perches as a base but would forage further afield, including over low over stunted growth and grasslands and even golf courses, football pitches and parks adjacent to water bodies. When doing so, they would sometimes join other Hirundines, especially Grey-breasted Martin *Progne chalybea* and Southern Rough-winged Swallow *Stelgidopteryx ruficollis*. In the late afternoon to evening, the Magdalena Swallow would continue to feed with mixed swallow groups but higher above ground-level, up to 20-60 m high and up to hundreds of metres from water bodies. During these hours, birds would perch higher, e.g. on telegraph wires. I have also observed White-winged Swallows in Amazonia foraging away from major rivers, including into small nearby towns, during afternoon hours.

The Magdalena Swallow, like White-winged Swallow, probably nests mostly in crevices and holes, in rocks, tree branches and banks (Sick 1993). I found an active nest being used by a pair with juveniles close to fledgling age, of eastern White-winged Swallows at Caño Cristales in Meta in a rock crevice in early August 2023. Nests of *Tachycineta* are considered generally to be located in cavities, lined mostly with feathers and some foliage (e.g. Liljesthröm *et al.* 2009, Stager *et al.* 2012). Magdalena Swallow has been observed even to nest in unusual contexts and artificial constructs: Miller (1947, p. 370) observed birds attributable to the new subspecies nesting in crannies under the caves of a railway station in Huila; Mangrove Swallow has been observed nesting in the roof of a boat (Pineda *et al.* 2019) and an abandoned tyrant-flycatcher nest (Dyrcz 2000).

Taxonomic rank

Whether or not to recognise the Magdalena Swallow at all taxonomically (and, if so, at which rank) proved vexing topics, resulting in the long time to publication, large data sets deployed and length of this paper. Vocal results imply that Magdalena Swallow is differentiated to the extent it should be recognized as a species. However, my sample is concentrated in the mid-Magdalena Valley (one Colombian coastal recording and none from the Cauca/Sinú) and only one Maracaibo recording was available, so this is a tentative finding. Based on Donegan (2018)'s methods to measure differentiation, Magdalena Swallow would be a species based on vocal differentiation but not even a subspecies (i.e. an unnamed geographical variant) based on biometrics. Using Tobias *et al.*'s (2010) species scoring, it would be a borderline species (see analysis above).

The situation with plumages means that species rank would be inappropriate. There are clear geographical variations between Magdalena and White-winged Swallows, but populations each side of the Andes are variable and overlap with one another to some extent. The zone of intermediates near the Táchira depression into Maracaibo is a broad region, although perhaps not in the context of the near-pan-continental distribution of White-winged Swallow (*sensu lato*). Helbig *et al.* (2002) would regard Magdalena Swallow and White-winged Swallow as 'semispecies', with rank to be determined based upon the stability of the hybrid zone and the relative occurrence of 'parental' and/or hybrids in that zone. Unfortunately, the sample size from Maracaibo is small, especially of sound recordings, making this question difficult to assess and precluding any assessment which could reasonably arrive at any recommendation of species rank. Molecular data are also lacking.

Amadon (1949) and Patten & Unitt (2002) proposed a 75% diagnosis test for subspecies, which is here considered met by Magdalena Swallow for vocal and plumage characters but not biometrics. Remsen (2010) proposed a subspecies test requiring diagnosability in at least a single character, which is synonymous with a phylogenetic species definition and would be met here for vocal but not other characters.

Overall, the Magdalena Swallow is a distinct population occurring in a different geography from White-winged Swallows. Its voice and plumage indicate that it is neither White-winged nor Mangrove Swallow (e.g. Fig. 1), but more closely-related to the former. On the other hand, to pass off Magdalena Swallow as just an unnamed north-western extreme of a cline within White-winged would involve a mislabelling, and to lump Mangrove, Magdalena and White-winged Swallows into a single species, on the basis of limited introgression of the former, would be unwarranted. Subspecies rank remains a controversial category in general, but here seems the most appropriate treatment in the round for Magdalena Swallow.

Status of other *Tachycineta* species in northern and western Colombia

Following the description of the Magdalena Swallow, it is recommended that all sight records of other *Tachycineta* species in northern or western Colombia (other than some records of distinctive Voilet-green Swallow *T. thalassina* and Tree Swallow *T. bicolor* as vagrants) be reassessed.

Mangrove Swallow

This species must be retained on the Colombian list for reasons discussed below. However, it should no longer be regarded as the subject of any acceptable sight record. The account of Gochfeld *et al.* (1980) perfectly matches the Magdalena Swallow. All subsequently reported photographic records of Mangrove Swallow in Colombia, including that reproduced in Donegan *et al.* (2010a), various other photographs sent to the same authors when they managed the Colombia checklist and various corrected records in eBird (2024) clearly refer to the new subspecies. In this study, a 'Colombia' specimen of Mangrove Swallow *T. albilinea* was found (AMNH 500733: Fig. 19), bearing a typical label of such specimens from the Boucard collection. The borders of Colombia in 1891 included most of modern-day Panama. It is usually considered that such specimens are not acceptable national records, since they lack a specific locality and could have been collected in another country, so they are usually placed in a hypothetical status (e.g. Donegan *et al.* 2018b).

Donegan & Avendaño (2015) reviewed some recent taxonomic studies involving 'Colombia' or 'Bogotá' specimens and noted that, for example, the type specimens of White-rumped Sirystes *Sirystes albocinereus*, Yellow-breasted Brush Finch *Atlapetes latinuchus simplex* and East Andean Antbird *Drymophila caudata* were probably collected in diverse locations: Amazonia (Eastern Colombia), Nariño or northern Ecuador and Boyacá or Santander (East Andes), respectively (Hellmayr 1927, Donegan 2013, Donegan & Huertas 2006, Isler *et al.* 2012).

It seems likely than the majority of 'Colombia' trade specimens are of species which occur within Colombia's current national boundaries. In the past (e.g. Hilty & Brown 1986) double-digit numbers of bird species were known in Colombia only from these sorts of specimens. However, by 2009 with increasing fieldwork in the country, that number had fallen to five (Donegan *et al.* 2009) and there are now only two. Donegan *et al.* (2018b) recognized the following three species as confirmed in Colombia only from such trade specimens: Rufous Potoo *Nyctibius bracteatus* (subsequently confirmed in the Amazon region by Carantón-Alaya *et al.* 2024), Ruff *Calidris pugnax* (which like Mangrove Swallow is a plausible vagrant to northern Colombia) and Blue-mantled Thornbill *Chalcostigma stanleyi* (of which there is now a sight record: Donegan *et al.* 2010a). To these may be added Mangrove Swallow.

Figure 19. Mangrove Swallow specimen, labelled 'Colombia' (AMNH 500733). Photograph by Thomas Donegan.

One Magdalena Swallow specimen (AMNH 133917, paratype 35 in App. 6; Fig. 22(v)) is unique in the White-winged Swallow (*sensu lato*) series in having a clear pale loral marking. Another specimen in the same series (AMNH H13198) has a thinner loral marking. Such a loral stripe is generally considered a diagnostic plumage character of Mangrove Swallow. This specimen suggests that vagrancy could result in occasional introgression in northern Colombia, which would be consistent with the non-monophyly of these species reported by Dor *et al.* (2012).

Mangrove Swallow must therefore be retained on the Colombian checklist, but under relevant categories for species confirmed only from 'Bogotá' specimens. It seems likely to occur as a vagrant in the north of the country. Any acceptable record would need to be based upon a documented photographic or specimen record of a bird with a white loral and turquoise mantle, or a sound recording of the slower rising call of this species.

Bahama Swallow

Strewe (2006) reported a juvenile Bahama Swallow *T. cyaneoviridis* in northern Colombia (La Guajira). The observer is experienced and highly reliable, so this record must be taken seriously, but the observation was made and published prior to any publications with photographs of dark-winged swallows from western Colombia, which started in Donegan *et al*. (2010a). Magdalena Swallows are considered here an uncommon visitor or rare resident in La Guajira. Strewe's (2006) record is described as being a bird with a dark greyish back, white underparts and a contrast between the white underwing coverts. dark primaries and forked tail, all of which are consistent for immature *T. a. magdalenae* (e.g. the darker paratype shown in Fig. 17, fourth from left). It perched on a wire, which may have confused, but is here considered normal for Magdalena Swallow (see "Ecology"). No attempt was made by Strewe (2006) to identify his observed bird as against dark-winged White-winged Swallows. Possible confusion species discussed in his paper are other species with dark wings. This sole Colombian record of Bahama Swallow is considered inadmissible in light of the description here of Magdalena Swallow.

Violet-green Swallow

The sole record of *T. thalassina* is reported in Hilty & Brown (1986) based on observations by two experienced observers, R. Ridgely and B. Whitney at 2,200 m high in the Santa Marta mountains, an unlikely elevation and habitat for Magdalena Swallow.

Tree Swallow

Vagrancy of Tree Swallow is confirmed by a specimen collected in Pasto, Nariño by J.I. Borrero in 1950 (specimen no. ICN 3827) (Hilty & Brown 1986), which was not re-inspected here but is assumed correctly identified. This species has likely been mistaken in the past for Magdalena Swallow and over-reported in Colombia. For example, a series of specimens at CSJ labelled as of Tree Swallow are in fact of Magdalena Swallow (App. 6, paratypes 5-7; Figs. 22(i-iii)). Past sight records of Tree Swallow from Riohacha, Guajira and PN Salamanca (in Hilty & Brown 1986, all of which lack a detailed description and are localities where Magdalena Swallow occurs) seem dubious.

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Appendix 1: sound recordings studied

Magdalena Swallow

Fast rising calls:

COLOMBIA. Hacienda La Estancia, Melgar, Tolima (Thomas Donegan, 06/01/2016: XC942997=original file no. of recording LS110524; 01/01/2017: XC942998=LS110673). El Peñon, Girardot, Cundinamarca (Thomas Donegan, XC943004= LS111586: 31/12/2023).

Buzzes:

COLOMBIA. Girardot, Cundinamarca (Pere Sugranyes, date not known but prior to upload date of 22/06/2016: ML718593, ML718594). XC942997=LS110524 (as above). XC942998, XC943000 (both = LS110673; both, as XC942998 above). XC943003-5, XC943009 (all, as XC943004 or above = LS111584, LS111596-7). XC943011=LS111600, XC943013= LS111601) (both, as XC943004, but 01/01/2024).

Whistles:

COLOMBIA. Malecón Puerta de Oro, Atlántico (Jason Vasallo, 06/01/2023: ML585771491).

Maracaibo population

Buzzes:

VENEZUELA. Cienaga de Moturo, Falcón (Francisco Contreras, 04/02/2024: ML614419372).

Other:

VENEZUELA. ML616436634 (as ML614419372, but 24/03/2024; has unusual note shapes).

White-winged Swallow

Fast rising calls:

Llanos-Venezuela

COLOMBIA. Caño Orosi, Finca Candalayes, Vereda Candalayes, Trinidad, Casanare (Oscar Humberto Marín Gómez & Juan Pablo López, 15/07/2012: XC244958). Las Brisas, Maní, Casanare (Cristian A. Ramirez-Alvarez, 28/12/2020: ML608335123). Punto de conteo 34, Casanare, (David Ricardo Rodriguez Villamil, 21/08/2024: ML623952263).

VENEZUELA. Maracay, Lake Valencia, Aragua (Paul A. Schwartz, 14/03/1966: ML66680). Hato Corozal, Isla Ruende, Barinas (Paul A. Schwartz, 18/05/1964: ML66679).

Guyana shield

VENEZUELA. Villa Lola area, Bolivar (Peter Boesman, 06/08/2003: XC230432=ML292286).

GUYANA. Kuyuwini River, Upper Takutu-Upper Essequibo (Davis Finch, 13/11/1999: ML106405).

FRENCH GUIANA. Maripasoula, Grand Inini (Alexandre Renaudier, 06/10/2011: XC88480). Marais Leblond, Cayenne (Brice de la Croix, 26/06/2020: XC583588).

West and South Amazonia

COLOMBIA. Piamonte, Cauca (Mauricio Cuellar Ramirez, 23/06/2021: XC660138).

ECUADOR. Sani Lodge, Sucumbíos (Jerome Fischer, 18/05/2019: XC475351, XC475352). La Selva Jungle Lodge, North bank Río Napo, Sucumbíos (John V. Moore, 11/1993: XC259256, XC259257; Niels Krabbe, 22/01/1992: XC243135=ML242118). Sacha Lodge, Sucumbios (Daniel Lane, 24/02/2009: XC94866). Kapawi area, left bank Río Pastaza, Pastaza (Niels Krabbe, 25/10/1996: XC243134=ML244208). Laguna Añangu, Napo Wildlife Center, South bank Río Napo, Orellana (John V. Moore, 5/2005: XC259258).

PERU: Rio Javarí, Lago Santo Antonio, Loreto (Jeremy Minns, 20/09/2003: XC82095). Laguna Juanacha, Ucayali (Oscar Johnson, 22/08/2019: ML176570171). Cocha Cashu, Manu National Park, Madre de Dios (Ted Parker, 20/09/1982: ML29972; Lewis Kibler, 08/08/1986: ML39462, ML39468; Joseph Tobias & Nathalie Seddon, 18/09/2001: XC64227; Blaine Carnes, 27/08/2018: ML124889671). Cocha Salvador, Manu National Park, Madre de Dios (Lewis Kibler, 06/08/1986: ML37326). Cocha Camungo, Canopy Platform, Madre de Dios (Daniel Lane, 07/07/2010: ML392620661).

BOLIVIA. Flor de Oro, Noel Kempff Mercado NP, Santa Cruz (A. Bennett Hennessey, 05/10/2001: XC3275, ML110731).

Campamento La Torre, Santa Cruz, Bolivia (Ted Parker, 25/05/1991: ML80571).
BRAZIL. São Gabriel da Cachoeira, Amazonas (Jeremy Minns, 19/12/1998: XC211444, XC211445). Barreira do Campo, Rio Araguaia, Santana do Araguaia, Pará (Dante Buzzetti, 28/04/2004: XC522735). Pousada Praia Alta e Entorno, Tocantins (Josep del Hoyo, 04/08/2011: ML203899461). Palm, Praia da Graciosa, Tocantins (Iza Alencar, 19/06/2022: ML462212521). Reserva Ecologica Cristalino, Trilha de Castaneira, Mato Grosso (Curtis Marantz, 18/11/1997: ML88904). Poconé--Pousada Piuval, Mato Grosso (Brian Henderson, 23/08/2016: ML143936401).

Atlantic-Cerrado
BRAZIL. Potengi, Sítio Pau Preto, Ceará (Luciano Bernardes, 02/04/2016: ML254524871). Belmonte, Bahia (Fernando Igor de Godoy, 29/03/2017: XC421906). Cond Veredas Piatã, Bahia (Ben Phalan, 21/06/2019: ML172083851). Praia do Gamela, Sirinhaém, Pernambuco (Mauricio Cabral Periquito, 27/09/2009: XC39387). Transpantaneira-Rio Pixaim, Pantanal, Mato Grosso do Sul (Miguel Castelino, 14/11/1990: XC60900, XC60901). Rio Sucuriú, Três Lagoas, Mato Grosso do Sul (Dante Buzzetti, 22/07/2022: XC580186). Setor Samambaia, mata seca, perto da UFG-Agronomia, Goiânia-Goiás (Jayrson Araujo de Oliveira, 11/11/2019: XC506682). Chácara Jayrson, Santa Rita do Novo Destino, Goiás (Jayrson Araujo de Oliveira, 21/01/2020: XC522421; 14/07/2020: XC577510; 08/09/2021: XC674369; 15/06/2022: XC732842; 11/07/2022: XC737499). Goiânia, Goiás (Nunes D´Acosta, 14/07/2022: XC737573, XC737574, XC737575, XC737576). Sacramento, Lagoa dos Patos, Minas Gerais (Márcio Repenning, 16/03/2013: ML199163). Arealva, São Paulo (Fernando Igor de Godoy, 30/01/2017: XC705069). Jaboticabal--Ponte Velha do Rio Mogi-Guaçu, São Paulo (João Souza, 23/01/2021: ML300590191). Floresta Estadual Edmundo Navarro de Andrade, São Paulo (Carlos Otávio Gussoni, 01/07/2022: ML463973311). Londrina, Paraná (Joao Menezes, 26/07/2006: XC6708). Parna do Iguaçu, Trilha do Poço, Preto, Paraná (Marcelo da Rocha, 23/12/2022: ML515982871). Campo Mourão, Paraná (Luiz C. Silva, 05/11/2015: XC292344).

Buzzes:
Llanos-Venezuela
COLOMBIA. XC244958 (as above).

Guyana shield
VENEZUELA. Orinoco River islands, Amazonas (Peter Boesman, 28/03/1997: XC230431=ML287886).
GUYANA. Honey Pond, Karanambu Ranch (Charlie Vogt, 19/03/2010: XC46202). ML106405 (as above).

West and South Amazonia
COLOMBIA. Playón Rio Orteguaza, Vereda Canelos, Caquetá (Mauricio Cuellar Ramirez, 29/12/2021: XC695081). XC660138 (as above).
ECUADOR. XC243134=ML244208, XC243135, XC475352 (all, as above).
PERU: Puerto Maldonado, Tambopata Reserve, Madre de Dios (Ted Parker, 03/10/1981: ML24135). Los Amigos Biological Station (CICRA), Madre de Dios (Dale Forbes, 04/11/2022: ML506251161). ML124857061 (as ML124889671). ML124857271 (as ML124889671). ML124761021 (as ML124889671, 23/08/2018). ML37326, ML39468, ML176570171, ML392620661, XC82095 (all, as above).
BOLIVIA. ML80571 (as above).
BRAZIL. Cristalino Jungle Lodge, Mato Grosso (Andrew Spencer, 05/10/2009: XC47989). Gaúcha do Norte, Mato Grosso (Guilherme Melo, 26/09/2020: ML286351621). XC211444 (as above). XC211445 (as XC211444).

Atlantic-Cerrado
BRAZIL. RVS Mata do Buraquinho, João Pessoa, Paraíba (Antônio Cláudio C. Almeida, 16/07/2017: XC382021). Curaçá, Bahia (Juan Mazar Barnett, 28/01/1997: XC15335). Palmas--Parque Cesamar, Tocantins (Iza Alencar, 19/06/2022: ML460885731). Ponte das Laranjeiras, Piraí, Rio de Janeiro (Ricardo Gagliardi, 27/12/2019: XC549190). XC577510 (as above). XC731352, (as XC674369, but 11/06/2022). ML199163, ML172083851, ML254524871, ML463973311, XC6708, XC60900, XC421906, XC674369, XC732842, XC737573, XC737574, XC737575, XC737576 (all, as above).

Whistles:
Llanos-Venezuela
COLOMBIA. Hato Barley, Casanare, Colombia (Johnnier Arango, 26/10/2022: ML500758891, 27/10/2022: ML503990851, ML503990861).

West and South Amazonia
ECUADOR. Pastaza (Christiana Fattorelli, 8/10/2023: ML609750381)
BOLIVIA. Cachuela Esperanza, Beni, Bolivia (Joseph Tobias & Nathalie Seddon, 09/10/2005: XC74199).
BRAZIL. Presidente Figueiredo, Amazonas (Gabriel Leite**,** 30/09/2010: XC119308).

Atlantic-Cerrado
BRAZIL. Serra do Ouro, Estação Ecológica de Murici, Murici, Alagoas (Dante Buzzetti, 06/10/2002: XC500640; 09/10/2002: XC504977).

<u>Mangrove Swallow</u>
Rising calls:
MEXICO. Guásimas, Guaymas, Sonora (Richard E. Webster, 08/05/2018: XC449271). Topolobampo, Ahome, Sinaloa (Isain Contreras Rodríguez, 04/03/2020: XC531834, XC531835, XC531836, XC531840; 25/03/2020: XC538378; 03/06/2020: XC564899, XC564901; 20/04/2020: XC549239; 17/6/2020: XC569588). Rio La Tovara, Nayarit (Nathan Pieplow, 31/05/2015: ML516334711). Minatitlan, refinería de Santa Alejandrina, Veracruz (Manuel Grosselet, 24/07/2014: XC244665; 02/05/2016: XC315089=ML28162511). Playa Santa Maria Xadani, Oaxaca (Anuar López, 15/06/2021: ML348187181). Balancán, Centro-Popalillo, Tabasco (Uriel Martinez, 11/07/2016: ML31121011=XC326719). Reserva Ecológica El Corchito, Yucatán (Thomas Brooks, 18/07/2019: ML168869921). Puerto de Abrigo Sisal, Yucatán (Alán Palacios, 30/07/2021: ML358859081).
BELIZE. Hill Bank Field Station, Orange Walk (Rebecca Windsor, 15/04/2011: ML166502, ML166503, ML166505; 16/04/2011: ML166506, ML166508; 17/04/2011: ML166509; 18/04/2011: ML166512, ML166513; Deysha Rivera,

16/04/2011: ML166507; 18/04/2011: ML166511; Gianni E. Espadas, 17/04/2011: ML166510; T. Salzman, 19/04/2011: ML166516, ML166517, ML166518). Black Rock Lodge, Cayo (Blaine Carnes, 31/03/2019: ML149420881). Crooked Tree Wildlife Sanctuary, Bird's Eye View Lodge (Michael O'Brien, 20/03/2022: ML428570051). Crooked Tree Junction (Francis Canto, 18/04/2022: ML437254591; 21/04/2022: ML439644711). Lamani Outpost Lodge (Mary Beth Stowe, 37/3/2011: XC77699).

EL SALVADOR. Usulután (Guillermo Funes, 24/09/2016: XC336346=ML36110321). Bocana, Río San Juan (John van Dort, 06/02/2011: XC71381; Guillermo Funes, 10/01/2021: ML296548211).

COSTA RICA. Medio Queso Wetland, Alajuela (David W. Foster, 12/11/2022: ML507260381). Tarcoles mangroves, Puntarenas (Peter Boesman, 23/03/2010: XC274356 = ML300149; XC274357 = ML300148; Brian Henderson, 05/11/2018: ML360248421). Rincon, Osa, Puntarenas (Gabriel Leite, 27/07/2019: XC490152=ML172848521). Tárcoles, Puntarenas (Greg Baker, 06/04/2001: ML203963001; Robert Bochenek, 09/03/2019: ML148353121; Daniel Garrigues, 16/12/2020: ML288846171). Chomes, Puntarenas (Albert Lastukhin, 24/01/2017: XC376336. Puntarenas (Don Witter, 26/03/2022: ML446004271).

PANAMA. Ammo Dump Ponds, Colon Province (Andrew Spencer, 24/03/2009: XC31778). Gamboa town, Colón (Dave Slager, 18/09/2017: ML101599891). Ammo Dump Ponds, Colón (Jay McGowan, 29/12/2019: ML199612081). Gamboa Rainforest Resort, Colón (Nicholas Sly, 19/02/2013: ML541961041).

Buzzes:

MEXICO. ML516334711, XC564901 (both, as above).

BELIZE. ML166513, ML166518 (both, as above).

HONDURAS. Reserva El Jicarito, Choluteca (Roselvy Juárez, 12/08/2018: ML110787551).

EL SALVADOR. ML110745901 (as ML110787551 but John van Dort, 12/08/2018).

PANAMA. ML541961041 (as above).

Vaguely resembles 'chatter' of some other spp.:

BELIZE. ML166504 (as ML166503), ML166505, ML166513 (all, as above).

Tumbes Swallow

Fast rising calls:

ECUADOR. Río Alamor, La Ceiba, Outside Zapotillo, Loja (Gary Rosenberg, 06/04/1992: ML73339=ML313324831).

PERU. Santuario Historico Bosque de Pómac, Lambayeque (Daniel Lane, 06/08/2005: ML308401; Fernando Angulo, 12/04/2007: XC12324; Jonas Nilsson, 01/12/2002: XC276530; 02/12/2002: XC276531).

Buzzes:

PERU. Piura, N of Sullana (Paul Coopmans, 02/1999: XC264784). ML242288471 (as ML308401 but J. Quillen Vidoz, 04/06/2019). ML308410 (as above).

Whistle/chip:

PERU. ML308401 (as above).

White-rumped Swallow

Fast rising calls

BRAZIL. Setor Samambaia, mata seca, nr. UFG-Agronomia, Goiânia, Goiás (Jayrson Araujo de Oliveira, 29/10/2019: XC505154; 17/08/2021: XC668957). Madre de Deus de Minas, Minas Gerais (Luiz Fernando Matos, 22/11/2020: XC656898). Parque Nacional Serra da Canastra, São Roque de Minas, MG (Jeremy Minns, 30/10/2002: XC82409, XC82410). Reserva Ecológica de Guapiaçu, Rio de Janeiro (Jeremy Minns, 02/11/2006: XC82411; Leonardo Pimentel, 30/10/2007: XC15857). Seropédica, Universidade Federal Rural - UFRRJ, Rio de Janeiro (Gustavo Quintanilha, 18/09/2022: ML485532361). São José dos Campos, São Paulo (Rodrigo de la Rosa de Souza, 02/12/2011: XC118109). Rua Senai, Indaiatuba, São Paulo (Rafaela Wolf de Carvalho, 24/09/2023: ML609349661). São Bento, Indaiatuba, São Paulo (Rafaela Wolf de Carvalho, 20/07/2021: ML383680281). Parque da Cidade de Jundiaí, São Paulo (André Zambolli, 05/11/2020: ML277552201). Santa Branca, Estrada Casa Logos, São Paulo (Marcos Moura, 14/09/2019: ML177069571). Unnamed locality, São Paulo (Celso Modesto Jr., 10/09/2023: ML611122221, ML611122222). Campo Mourão, Paraná. (Luiz C. Silva, 06/10/2016: XC337442; 03/12/2022: XC808980, XC808981). Vidal Ramos, Santa Catarina (Douglas Meyer, 03/11/2011: XC173726). Rua José Tambosi, Santa Catarina, (Miguel Angelo Biz, 25/07/2020: ML251514871). Mostardas area, Rio Grande do Sul, (Peter Boesman, 03/08/2005: ML295772 = XC230436, ML295777 = XC230438). Tavares, Chácara Manduca Belém, Rio Grande do Sul (Arthur Gomes, 28/05/2021: ML346065021). Banhado do Maçarico region, Rio Grande, Rio Grande do Sul (Rafael Antunes Dias, 06/10/2011: XC88867). RPPN Pontal da Barra, Pelotas, Rio Grande do Sul (Fernando Jacobs, 25/11/2007: XC17398).

URUGUAY. Bañado del Indio, Rocha (Diego Castelli, 07/09/2022: ML482569071). Puntas de Valentín, Departamento de Salto (Pedro Rinaldi, 05/02/2019: XC615177).

ARGENTINA. Laguna Popayan, San Antonio, Jujuy (Luis Fernandez, 20/10/2018: ML120982551). Dique Campo Alegre, Salta (Natxo Areta, 31/10/2012: ML171517). San Clemente, Santa María, Córdoba (Alasco López, 18/09/2021: ML382608041). Puerto Piracuacito, Santa Fe (Emilio Ariel Jordan, 03/11/2013: ML217742, Natxo Areta, 03/11/2013: ML216273). Bajos Submeridionales (Laguna El Palmar), Vera, Santa Fe (Bernabe Lopez-Lanus, undated: XC46813). PN Pre-Delta, Diamante, Entre Ríos (Emilio Ariel Jordan, 14/10/2020: ML270911361, ML270909071).

Slow rising calls:

PERU. Huacarpay lake and wetlands, Cusco (Israel Aragon, 05/08/2007: XC18774).

BOLIVIA. Wet pasture north of Trinidad, Beni dept. (Daniel Lane, 08/09/2011: XC96701).

BRAZIL. Três Lagoas, Mato Grosso do Sul (Fernando Igor de Godoy, 26/07/2019: XC705468). Viçosa, Minas Gerais (Noé Eiterer, 27/04/2013: XC132307). Parque Vila do Rodeio, São Paulo - SP (Marcos Melo, 13/10/2008: XC33671). Bom Jardim da Serra, Santa Catarina (Adrian Eisen Rupp, 23/11/2009: XC41809; Marcelo Villegas, 20/11/2014: XC288535). Trilha do Talha-Mar, PARNA Lagoa do Peixe, Tavares, Rio Grande do Sul (Rafael Antunes Dias, 08/11/2011: XC146734). Monte Negro, Rio Grande do Sul (Márcio Repenning, 18/11/2022: ML543276991). XC286807 (as XC82411 but Jerome Fischer, 23/10/2015). XC510895 (as XC230436 but Gabriel Leite, 22/11/2019). XC132309 (as XC132307). ML295772 = XC230436, ML295777 = XC230438, ML485532361, ML609349661, XC15857, XC17398, XC82409, XC82410, XC82411, XC88867, XC118109, XC173726, XC668957, XC808980.

URUGUAY. Minas (Alvaro Riccetto, 21/10/2006: XC7883). Hotel Parque Oceanico, Rocha (Bernabe Lopez-Lanus, 19/09/2004: XC52077).

ARGENTINA. Finca La Montaña, Capital, Salta (Oliver Kohler, 06/09/2023: ML608550817). Reserva Tara Inti, Rió Hondo, Santiago del Estero (Viviana Fuentes, 30/07/2023: ML599240931). Campo Avalos-KM 173, Monte Caseros, Corrientes (Bernabe Lopez-Lanus, 18/08/2010: XC61220). Cullen y Schneider, Las Colonias, Santa Fe (Pablo Hernan Capovilla, 12/04/2020: ML223071551). Santa Cruz, Chascomús, Buenos Aires (Santiago Imberti, 19/08/2005: ML491921231). Saladillo, La Rinconada, Buenos Aires (Bernabe Lopez-Lanus, 19/10/2001: XC52076). Vuelta de Obligado, San Pedro, Buenos Aires (Carlos Ferrari, 10/2004: XC53099). Los Relinchos, Patagones, Buenos Aires (Pablo Alejandro Pla, 27/08/2021: ML366764631). ML189550 (as ML171517, but Matthew D. Medler, 31/10/2012). ML217332 (as ML171517, but 28/09/2014). ML171517, ML216273, ML217742, ML120982551, ML251514871, XC46813 (all, as above).

Buzzes:

BRAZIL. Icapuí, Ceará (Ciro Albano, 09/09/2006: XC7313). Reserva do Setor Sítio de Recreio Caraíbas-Goiânia, Goiás (Jayrson Araujo de Oliveira, 26/11/2018: XC444163; 07/10/2020: XC599517). Santa Rita do Novo Destino, Goiás, Chácara Jayrson (Jayrson Araujo de Oliveira, 24/06/2020: XC573065). MONA da Lagoa do Peri, Estrada Sertão do Peri, Santa Catarina (Fernando Farias, 15/01/2021: ML298074601). XC132307, XC17398, XC82410, XC505154, XC808981 (all, as above).

ARGENTINA. Parque Nacional Predelta, Diamante, Entre Ríos (Rosendo Manuel Fraga, 12/11/2005: XC591941). Reserva Ecológica Costanera Sur, Buenos Aires (Michael Hurben, 01/12/2022: ML509071661).

Laguna de San Vicente, San Vicente, Buenos Aires (Numa Nazar, 04/02/2023: ML607300491). ML171517, ML270911361 (both, as above).

Chatter:

PERU. XC18774 (as above).

BOLIVIA. XC96701 (as above).

BRAZIL. Chapada dos Guimarães, Mirante, Mato Grosso (Rich Hoyer, 29/06/2023: ML597418191). Caconde, São Paulo (Luciano Bernardes, 15/10/2015: ML254533151). Major Gercino, Cascata do Alho, Santa Catarina (Ana Guztzazky, 12/12/2020: ML287962181). Rio Claro, Residencial Florença, São Paulo (Carlos Otávio Gussoni, 26/06/2021: ML350379351). Barra do Quaraí, Rio Grande do Sul (Guy Kirwan, 28/07/2023: XC823943). Unnamed locality with coordinates at ML, Rio Grande do Sul (Guilherme Melo, 21/11/2019: ML199713361). PN Lagoa do Peixe, Trilha do Talha-Mar, Rio Grande do Sul (Gabriel Leite, 20/11/2019: ML202234471). Duque De Caxias, Rio Grande do Sul (Luis Weymar Junior, 21/10/2020: ML524031171). PE do Espinilho, Rio Grande do Sul (Guy Kirwan, 28/07/2023: ML601699681). XC132309 (as XC132307). XC573069 (as XC573065). XC674326 (as XC573065, but 08/09/2021). XC674587 (as XC573065, but 11/09/2021). XC510849 (as XC146734, but Gabriel Leite, 21/11/2019). XC705466, XC705467 (both, as XC705468). ML295771 = XC230437 (as ML295772 = XC230436). ML295772 = XC230436, ML295777 = XC230438, XC15857, XC17398, XC33671, XC41809, XC61220, XC82409, XC82410, XC82411, XC88867, XC118109, XC132307, XC146734, XC173726, XC286807, XC288535, XC444163, XC505154, XC510895, XC599517, XC668957, XC705468, XC808980, ML177069571, ML298074601, ML346065021, ML485532361, ML543276991, ML609349661(all, as above).

URUGUAY. Minas, Lavalleja (Àlvaro Riccetto, 21/10/2006: ML135092891). Minas (Alvaro Riccetto, 21/10/2006: XC7883). XC52077, XC615177, ML482569071 (all, as above).

ARGENTINA. Dique la Angostura, Tafí del Valle, Tucumán (Viviana Fuentes, 23/10/2022: ML496752411, ML496740631). Victoria, Entre Ríos (Franco Vushurovich, 29/09/2019: XC584180; 03/12/2019: XC579691).

Arroyo Correa, La Plata, Buenos Aires (Ignacio Siemersi, 01/08/2009: ML203695511). Reserva Natural y Cultural Municipal Isla De Puán, Puán, Buenos Aires (Dana Melisa Piedrabuena, 01/10/2023: ML609476771). Reserva Natural Municipal Claromecó, Tres Arroyos, Buenos Aires (Pablo Alejandro Pla, 06/10/2019: ML180941191). Larsen y Nazca, Ciudad Autónoma de Buenos Aires (Andrés de Miguel, 17/10/2020: ML272615101). Buenos Aires, Comuna 1, Buenos Aires (Michael Hurben, 01/12/2022: XC854320). ML217743 (as ML217742). ML269805381 (as ML509071661, but Diego Caiafa, 10/07/2005). ML521958221 (as ML509071661, but Gonzalo Diaz, 07/01/2023). ML366767161 (as ML366764631). ML610097611 (as ML270911361, but 19/08/2023). XC46813, XC52076, XC53099, ML171517, ML189550, ML216273, ML217332, ML217742, ML120982551, ML270909071, ML270911361, ML366764631, ML382608041, ML491921231, ML509071661, ML607300491, ML608550817 (all, as above).

Chilean Swallow

Fast rising calls:

BRAZIL. Tapejara, Lagoa de Tamarana, Paraná (Luiz Silva, 30/06/2021: ML351362861, ML351362831). Rio do Oeste, Santa Catarina (Miguel Angelo Biz, 25/07/2020: XC582627).

ARGENTINA. PN Pre-Delta, Diamante, Entre Ríos (Emilio Ariel Jordan, 13/05/2023: ML573071841). Los Relinchos, Patagones, Buenos Aires (Pablo Alejandro Pla, 23/08/2020: ML318690541). Virgen de las Misiones, Paso Córdova, Río Negro (Natxo Areta, 02/05/2011: ML220393).

CHILE. Loma Linda, El Quisco, Valparaíso (Natacha González, 15/02/2018: ML91295101). Humedal Urbano, Cartagena, Valparaíso (Manuel Pinochet Rojas, 14/12/2023: ML612224709; 18/12/2023: ML612383872). Paula Jaraquemada, Yerbas Buenas, Maule (Pablo Martinez Morales, 24/09/2021: ML372222401). Termas de Chillan, VIII Región, Pinto, Ñuble (Peter Boesman, 01/12/2018: ML303627 = XC450171). Niebla, Valdivia, Los Ríos (Joe Angseesing, 09/02/2008: ML203883801). Humedal Miraflores, Valdivia, Los Ríos (Nicolas Vilches, 19/12/2023: ML612627656). PN Puyehue-Aguas Calientes, Los Lagos/Los Ríos (Peter Boesman, 02/12/2018: ML303660=XC450172). Piedra Azul Alto, Puerto Montt, Llanquihue, Los Lagos (Dante Buzzetti, XC534314; 28/02/2020: XC540440). Los Muermos, Los Lagos (Eduardo Quintanilla, 19/09/2023: ML609088199). Leñadura, Punta

Arenas, Magallanes (Santiago Imberti, 23/12/2020: ML291382411).

Slow rising calls:

BRAZIL. Bertioga, São Paulo (Fernando Igor de Godoy, 29/06/2021: XC713830). Cianorte--Fazenda Nerial, Paraná (Giovan Alex, 20/08/2020: ML256737911). Rio Grande, Banhado da Marambaia, Rio Grande do Sul (Luis Weymar Junior, 09/08/2021: ML367283451). XC21150 (as XC22559 but 21/06/2008). XC582627 (as above).

URUGUAY. Cantera, San José (Pablo G. Fernández, 08/06/2023: ML583233411).

ARGENTINA. Jardín Botánico Municipal Ing. Lorenzo Parodi, La Capital, Santa Fe (Pablo Hernan Capovilla, 07/06/2022: ML457851701, ML457850191). Arroyo Saladillo-Saladillo, Buenos Aires (Bernabe Lopez-Lanus, 15/02/2006: XC52068). Villa Pehuenia, Alumine, Neuquén (Bernabe Lopez-Lanus, 19/01/2005: XC52065). Los Lagos, Neuquén (Bobby Wilcox, 14/01/2019: XC465068). Camping de Lahuen, Huiliches, Neuquén (Pablo Alejandro Pla, 01/03/2021: ML322278541). Paso Córdova, Bardas Blancas, Río Negro (Natxo Areta, 07/05/2011: ML220420). PN Lago Puelo, Chubut (Felix Vidoz, 01/1999: XC53523; 10/1992: XC53524, XC53525; 12/1999: XC53526). Laguna Nimez, Calafate, Santa Cruz, (Gabriel Leite, 12/01/2020: XC521719, XC521720). El Calafate, Lago Argentino, Santa Cruz (Meena Haribal, 03/01/2005: XC620408). Reserva Natural Municipal Laguna Nimez, Lago Argentino, Santa Cruz (Gabriel Leite, 13/01/2020: ML202231551). Ushuaia, Tierra del Fuego (Michael Hurben, 04/12/2022: ML510048341=XC854864). Ushuaia--Muelle Club Náutico, Ushuaia, Tierra del Fuego (Ted Floyd, 09/11/2022: ML510073301). ML265106181 (as ML318690541, but 23/09/2020). XC46815 (as XC46816). ML220393, ML318690541, ML573071841 (all, as above).

CHILE. Humedal de Mantagua, Valparaíso (Cristian Pinto Fernandez, 09/04/2022: XC714529; Heraldo V. Norambuena, 21/05/2023: XC806735). Estero Mantagua, Quintero, Valparaíso (Ignacio Escobar Gutiérrez, 07/02/2022: ML419288251; José Ignacio Catalán Ruiz, 27/08/2022: ML478755671; Valentina Espinoza, 20/05/2023: ML595778461; Heraldo V. Norambuena Ramírez, 21/05/2023: ML576511641; Anonymous, 21/05/2023: ML576414431). SN Humedal Río Maipo, Santo Domingo, Valparaíso (Matías Garrido, 18/01/2017: ML45912631; Ignacio Escobar Gutiérrez, 05/02/2021: ML304599901, ML304708701, ML304599861). Estero Puangue (Cerro Viejo), Quilpué, Valparaíso (Nelson Contardo, 10/10/2013: ML167751321). Parque Quinta Vergara, Viña del Mar, Valparaíso (Milena Maira, 08/08/2019: ML171658011). Estación Miramar, Viña del Mar, Valparaíso (Patricio Camacho, 16/07/2023: ML594623151). SN Quebrada de Córdova, El Quisco, Valparaíso (Ignacio Escobar Gutiérrez, 14/02/2021: ML307777361).

Laguna Batuco, Región Metropolitana (Daniel González Amat, 26/04/2007: XC13056, XC13057, XC13058; Cristian Pinto, 07/05/2017: XC368936; Ignacio Escobar Gutiérrez, 23/12/2021: ML398564991, ML398565001). Mahuida, La Reina, Santiago (Daniel González Amat, 13/11/2012: XC112861). Tranque La Cadellada, Batuco / Lampa, Región Metropolitana (Nelson Contardo, 19/01/2020: ML200739701, ML200739691, Cristian Pinto Fernandez, 12/06/2023: XC817123). Parcela Santa Julia, Maipú, Región Metropolitana de Santiago (Matías Garrido, 21/10/2017: ML73637441). Casa Franco Maipú, Región Metropolitana de Santiago (Franco Villalobos, 05/04/2018: ML93379371). Laguna de Aculeo, Paine, Región Metropolitana de Santiago (Pablo Gutiérrez Maier, 21/09/2018: ML115856141). Condominio Mirador El Carmen, Huechuraba, Región Metropolitana de Santiago (José Ignacio Catalán Ruiz, 08/08/2020: ML273520491). Cesfam Apoquindo, Las Condes, Región Metropolitana de Santiago (Ximena Arangua Castedo, 04/01/2021: ML294952501). Mirador Casa Exploradores, Región Metropolitana de Santiago (Marisol Paz Oporto Fuentes, 31/05/2021: ML345025411; 02/09/2021: ML368921191). Puente Estero Puangue, Curacaví, Región Metropolitana de Santiago (Ignacio Escobar Gutiérrez, 12/07/2022: ML470502231, ML470502241). Parque Padre Hurtado--Laguna, La Reina, Región Metropolitana de Santiago (José Ignacio Catalán Ruiz, 27/09/2022: ML488198791). RN Río de Los Cipreses, Machalí, Libertador General Bernardo O'Higgins (Nelson Contardo, 03/12/2017: ML77497211). I-72, Santa Cruz, VI Región, Santa Cruz, Libertador General Bernardo O'Higgins (Matías Garrido, 22/11/2017: ML77625281). Lagunillas, Paredones, Libertador General Bernardo O'Higgins (José Ignacio Catalán Ruiz, 21/06/2022: ML481295241, ML472623751; 02/01/2023: ML603597891). 1704 Pasaje El Sauce, Machalí, O'Higgins, Machalí, Libertador General Bernardo O'Higgins (Danae Garrido Hollstein, 14/09/2023: ML609293954). Viña Richards, Curepto, Maule (James Mitchell, 18/02/2023: ML537301831). Laguna Torca, Curicó, Maule (Fernando Medrano, 19/08/2013: XC148978). Pasaje Manuel Rengifo, Curicó, Maule (Antonieta Gonzalez Soto, 11/04/2021: ML369861441; 11/05/2020: ML233693241). MN Contulmo, Purén, Araucanía (Heraldo V. Norambuena Ramírez, 10/11/2013: ML609232241). Borderio Parque Villarrica, Villarrica, Araucanía (Nicolas Vilches, 03/12/2023: ML611923797). Valdivia, Los Ríos, Los Ríos (Nicolas Vilches, 21/12/2023: ML612645079). Puerto Varas (near Petrohue), Llanquihue, Los Lagos (Blair Jollands, 23/11/2017: XC538862). Misael Escuti, Puerto Montt, Los Lagos (Nicole Arcaya, 20/08/2019: ML173309371). Estero Ovejería, Osorno, Los Lagos (Carlos Silva, 22/09/2021: ML373138801). Camping Playa Blanca, Palena, Los Lagos (Freddy Sepúlveda, 08/01/2022: ML404854631; Tamara Catalán Bermudez, 08/01/2022: ML407818921). Quellón--El Mirador, Quellón, Los Lagos (Camilo Rojas-Valdivia, 07/09/2022: ML483083711). Achao, Quinchao, Los Lagos (José Ignacio Catalán Ruiz, 06/02/2023: ML532446791). Chaiten, Los Lagos, (Tamara Catalán Bermudez, 27/08/2023: ML607902291). Quillaipe, Puerto Montt, Los Lagos (Danae Garrido Hollstein, 08/09/2023: ML609293922). Humedal Pudeto--norte, Ancud, Los Lagos (Danae Garrido Hollstein, 21/12/2023: ML613042779). Villa Punta Delgada, San Gregorio, Magallanes (Sebastián Saiter Villagrán, 15/11/2022: ML585140401, ML585145971, ML585137991). Cueva del Mylodon, XII Region, Magellanes (Alvaro Jaramillo, 15/11/1999: XC60138). ML303677=XC450173 (as ML303660=XC450172, but 03/12/2018). XC534314 (as XC540440, but 25/02/2020). ML111995831 (as ML138080881 but Pablo Gutiérrez Maier, 15/08/2018). ML609088199 (as ML609774458, but 19/09/2023). ML609774458 (as ML609088199, but 25/09/2023). ML303627 = XC450171, ML303660 = XC450172, ML291382411, ML203883801, ML372222401, ML612627656, XC540440 (all, as above).

Buzzes:
BRAZIL. Reserva Biológica do Mato Grande, Arroio Grande, Rio Grande do Sul (Fernando Jacobs, 23/08/2008: XC22559). ML351362861 (as above).
ARGENTINA. Lago Alumine (El Puente), Villa Pehuenia, Neuquen (Bernabe Lopez-Lanus, 20/01/2005: XC46816). ML220393, ML573071841, XC53523 (all, as above).
CHILE. Villa Maestranza, San Bernardo, Región Metropolitana de Santiago (Natacha González, 30/01/2019: ML138080731, ML138080881). Estero Nilahue--Desembocadura, Pichilemu, Libertador General Bernardo O'Higgins (Natacha González, 24/09/2021: ML372895291). Caicaén, Calbuco, Los Lagos (Fernando Pizarro, 17/10/2020: ML274970861). Los Muermos, Los Lagos (Eduardo Quintanilla, 25/09/2023: ML609774458).
ML612383872, ML612627656, ML77497211, XC112861 (all, as above).

Chatter:
BRAZIL. ML351362861, XC22559 (both, as above).
ARGENTINA. Paso Icalma, Alumine, Neuquen (Bernabe Lopez-Lanus, 21/01/2005: XC52066). PN Lanin-Lago Tromen, Neuquen (Bernabe Lopez-Lanus, 02/08/2004: XC52070). ML175210761 (as ML318690541, but 31/08/2019). ML573071651 (as ML573071841). XC52069 (as XC52065, but 23/01/2005). XC46815 (as XC46816). ML220393, ML220420, ML265106181, ML318690541, ML457850191, ML510048341, ML510073301, ML573071841, XC52065, XC53523, XC53524, XC53525, XC465068, XC538862, XC854864 (all, as above).
CHILE. Quintero, Valparaíso (Matías Garrido, 26/01/2021: ML303169921). Las Condes, Región Reserva Cartagena, Cartagena, V Region (Bernabe Lopez-Lanus, 23/09/2006: XC52067). Metropolitana de Santiago (José Ignacio Catalán Ruiz, 06/09/2020: ML260763101). General Baquedano, Nueva Branau, Puerto Varas, Los Lagos (Nicole Arcaya, 26/08/2023: ML607170171, ML607170161). Puerto Natales, XII Region, Magellanes (Andrew Spencer, 16/11/2012: XC116040). ML290152751 ML290152781 (both, as ML291382411 but 21/12/2020). ML585142711 (as ML585145971). ML612800711, ML612800713 (both, as ML291382411 but 29/12/2023). ML606418851 (as ML609088199, but 23/08/2023). ML303627 = XC450171, ML303660 = XC450172, ML303677 = XC450173, ML73637441, ML77625281, ML91295101, ML93379371, ML111995831, ML115856141, ML167751321, ML171658011, ML173309371, ML200739701, ML200739691, ML233693241, ML273520491, ML291382411, ML294952501, ML345025411, ML368921191, ML369861441, ML372222401, ML373138801, ML404854631, ML407818921, ML419288251, ML470502231, ML470502241, ML483083711, ML481295241, ML537301831, ML576511641, ML585137991, ML585140401, ML585145971, ML594623151, ML603597891, ML607902291, ML609088199, ML609232241, ML609774458, ML611923797, ML612224709, ML612627656, ML612645079, ML613042779, XC60138, XC112861, XC148978, XC540440, XC806735 (all, as above).
PARAGUAY. Paraguay Lolita, dpto. Presidente Hayes (Paul Smith, 05/10/2007: XC15703, XC15704).

Appendix 2: vocal data

1. Rising calls

In this and the following sections of this Appendix, for each population, data are presented as follows: mean ± standard deviation (lowest recorded value–highest recorded value) (*n* = no. of vocalizations analysed).

Taxon	No. of notes (notes)	Length (s)	Speed (notes/s)	Max. frequency at start (kHz)	Max. frequency at end (kHz)	Min. frequency at start (kHz)	Min. frequency at end (kHz)	Bandwidth at start (kHz)
Magdalena Swallow	10.33 ± 1.41 (8.0–12.0) (*n*=9)	0.17 ± 0.02 (0.14–0.20) (*n*=9)	61.31 ± 2.47 (58.82–65.36) (*n*=9)	4367 ± 399 (3967–5149) (*n*=9)	5767 ± 592 (5038–6726) (*n*=9)	3305 ± 292 (2829–3660) (*n*=9)	3645 ± 338 (3040–4123) (*n*=9)	1061 ± 345 (579–1489) (*n*=9)
White-winged Swallow	12.34 ± 2.46 (7.0–18.0) (*n*=137)	0.17 ± 0.03 (0.08–0.23) (*n*=147)	75.67 ± 6.64 (64.29–90.09) (*n*=137)	3321 ± 566 (1959–5184) (*n*=147)	5368 ± 590 (3722–6956) (*n*=147)	2489 ± 470 (1328–3959) (*n*=147)	3195 ± 454 (2204–4367) (*n*=146)	831 ± 307 (102–1808) (*n*=147)
Mangrove Swallow	4.98 ± 1.21 (3.0–11.0) (*n*=96)	0.10 ± 0.02 (0.06–0.21) (*n*=96)	48.89 ± 9.05 (26.09–78.27) (*n*=96)	3843 ± 924 (2026–5657) (*n*=96)	5324 ± 757 (3073–7633) (*n*=96)	2376 ± 532 (1373–3826) (*n*=96)	3493 ± 584 (2180–4931) (*n*=96)	1466 ± 662 (351–3187) (*n*=96)
Tumbes Swallow	10.88 ± 1.50 (8.0–13.0) (*n*=17)	0.12 ± 0.02 (0.09–0.15) (*n*=22)	92.70 ± 10.83 (75.76–113.21) (*n*=17)	3911 ± 605 (2836–4997) (*n*=22)	5537 ± 601 (4551–6640) (*n*=22)	2668 ± 544 (1385–3469) (*n*=22)	3717 ± 685 (2585–4859) (*n*=22)	1243 ± 432 (461–2026) (*n*=22)
White-rumped Swallow	10.81 ± 1.78 (6.0–15.0) (*n*=72)	0.15 ± 0.02 (0.10–0.19) (*n*=76)	73.57 ± 8.01 (57.97–94.74) (*n*=72)	4121 ± 578 (2928–5459) (*n*=76)	4390 ± 393 (3551–5356) (*n*=76)	2504 ± 486 (1688–4156) (*n*=75)	3071 ± 353 (2151–3743) (*n*=75)	1619 ± 442 (604–2858) (*n*=75)
Chilean Swallow	10.31 ± 1.62 (7.0–13.0) (*n*=35)	0.14 ± 0.02 (0.09–0.19) (*n*=35)	75.97 ± 7.24 (62.50–97.01) (*n*=35)	5077 ± 694 (3784–6265) (*n*=35)	5098 ± 601 (4138–6367) (*n*=35)	3225 ± 568 (2273–4632) (*n*=35)	3477 ± 529 (2138–4202) (*n*=35)	1853 ± 511 (992–2768) (*n*=35)

Taxon	Bandwidth at end (kHz)	Max. freq. at peak (kHz)	Position of peak (% of length)	Max. freq. at trough (kHz)	Position of trough (% of length)	Change in max. frequency start to end (kHz)	Change of frequency start to trough (kHz)	Change of frequency trough to peak (kHz)	Change of frequency peak to end (kHz)
Magdalena Swallow	2122 ± 656 (1427–3459 (*n*=9)	5950 ± 614 (5169–6726) (*n*=9)	0.87 ± 0.05 (0.81–0.94) (*n*=9)	4294 ± 305 (3967–4738) (*n*=9)	0.06 ± 0.09 (0.00–0.22) (*n*=9)	1400 ± 345 (886–1791) (*n*=9)	73 ± 137 (0–411) (*n*=9)	1656 ± 375 (971–2076) (*n*=9)	183 ± 187 (0–476) (*n*=9)
White-winged Swallow	2169 ± 623 (745–3568) (*n*=146)	5484 ± 603 (3908–6956) (*n*=146)	0.88 ± 0.09 (0.55–1.00) (*n*=147)	3267 ± 542 (1959–4959) (*n*=147)	0.02 ± 0.06 (0.00–0.52) (*n*=147)	2048 ± 597 (224–3464) (*n*=147)	24 ± 123 (0–1306) (*n*=147)	2194 ± 580 (1102–3486) (*n*=146)	120 ± 205 (0–965) (*n*=146)
Mangrove Swallow	1831 ± 672 (534–3861) (*n*=96)	5655 ± 711 (4065–7633) (*n*=95)	0.56 ± 0.22 (0.00–0.96) (*n*=95)	3841 ± 929 (2026–5657) (*n*=95)	0.02 ± 0.08 (0.00–0.64) (*n*=95)	1481 ± 981 (-1186–5352) (*n*=96)	12 ± 66 (0–597) (*n*=95)	1814 ± 907 (0–5352) (*n*=95)	342 ± 451 (0–2004) (*n*=95)
Tumbes Swallow	1819 ± 663 (1148–3639) (*n*=22)	5788 ± 536 (4612–6640) (*n*=22)	0.83 ± 0.10 (0.66–1.00) (*n*=22)	3706 ± 623 (2746–4997) (*n*=22)	0.08 ± 0.12 (0.00–0.46) (*n*=22)	1625 ± 696 (517–3164) (*n*=22)	205 ± 321 (0–895) (*n*=22)	2082 ± 624 (855–3247) (*n*=22)	251 ± 292 (0–945) (*n*=22)
White-rumped Swallow	1320 ± 501 (408–2482) (*n*=75)	5329 ± 390 (4546–6061) (*n*=75)	0.65 ± 0.15 (0.16–1.00) (*n*=74)	3940 ± 443 (2928–4993) (*n*=75)	0.08 ± 0.10 (0.00–0.36) (*n*=75)	268 ± 650 (-1758–1551) (*n*=76)	189 ± 309 (0–1241) (*n*=75)	1389 ± 442 (406–2339) (*n*=75)	940 ± 468 (0–2234) (*n*=75)
Chilean Swallow	1622 ± 684 (409–2898) (*n*=35)	6653 ± 675 (5162–7871) (*n*=35)	0.57 ± 0.16 (0.21–0.84) (*n*=35)	5024 ± 660 (3784–6234) (*n*=35)	0.02 ± 0.04 (0.00–0.15) (*n*=35)	21 ± 733 (-1418–2020) (*n*=35)	53 ± 121 (0–507) (*n*=35)	1619 ± 621 (413–2812) (*n*=35)	1555 ± 527 (551–2807) (*n*=35)

2. Buzzes

Taxon	No. of notes (notes)	Length (s)	Speed (notes/s)	Max. frequency at start (kHz)	Max. frequency at end (kHz)	Change in max. frequency (kHz)
Magdalena Swallow	9.69 ± 2.41 (5–16) (*n*=29)	0.12 ± 0.03 (0.05–0.19) (*n*=29)	82.86 ± 8.70 (65.57–98.90) (*n*=29)	5618 ± 644 (4562–7194) (*n*=25)	5506 ± 569 (4343–6617) (*n*=28)	-105 ± 613 (-2252–1024) (*n*=25)
White-winged Swallow	10.42 ± 2.77 (6–20) (*n*=52)	0.14 ± 0.04 (0.07–0.27) (*n*=58)	77.84 ± 8.67 (61.95–97.56) (*n*=52)	4580 ± 680 (2633–5570) (*n*=58)	5291 ± 669 (3820–8073) (*n*=58)	711 ± 596 (-811–2890) (*n*=58)
Mangrove Swallow	8.29 ± 2.39 (3–12) (*n*=17)	0.11 ± 0.04 (0.03–0.15) (*n*=17)	79.83 ± 12.16 (61.64–98.77) (*n*=17)	5313 ± 546 (4355–6143) (*n*=17)	5200 ± 523 (3839–6184) (*n*=17)	-114 ± 540 (-959–845) (*n*=17)
Tumbes Swallow	7.36 ± 1.86 (5.0–10.0) (*n*=11)	0.10 ± 0.03 (0.06–0.14) (*n*=11)	77.69 ± 9.61 (60.98–90.91) (*n*=11)	4282 ± 920 (2926–5718) (*n*=11)	4735 ± 990 (3399–6224) (*n*=11)	453 ± 1012 (-1035–2116) (*n*=11)
White-rumped Swallow	9.10 ± 2.78 (5.0–17.0) (*n*=41)	0.12 ± 0.03 (0.06–0.21) (*n*=46)	79.70 ± 8.24 (61.86–91.67) (*n*=41)	4958 ± 679 (4041–6796) (*n*=46)	4773 ± 620 (3660–5997) (*n*=46)	-185 ± 697 (-2813–1075) (*n*=46)
Chilean Swallow	10.65 ± 2.80 (6.0–16.0) (*n*=31)	0.14 ± 0.03 (0.10–0.20) (*n*=33)	76.86 ± 14.58 (45.45–95.65) (*n*=31)	5033 ± 743 (3515–6184) (*n*=31)	5406 ± 668 (4006–6494) (*n*=31)	373 ± 720 (-1068–1840) (*n*=31)

Taxon	Min. frequency at start (kHz)	Min. frequency at end (kHz)	Bandwidth at start (kHz)	Bandwidth at end (kHz)
Magdalena Swallow	3829 ± 573 (3102–5294) (*n*=29)	3712 ± 404 (2983-4416) (*n*=28)	1733 ± 552 (878–3513) (*n*=25)	1829 ± 554 (786–2874) (*n*=27)
White-winged Swallow	2963 ± 687 (1761–4860) (*n*=58)	3286 ± 642 (1876–4650) (*n*=58)	1616 ± 660 (585–3392) (*n*=58)	2053 ± 747 (1034–5340) (*n*=58)
Mangrove Swallow	3247 ± 492 (2260–4243) (*n*=17)	3382 ± 817 (1942–4878) (*n*=17)	2067 ± 729 (721–3597) (*n*=17)	1818 ± 820 (598–3501) (*n* =17)
Tumbes Swallow	2438 ± 447 (1666–3332) (*n*=11)	2719 ± 660 (1755–3984) (*n*=11)	1844 ± 687 (788–3128) (*n*=11)	2016 ± 851 (1058–3367) (*n*=11)
White-rumped Swallow	3122 ± 687 (1813–4842) (*n*=45)	3106 ± 539 (1964–4562) (*n*=45)	1816 ± 675 (694–3429) (*n*=45)	1678 ± 509 (734–2622) (*n*=45)
Chilean Swallow	3239 ± 704 (2193–4849) (*n*=31)	3427 ± 586 (2138–5041) (*n*=31)	1794 ± 555 (455–2449) (*n*=31)	1979 ± 485 (1171–3000) (*n*=31)

3. Slow rising calls

Taxon	No. of notes (notes)	Length (s)	Speed (notes/s)	Max. frequency at start (kHz)	Max. frequency at end (kHz)	Min. frequency at start (kHz)	Min. frequency at end (kHz)	Bandwidth at start (kHz)
White-rumped Swallow	7.59 ± 1.90 (4.0–12.0) (*n*=71)	0.16 ± 0.04 (0.07–0.24) (*n*=71)	47.38 ± 8.21 (31.75–75.95) (*n*=71)	3950 ± 610 (2088–5716) (*n*=71)	4943 ± 672 (3660–6153) (*n*=71)	2157 ± 507 (1096–3347) (*n*=71)	2950 ± 494 (1758–4176) (*n*=70)	1793 ± 646 (486–3214) (*n*=71)
Chilean Swallow	7.42 ± 1.55 (5.0–12.0) (*n*=79)	0.16 ± 0.04 (0.09–0.29) (*n*=79)	49.11 ± 10.85 (35.86–81.08) (*n*=79)	3861 ± 741 (2316–5657) (*n*=79)	5645 ± 585 (4628–7571) (*n*=79)	2491 ± 499 (1572–3805) (*n*=78)	3482 ± 587 (1918–5204) (*n*=78)	1366 ± 550 (414–2978) (*n*=78)

Taxon	Bandwidth at end (kHz)	Max. freq. at peak (kHz)	Position of peak (% of length)	Max. freq. at trough (kHz)	Position of trough (% of length)	Change in max. frequency start to end (kHz)	Change of frequency start to trough (kHz)	Change of frequency trough to peak (kHz)	Change of frequency peak to end (kHz)
White-rumped Swallow	1997 ± 691 (855–3712) (*n*=70)	5187 ± 623 (3932–6175) (*n*=71)	0.71 ± 0.19 (0.17–0.93) (*n*=71)	3850 ± 538 2088–5108) (*n*=71)	0.04 ± 0.09 (0.00–0.50) (*n*=71)	993 ± 701 (-803–2309) (*n*=71)	99 ± 221 (0–1068) (*n*=71)	1336 ± 578 (310–2901) (*n*=71)	243 ± 407 (0–1710) (*n*=71)
Chilean Swallow	2156 ± 698 (918–3906) (*n*=78)	5783 ± 616 (4670–7571) (*n*=79)	0.79 ± 0.14 (0.38–0.98) (*n*=79)	3832 ± 736 (2316–5571) (*n*=79)	0.02 ± 0.06 (0.00–0.26) (*n*=79)	1832 ± 748 (455–5657) (*n*=79)	29 ± 116 (0–682) (*n*=79)	1952 ± 533 (806–3347) (*n*=79)	138 ± 287 (0–1540) (*n*=79)

4. Chatter

Taxon	No. of notes (notes)	Length (s)	Speed (notes/s)	Max. frequency at start (kHz)	Max. frequency at end (kHz)	Change in max. frequency (kHz)	Min. frequency at start (kHz)	Min. frequency at end (kHz)
White-rumped Swallow	8.90 ± 3.52 (3.0–23.0) (*n*=91)	0.22 ± 0.07 (0.09–0.48) (*n*=91)	41.52 ± 8.38 (19.46–64.36) (*n*=91)	5004 ± 866 (2709–7041) (*n*=91)	5036 ± 1123 (1964–6735) (*n*=91)	32 ± 1022 (-2674–3574) (*n*=91)	2802 ± 799 (1654–4551) (*n*=91)	4172 ± 636 (1371–4331) (*n*=91)
Chilean Swallow	7.89 ± 2.51 (4.0–14.0) (*n*=87)	0.18 ± 0.07 (0.08–0.34) (*n*=87)	44.94 ± 9.36 (27.93–70.87) (*n*=87)	5081 ± 989 (3059–7750) (*n*=87)	5429 ± 691 (3492–6843) (*n*=87)	348 ± 1191 (-4021–2396) (*n*=87)	3067 ± 679 (1653–4398) (*n*=87)	3181 ± 783 (848–5426) (*n*=87)

Taxon	Change in max. frequency (kHz)	Min. frequency at start (kHz)	Min. frequency at end (kHz)	Bandwidth at start (kHz)	Bandwidth at end (kHz)
White-rumped Swallow	32 ± 1022 (-2674–3574) (*n*=91)	2802 ± 799 (1654–4551) (*n*=91)	4172 ± 636 (1371–4331) (*n*=91)	2202 ± 920 (489–4544) (*n*=91)	2597 ± 1172 (370–5645) (*n*=91)
Chilean Swallow	348 ± 1191 (-4021–2396) (*n*=87)	3067 ± 679 (1653–4398) (*n*=87)	3181 ± 783 (848–5426) (*n*=87)	2014 ± 739 (408–3694) (*n*=87)	2247 ± 941 (555–3977) (*n*=87)

5. Rising calls – within White-winged Swallow

Taxon	No. of notes (notes)	Length (s)	Speed (notes/s)	Max. frequency at start (kHz)	Max. frequency at end (kHz)	Min. frequency at start (kHz)	Min. frequency at end (kHz)	Bandwidth at start (kHz)	Bandwidth at end (kHz)
Magdalena Swallow	10.33 ± 1.41 (8.0–12.0) (*n*=9)	0.17 ± 0.02 (0.14–0.20) (*n*=9)	61.31 ± 2.47 (58.82–65.36) (*n*=9)	4367 ± 399 (3967–5149) (*n*=9)	5767 ± 592 (5038–6726) (*n*=9)	3305 ± 292 (2829–3660) (*n*=9)	3645 ± 338 (3040–4123) (*n*=9)	1061 ± 345 (579–1489) (*n*=9)	2122 ± 656 (1427–3459 (*n*=9)
Llanos – Venezuela	13.29 ± 1.96 (9.0–17.0) (*n*=17)	0.17 ± 0.02 (0.11–0.20) (*n*=17)	78.74 ± 6.57 (68.32–90.40) (*n*=17)	3452 ± 682 (2471–5184) (*n*=17)	5312 ± 642 (4429–6292) (*n*=17)	2691 ± 501 (2069–3959) (*n*=17)	3065 ± 506 (2511–4367) (*n*=17)	760 ± 298 (402–1408) (*n*=17)	2247 ± 663 (745–3270) (*n*=17)
Guyana shield	12.00 ± 1.66 (10.0–15.0) (*n*=9)	0.16 ± 0.02 (0.13–0.19) (*n*=9)	74.77 ± 7.05 (64.71–87.72) (*n*=9)	3738 ± 546 (3030–4830) (*n*=9)	5574 ± 470 (5051–6313) (*n*=17)	2942 ± 354 (2280–3492) (*n*=9)	3234 ± 537 (2309–3896) (*n*=9)	796 ± 449 (346–1807) (*n*=9)	2340 ± 565 (1357–3328) (*n*=9)
W & S Amazonia	12.20 ± 2.71 (7.0–18.0) (*n*=82)	0.16 ± 0.03 (0.08–0.23) (*n*=86)	75.64 ± 6.51 (64.29–89.74) (*n*=82)	3204 ± 536 (1959–4884) (*n*=86)	5320 ± 593 (3722–6956) (*n*=86)	2365 ± 435 (1328–3659) (*n*=86)	3148 ± 431 (2204–4182) (*n*=85)	839 ± 302 (102–1654) (*n*=86)	2163 ± 608 (993–3405) (*n*=85)
Atlantic - Cerrado	12.60 ± 2.19 (9.0–16.0) (*n*=40)	0.17 ± 0.03 (0.10–0.23) (*n*=46)	74.99 ± 7.31 (64.81–90.09) (*n*=40)	5440 ± 548 (4184–4358) (*n*=46)	5440 ± 548 (4184–6326) (*n*=46)	2591 ± 445 (1755–3685) (*n*=46)	3347 ± 457 (2309–4265) (*n*=46)	852 ± 299 (350–1808) (*n*=46)	2093 ± 639 (1000–3568) (*n*=17)

Taxon	Bandwidth at end (kHz)	Max. freq. at peak (kHz)	Position of peak (% of length)	Max. freq. at trough (kHz)	Position of trough (% of length)	Change in max. frequency start to end (kHz)	Change of frequency start to trough (kHz)	Change of frequency trough to peak (kHz)	Change of frequency peak to end (kHz)
Magdalena Swallow	2122 ± 656 (1427–3459 (*n*=9)	5950 ± 614 (5169–6726) (*n*=9)	0.87 ± 0.05 (0.81–0.94) (*n*=9)	4294 ± 305 (3967–4738) (*n*=9)	0.06 ± 0.09 (0.00–0.22) (*n*=9)	1400 ± 345 (886–1791) (*n*=9)	73 ± 137 (0–411) (*n*=9)	1656 ± 375 (971–2076) (*n*=9)	183 ± 187 (0–476) (*n*=9)
Llanos – Venezuela	2247 ± 663 (745–3270) (*n*=17)	5473 ± 614 (4429–6292) (*n*=17)	0.88 ± 0.07 (0.74–0.98) (*n*=17)	3345 ± 586 (2471–4959) (*n*=17)	0.06 ± 0.08 (0.00–0.24) (*n*=17)	1861 ± 718 (224–3146) (*n*=17)	107 ± 315 (0–1306) (*n*=17)	2128 ± 556 (1327–3146) (*n*=17)	161 ± 250 (0–747) (*n*=17)
Guyana shield	2340 ± 565 (1357–3328) (*n*=9)	5606 ± 440 (5080–6313) (*n*=9)	0.91 ± 0.05 (0.81–1.00) (*n*=9)	3693 ± 533 (3030–4830) (*n*=9)	0.03 ± 0.07 (0.00–0.21) (*n*=9)	1837 ± 348 (1356–2491) (*n*=9)	45 ± 124 (0–375) (*n*=9)	1913 ± 375 (1385–2491) (*n*=9)	32 ± 87 (0–259) (*n*=9)
W & S Amazonia	2163 ± 608 (993–3405) (*n*=85)	5441 ± 619 (3908–6956) (*n*=86)	0.87 ± 0.09 (0.54–0.99) (*n*=86)	3189 ± 521 (1959–4533) (*n*=86)	0.02 ± 0.06 (0.00–0.52) (*n*=86)	2115 ± 583 (788–3464) (*n*=86)	15 ± 65 (0–351) (*n*=86)	2252 ± 571 (1116–3486) (*n*=86)	122 ± 197 (0–965) (*n*=86)
Atlantic - Cerrado	2093 ± 639 (1000–3568) (*n*=17)	5572 ± 576 (4184–6451) (*n*=45)	0.88 ± 0.10 (0.55–1.00) (*n*=46)	3443 ± 534 (2429–4358) (*n*=46)	0.00 ± 0.00 (0.00–0.00) (*n*=46)	1997 ± 580 (788–3346) (*n*=46)	0 ± 3 (0–20) (*n*=46)	2148 ± 597 (1102–3346) (*n*=45)	143 ± 246 (0–837) (*n*=45)

6. Buzzes– within White-winged Swallow

Taxon	No. of notes (notes)	Length (s)	Speed (notes/s)	Max. frequency at start (kHz)	Max. frequency at end (kHz)	Change in max. frequency (kHz)
Magdalena Swallow	9.69 ± 2.41 (5–16) (*n*=29)	0.12 ± 0.03 (0.05–0.19) (*n*=29)	82.86 ± 8.70 (65.57–98.90) (*n*=29)	5618 ± 644 (4562–7194) (*n*=25)	5506 ± 569 (4343–6617) (*n*=28)	-105 ± 613 (-2252–1024) (*n*=25)
Maracaibo	11.75 ± 1.50 (10–13) (*n*=4)	0.14 ± 0.02 (0.12–0.16) (*n*=4)	87.01 ± 7.64 (78.74–95.59) (*n*=4)	5435 ± 485 (5076–6148) (*n*=4)	5186± 463 (4827–5861) (*n*=4)	-249 ± 31 (-287–-211) (*n*=4)
Llanos – Venezuela	13.00 ± 4.24 (10–16) (*n*=2)	0.16 ± 0.05 (0.13–0.20) (*n*=2)	78.49 ± 3.86 (75.76–81.21) (*n*=2)	4820 ± 327 (4589–5051) (*n*=2)	5353 ± 265 (5166–5541) (*n*=2)	534 ± 62 (490–577) (*n*=2)
Guyana shield	9.00 ± 1.41 (8–10) (*n*=2)	0.13 ± 0.02 (0.11–0.15) (*n*=4)	68.42 ± 2.48 (66.67–70.18) (*n*=2)	4852 ± 819 (3810–5570) (*n*=4)	5150 ± 972 (3896–5570) (*n*=4)	297 ± 158 (86–462) (*n*=4)
W & S Amazonia	9.70 ± 2.77 (6–16) (*n*=27)	0.13 ± 0.04 (0.07–0.21) (*n*=28)	78.63 ± 7.34 (61.95–97.22) (*n*=28)	4690 ± 656 (3019–5527) (*n*=28)	5409 ± 775 (3820–8073) (*n*=28)	720 ± 731 (-811–2890) (*n*=28)
Atlantic - Cerrado	11.24 ± 2.53 (8–20) (*n*=21)	0.14 ± 0.04 (0.08–0.27) (*n*=24)	77.65 ± 10.53 (64.10–97.5) (*n*=21)	4386 ± 690 (2633–5497) (*n*=24)	5171 ± 492 (3857–5945) (*n*=24)	785 ± 458 (116–1687) (*n*=24)

Taxon	Min. frequency at start (kHz)	Min. frequency at end (kHz)	Bandwidth at start (kHz)	Bandwidth at end (kHz)
Magdalena Swallow	3829 ± 573 (3102–5294) (*n*=29)	3712 ± 404 (2983-4416) (*n*=28)	1733 ± 552 (878–3513) (*n*=25)	1829 ± 554 (786–2874) (*n*=27)
Maracaibo	3706 ± 582 (3237–4540) (*n*=4)	3836 ± 643 (3199–4731) (*n*=4)	1729 ± 176 (1552–1916) (*n*=4)	1350 ± 220 (1130–1628) (*n*=4)
Llanos – Venezuela	3117 ± 530 (2742–3492) (*n*=2)	3391 ± 714 (2886-3896) (*n*=2)	1703 ± 857 (1097–2309) (*n*=2)	1963 ± 979 (1270–2655) (*n*=2)
Guyana shield	3167 ± 701 (2222–3889) (*n*=4)	3341 ± 719 (2338-4026) (*n*=4)	1685 ± 526 (1179–2424) (*n*=4)	1808 ± 446 (1468–2453) (*n*=4)
W & S Amazonia	2951 ± 690 (1761–4860) (*n*=28)	3333 ± 608 (2367-4650) (*n*=28)	1738 ± 700 (624–3392) (*n*=28)	2070 ± 821 (1034–5340) (*n*=28)
Atlantic - Cerrado	2931 ± 723 (1847–4233) (*n*=24)	3213 ± 700 (1876-4473) (*n*=24)	1456 ± 626 (585–2800) (*n*=24)	2080 ± 715 (1193–4329) (*n*=24)

Appendix 3: differences in particular vocal variables between species pairs and White-winged Swallow populations

In the tables below, the following codes are used to refer to each vocal variable measured. Scores for variables which were excluded from calculations resulting in the results shown in Appendix 3 due to correlation with other variables, are shown in italics. Scores in bold are those above 4, indicating full diagnosability based on a single vocal variable. *n*=sample size for number of notes (NN).

NN=Number of notes
SL=Song length
SS=Song speed
MFS=Maximum acoustic frequency at start
MFE= Maximum acoustic frequency at end
MFP=Maximum acoustic frequency at peak
MFT=Maximum acoustic frequency at trough
mFS=Minimum acoustic frequency at start
mFE= Minimum acoustic frequency at end
FVSE=Acoustic frequency variation start to end
FVST=Acoustic frequency variation start to trough
FVTP=Acoustic frequency variation trough to peak
FVPE=Acoustic frequency variation peak to end
BS=Bandwidth at start
BE=Bandwidth at end
PP=Position of peak
PT=Position of trough

Between *Tachycineta* species and Magdalena Swallow. 1. Fast rising calls

	White-winged (*n*=137)	Mangrove (*n*=96)	Tumbes (*n*=17)	White-rumped (*n*=72)	Chilean (*n*=35)
Magdalena (*n*=9)	SS (3.06) MFT (2.27) FVTP (1.09) mFS (2.05) *NN (1.00)* *MFS (2.07)* *FVSE (1.32)*	SL (2.78) SS (2.10) MFT (0.71) mFS (2.15) PP (2.33) *NN (3.78)*	SL (2.29) **SS (4.38)** MFT (1.18) mFS (1.41)	SS (2.26) MFE (2.56) mFE (1.55) mFS (1.95) FVPE (2.22) PP (2.20) BS (1.33) *FVSE (2.16)*	SL (1.43) SS (2.87) MFT (1.43) FVPE (3.65) PP (2.80) BS (1.72) *MFS (1.22)* *FVSE (1.70)*
White-winged (*n*=137)		SL (2.39) SS (3.44) MFT (0.76) mFE (0.59) FVTP (0.53) FVPE (0.67) PP (2.11) BS (1.34) BE (0.53) ***NN (4.07)*** *MFS (0.72)* *FVSE (0.73)*	SL (1.92) SS (1.85) mFE (0.91) BS (1.11) *NN (0.75)* *MFS (1.00)*	SL (0.71) MFT (1.33) MFE (2.01) FVTP (1.61) FVPE (2.43) FVST (0.77) PT (0.84) PP (1.93) BS (2.14) BE (1.53) *NN (0.75)* *MFS (1.43)* *FVSE (2.89)*	SL (1.15) MFT (2.88) MFP (1.83) mFS (1.42) FVTP (0.97) FVPE (3.86) PP (2.48) BS (2.50) BE (0.84) *NN (1.01)* *MFS (2.79)* *FVSE (3.05)*
Mangrove (*n*=96)			SL (0.71) **SS (4.38)** PP (1.73) *NN (4.23)*	SL (2.16) SS (2.91) MFP (0.60) MFE (1.63) mFE (0.91) FVTP (0.63) FVST (0.95) FVPE (1.31) PT (0.65) PP (0.50) BE (0.88) *NN (3.91)* *FVSE (1.50)*	SL (1.63) SS (3.31) MFT (1.95) MFP (1.43) mFS (1.54) FVPE (2.47) BS (0.66) *NN (3.74)* *MFS (1.52)* *FVSE (1.70)*
Tumbes (*n*=17)				SL (1.55) SS (1.97) MFP (0.97) MFE (2.26) mFE (1.22) FVTP (1.27) FVPE (1.79) PP (1.46) BS (0.85) BE (0.84) *FVSE (1.98)*	SL (0.98) SS (1.78) MFT (2.00) MFP (1.39) mFS (0.97) FVPE (3.11) PP (2.01) BS (1.26) *MFS (1.75)* *FVSE (2.18)*
White-rumped (*n*=72)					MFT (1.95) MFP (2.47) PT (0.87) FVST (0.63) FVPE (1.23) mFE (0.91) MFE (1.41) mFS (1.36) *MFS (1.49)*

2. Buzzes

	White-winged (*n*=52)	**Mangrove** (*n*=17)	**Tumbes** (*n*=11)	**White-rumped** (*n*=41)	**Chilean** (*n*=31)
Magdalena (*n*=29)	MFS (1.54) mFS (1.36) mFE (0.81) FVSE (1.33)	mFS (1.05)	MFS (1.58) mFS (2.57) mFE (1.72) *NN (1.03)*	MFS (0.98) MFE (1.21) mFS (1.11) mFE (1.27)	MFS (0.82) mFS (0.90)
White-winged (*n*=52)		MFS (1.16) FVSE (1.41) *NN (0.80)*	SL (1.20) mFS (0.89) *NN (1.26)*	SL (0.54) MFS (0.55) MFE (0.80) FVSE (1.38) BE (0.59)	MFS (0.63)
Mangrove (*n*=17)			MFS (1.29) mFS (1.59)	None.	SL (0.92) *NN (0.87)*
Tumbes (*n*=11)				mFS (1.15)	SL (1.49) mFS (1.32) mFE (1.06) NN (1.33)
White-rumped (*n*=41)					SL (0.73) MFE (0.97) FVSE (0.78)

3. Slow rising calls

	Chilean (*n*=79)
White-rumped (*n*=71)	MFP (0.97) mFS (0.67) mFE (0.99) FVTP (1.11) BS (0.72) *FVSE (1.16)* *MFE (1.12)*

4. Chatter

	Chilean (*n*=87)
White-rumped (*n*=91)	SL (0.49) MFE (0.44) mFE (1.41)

Between Magdalena Swallow and White-winged Swallow populations.

5. Rising calls

	Maracaibo (*n*=0)	**Llanos-Venezuela** (*n*=17)	**Guyana shield** (*n*=9)	**W & S Amazonia** (*n*=82)	**Atlantic-Cerrado** (*n*=40)
Magdalena (*n*=9)	/	**SS (4.38)** MFT (1.95) mFS (1.42) *NN (1.60)* *MFS (1.55)*	SS (2.46)	SS (3.14) MFT (2.74) FVTP (1.24) mFS (2.60) *MFS (2.50)* *FVSE (1.54)*	SS (2.67) MFT (1.92) mFS (1.82) *NN (1.17)* *MFS (1.85)* *FVSE (1.22)*
Maracaibo (*n*=0)		/	/	/	/
Llanos-Venezuela (*n*=17)			None	None	None
Guyana shield (*n*=9)				mFS (1.49)	None
W & S Amazonia (*n*=82)					mFS (0.61) MFT (0.59)

6. Buzzes

	Maracaibo (*n*=4)	**Llanos-Venezuela** (*n*=2)	**Guyana shield** (*n*=2)	**W & S Amazonia** (*n*=27)	**Atlantic-Cerrado** (*n*=21)
Magdalena (*n*=29)	None	FVSE (1.24)	SS (1.17)	MFS (1.39) mFS (1.36) FVSE (1.19)	MFS (1.79) mFS (1.35) mFE (0.88) FVSE (1.61)
Maracaibo (*n*=4)		None	FVSE (3.63)	FVSE (2.42) BE (1.21)	FVSE (3.95) BE (1.34)
Llanos-Venezuela (*n*=2)			None	None	None
Guyana shield (*n*=2)				None	FVSE (1.34)
W & S Amazonia (*n*=27)					None

Appendix 4: biometric data

A. Based on specimens studied here

Taxon	Wing-chord (mm)	Tail (mm)	Tarsus (mm)	Total culmen from skull (mm)	Feathered bill (mm)	Bill width (mm)	Bill depth (mm)	Tail fork (mm)	Body mass (g)
Magdalena Swallow									
All	98.8 ± 3.9 (94–113) (*n*=29)	41.9 ± 2.3 (37–47) (*n*=28)	10.0 ± 1.0 (8.2–11.9) (*n*=29)	11.8 ± 1.1 (10.1–13.1) (*n*=18)	8.1 ± 0.6 (7.3–9.5) (*n*=28)	5.2 ± 0.7 (4.5–6.7) (*n*=16)	3.2 ± 0.3 (2.6–3.9) (*n*=27)	6.0 ± 1.3 (4.0-8.5) (*n*=15)	16.3 ± 1.3 (15.0-17.5) (*n*=3)
Males	99.3 ± 5.4 (95–113) (*n*=9)	41.6 ± 1.7 (39–44) (*n*=9)	9.6 ± 0.4 (9.1–10.3) (*n*=9)	12.0 ± 1.5 (10.3–12.8) (*n*=3)	8.0 ± 0.6 (7.3–9.1) (*n*=9)	4.6 ± 0.1 (4.5–4.6) (*n*=2)	3.0 ± 0.2 (2.8–3.3) (*n*=7)	5.4 ± 1.2 (4.1-7.5) (*n*=7)	15.0 (*n*=1)
Females	98.9 ± 3.4 (94–105) (*n*=12)	41.3 ± 2.6 (37–46) (*n*=11)	10.3 ± 1.0 (8.5–11.9) (*n*=12)	11.9 ± 0.9 (10.4–13.0) (*n*=7)	8.2 ± 0.5 (7.4–9.2) (*n*=12)	5.0 ± 0.4 (4.5–5.4) (*n*=6)	3.3 ± 0.3 (2.9–3.9) (*n*=12)	5.9 ± 0.9 (4.4-6.8) (*n*=5)	16.3 (*n*=1)
Maracaibo									
All	97.5 ± 2.1 (96–99) (*n*=2)	39.0 ± 0.7 (39–40) (*n*=2)	10.8 ± 0.4 (8.2–11.9) (*n*=2)	12.2 ± 1.2 (11.3–13.0) (*n*=2)	7.5 ± 1.4 (6.5–8.5) (*n*=2)	4.8 ± 0.6 (4.4–5.2) (*n*=2)	3.0 ± 0.0 (3.0–3.0) (*n*=2)	/	/
White-winged Swallow (all)									
All	101.7 ± 4.5 (91–118) (*n*=89)	43.2 ± 2.4 (38.5–49.0) (*n*=88)	11.1 ± 0.7 (9.2–12.4) (*n*=78)	12.7 ± 0.6 (11.4–14.5) (*n*=89)	8.4 ± 0.6 (7.1–9.6) (*n*=89)	5.3 ± 0.4 (4.0–6.7) (*n*=90)	3.1 ± 0.3 (2.7–4.0) (*n*=86)	7.0 ± 1.5 (4.0-10.0) (*n*=50)	17.7 ± 2.0 (15.6–20.0) (*n*=4)
Males	101.3 ± 2.9 (94–106) (*n*=24)	43.0 ± 2.3 (39.0–48.5) (*n*=23)	11.2 ± 0.7 (10.0–12.2) (*n*=21)	12.9 ± 0.7 (11.7–14.5) (*n*=23)	8.7 ± 0.5 (7.6–9.5) (*n*=23)	5.3 ± 0.4 (4.4–5.8) (*n*=24)	3.2 ± 0.3 (2.8–4.0) (*n*=23)	7.1 ± 1.3 (5.0–9.2) (*n*=8)	16.9 ± 1.5 (15.7–18.5) (*n*=3)
Females	99.7 ± 3.3 (93–105) (*n*=28)	42.7 ± 1.9 (38.5–46.5) (*n*=27)	10.8 ± 0.8 (9.2–12.1) (*n*=22)	12.5 ± 0.5 (11.4–13.7) (*n*=28)	8.3 ± 0.6 (7.1–9.6) (*n*=28)	5.2 ± 0.5 (4.0–6.7) (*n*=28)	3.1 ± 0.3 (2.8–3.7) (*n*=25)	6.3 ± 1.1 (4.8–8.3) (*n*=8)	20.0 (*n*=1)
White-winged Swallow (Llanos - Venezuela)									
All	100.0 ± 4.6 (94–110) (*n*=11)	41.9 ± 1.6 (39.0–44.5) (*n*=11)	11.0 ± 0.8 (10.0–12.2) (*n*=11)	12.5 ± 0.5 (11.8–13.0) (*n*=11)	8.6 ± 0.6 (7.7–9.5) (*n*=11)	5.3 ± 0.7 (4.4–6.7) (*n*=11)	3.3 ± 0.4 (2.7–4.0) (*n*=11)	7.4 (*n*=1)	/
White-winged Swallow (Guyana shield)									
All	101.4 ± 4.3 (91–109) (*n*=22)	42.5 ± 1.7 (40.0–46.0) (*n*=23)	11.2 ± 0.5 (9.8–11.9) (*n*=19)	12.8 ± 0.6 (11.7–13.8) (*n*=23)	8.3 ± 0.5 (7.5–9.6) (*n*=23)	5.3 ± 0.2 (4.9–5.8) (*n*=23)	3.1 ± 0.2 (2.7–3.5) (*n*=23)	6.7 ± 1.5 (4.0–9.3) (*n*=22)	/
White-winged Swallow (West and South Amazonia)									
All	101.1 ± 3.1 (93–110) (*n*=42)	43.1 ± 2.2 (38.5–47.5) (*n*=40)	11.0 ± 0.7 (9.2–12.2) (*n*=35)	12.7 ± 0.6 (11.7–14.5) (*n*=41)	8.4 ± 0.7 (7.1–9.6) (*n*=41)	5.2 ± 0.4 (4.0–6.0) (*n*=42)	3.2 ± 0.2 (2.7–3.7) (*n*=38)	6.6 ± 1.4 (4.0–9.2) (*n*=15)	/
White-winged Swallow (Atlantic-Cerrado)									
All	106.6 ± 6.4 (94–118) (*n*=12)	46.4 ± 2.2 (43.0–49.0) (*n*=12)	11.5 ± 0.7 (10.5–12.4) (*n*=11)	12.9 ± 0.7 (11.5–14.0) (*n*=12)	8.4 ± 0.4 (7.5–9.2) (*n*=12)	5.4 ± 0.5 (4.6–6.0) (*n*=12)	3.1 ± 0.2 (2.8–3.4) (*n*=12)	7.8 ± 1.3 (6.0–10.0) (*n*=12)	/
Mangrove Swallow									
All	94.7 ± 3.1 (88–102) (*n*=34)	40.0 ± 1.6 (37.5–43.5) (*n*=34)	10.7 ± 0.7 (9.5–11.8) (*n*=33)	11.2 ± 0.6 (9.5–12.3) (*n*=33)	7.4 ± 0.5 (6.4–8.6) (*n*=34)	4.9 ± 0.4 (4.1–5.8) (*n*=34)	2.8 ± 0.2 (2.4–3.1) (*n*=31)	5.7 ± 1.2 (3.0–8.2) (*n*=33)	/
Males	97.0 ± 2.9 (92–102) (*n*=12)	41.0 ± 1.4 (38.5–43.5) (*n*=12)	10.6 ± 0.7 (9.5–11.4) (*n*=12)	11.4 ± 0.6 (10.2–12.3) (*n*=12)	7.5 ± 0.6 (6.6–8.6) (*n*=12)	4.9 ± 0.3 (4.2–5.5) (*n*=12)	2.8 ± 0.2 (2.5–3.0) (*n*=11)	6.1 ± 0.9 (4.2–7.5) (*n*=12)	/
Females	93.9 ± 2.9 (88–99) (*n*=12)	39.3 ± 1.4 (37.5–42.5) (*n*=12)	10.6 ± 0.8 (9.5–11.8) (*n*=12)	11.1 ± 0.7 (9.5–11.8) (*n*=12)	7.2 ± 0.6 (6.4–8.2) (*n*=12)	4.9 ± 0.5 (4.2–5.8) (*n*=12)	2.7 ± 0.2 (2.4–3.1) (*n*=10)	5.3 ± 1.3 (3.0–8.2) (*n*=11)	/
Tumbes Swallow									
All	91.5 ± 2.1 (90–93) (*n*=2)	42.0 ± 1.4 (41.0–43.0) (*n*=2)	10.1 ± 0.1 (10.0–10.1) (*n*=2)	8.8 ± 0.8 (8.2–9.3) (*n*=2)	5.3 ± 0.1 (5.2–5.3) (*n*=2)	3.9 ± 0.4 (3.6–4.2) (*n*=2)	2.5 ± 0.1 (2.4–2.5) (*n*=2)	7.5 ± 2.1 (6.0–9.0) (*n*=2)	/
White-rumped Swallow									
All	113.2 ± 5.3 (101–120) (*n*=20)	48.0 ± 1.8 (44.5–51.5) (*n*=20)	12.2 ± 0.9 (10.8–13.8) (*n*=20)	11.5 ± 0.5 (10.5–12.4) (*n*=18)	6.8 ± 0.5 (5.8–7.5) (*n*=18)	5.5 ± 0.4 (4.9–6.5) (*n*=19)	3.0 ± 0.3 (2.4–3.8) (*n*=19)	6.5 ± 1.7 (4.0–10.5) (*n*=20)	/
Males	112.4 ± 6.3 (101–119) (*n*=8)	47.5 ± 1.8 (44.5–49.5) (*n*=8)	12.6 ± 0.8 (11.8–13.8) (*n*=8)	11.4 ± 0.4 (11.0–12.0) (*n*=6)	6.9 ± 0.2 (6.7–7.3) (*n*=7)	5.4 ± 0.5 (4.9–6.1) (*n*=7)	3.0 ± 0.5 (2.4–3.8) (*n*=7)	6.3 ± 1.6 (4.3–9.0) (*n*=8)	/
Females	113.4 ± 5.4 (103–120) (*n*=9)	47.9 ± 1.9 (45.5–51.5) (*n*=9)	11.9 ± 1.0 (10.8–13.7) (*n*=9)	11.6 ± 0.6 (10.5–12.4) (*n*=9)	6.8 ± 0.6 (5.8–7.5) (*n*=9)	5.7 ± 0.4 (5.2–6.5) (*n*=9)	3.0 ± 0.2 (2.6–3.3) (*n*=9)	6.5 ± 2.1 (4.0–10.5) (*n*=9)	/
Chilean Swallow									
All	107.1 ± 3.4 (100–115) (*n*=14)	47.8 ± 2.5 (43.0–52.0) (*n*=14)	11.4 ± 0.9 (10.0–13.0) (*n*=11)	11.1 ± 0.3 (10.5–11.5) (*n*=13)	6.3 ± 0.5 (5.2–7.0) (*n*=14)	4.7 ± 0.6 (5.2–7.0) (*n*=14)	2.8 ± 0.2 (2.4–3.1) (*n*=13)	8.8 ± 2.0 (6.5–13.0) (*n*=14)	/
Males	106.8 ± 6.4 (100–115) (*n*=4)	47.1 ± 1.9 (45.0–49.5) (*n*=4)	11.6 ± 0.2 (11.5–11.8) (*n*=3)	11.2 ± 0.5 (10.5–11.5) (*n*=4)	6.3 ± 0.6 (5.6–6.8) (*n*=4)	4.6 ± 0.2 (4.4–4.9) (*n*=4)	2.8 ± 0.3 (2.5–3.1) (*n*=4)	8.2 ± 1.8 (6.5–10.5) (*n*=4)	/
Females	105 (*n*=1)	51.5 (*n*=1)	/	10.6 (*n*=1)	6.4 (*n*=1)	5.1 (*n*=1)	3.1 (*n*=1)	11.0 (*n*=1)	

B. Biometric data in previous publications

Taxon	Wing (mm)	Tail (mm)	Tarsus (mm)	Bill (mm)	Tail fork (mm)	Body mass (g)
White-winged Swallow						
All (Turner & Rose 1989)	104 (100-108)	46.4 (42-51)	11.3 (10.4-12.3)	11.8 (10.2-13.2)	8.0 (6.0-10.0)	(14-17)
Mangrove Swallow						
All (Turner & Rose 1989)	/	42 (39-47)	11 (9.5-11.5)	11 (9.9-11.8)	4.5 (2.0–9.0) (*n*=71)	15.0 (14.0–16.5) (*n*=18)
All (Sykes *et al.* 2004)	/	37.6 (32-41) (*n*=71)	/	/	5.0 (3.0-7.0)	13.9 (10-16)
Males (Robbins *et al.* 1997)	97.4 ± 1.8 (*n*=23)	40.5 ± 1.4 (*n*=23)	/	11.1 ± 0.5 (*n*=23)	/	/
Males (Turner & Rose 1989)	97.5 (92-105)	/	/	/	/	/
Males (Sykes *et al.* 2004)	97.3 (90-105) (*n*=58)	/	/	/	/	/
Females (Robbins *et al.* 1997)	93.6 ± 1.7 (*n*=22)	39.8 ± 1.5 (*n*=22)	/	10.8 ± 0.6 (*n*=22)	/	/
Females (Turner & Rose 1989)	94.7 (92-99)	/	/	/	/	/
Females (Sykes *et al.* 2004)	95.1 (90-100) (*n*=36)	/	/	/	/	/
Tumbes Swallow						
Males (Robbins *et al.* 1997)	93.8 ± 1.7 (*n*=5)	48.5 ± 2.5 (*n*=5)	/	8.8 ± 0.2 (*n*=5)	/	/
Females (Robbins *et al.* 1997)	88.5 ± 0.6 (88.1-89.0) (*n*=2)	44.9 ± 0.8 (44.4-45.5) (*n*=2)	/	8.6 ± 0.1 (8.6-8.7) (*n*=2)	/	/
White-rumped Swallow						
All (Turner & Rose 1989)	115.7 (111-122)	51.4 (49-57)	12.2 (11.5-13.2)	11.1 (10.2-12.2)	6.6 (5.0-8.0)	19 (17-21)
All (Sykes *et al.* 2004)	/	46.9 (40-55) (*n*=38)	/	/	5.0 (2.0–7.0) (*n*=32)	/
Males (Sykes *et al.* 2004)	115.7 (105-122) (*n*=22)	/	/	/	/	/
Females (Sykes *et al.* 2004)	114.4 (108-123) (*n*=14)	/	/	/	/	/
Chilean Swallow						
All (Turner & Rose 1989)	110.3 (105-117)	52.9 (47-57)	11.1 (10.6-12.5)	10.2 (9.6-11.1)	7.1 (5.0-10.0)	17 (15-20)

Note, in this Appendix, data are presented as follows: mean ± standard deviation (lowest recorded value–highest recorded value) (*n* = no. of specimens or individuals). For data taken from publications (section B), only some of this information is available or can be derived, resulting in lack of sample size or standard deviations for some cells.

Appendix 5: differences in biometric variables between species pairs and within White-winged Swallows

Differentiation in each biometric variable is shown here, based on the data set in Appendix 4A. Overall combined biometric variation, based on these data, is shown in Table 4. Tail length is shown in italics since it correlated with wing length. Scores of 4 indicate diagnosability and are shown in bold. In the tables below, the following codes are used to refer to each biometric variable measured. n= is based upon wing length sample size (see App. 4).

WI=Wing length
TA=Tail length
TR=Tarsus
BL=Bill length (to cranium)
BF= Bill length (feathered)
BN=Bill length (to nares)
BW=Bill width (at nares)
BD=Bill width (at nares)
MS=Mass
TF = Tail fork

A. Between *Tachycineta* species and Magdalena Swallow

1. Biometric differences between species

	White-winged (*n*=89)	**Mangrove** (*n*=34)	**Tumbes** (*n*=2)	**White-rumped** (*n*=20)	**Chilean** (*n*=14)
Magdalena (*n*=29)	WL (0.66) TR (1.28) BL (0.99)	WL (1.14) *TL (0.94)* TR (0.81) BF (1.33) BW (1.18) BD (1.84)	WL (2.15) BL (3.74) **BF (5.49)** BD (2.02)	WL (2.99) *TL (2.79)* TR (2.18) BF (2.36)	WL (2.16) *TL (2.32)* TR (1.39) BF (3.14) BW (1.30) BD (1.46) TF (1.53)
White-winged (*n*=89)		WL (1.80) *TL (1.56)* BL (2.50) BF (1.84) BW (0.86) BD (1.30) TF (0.98)	WL (2.73) TR (1.86) **BL (6.76)** **BF (6.06)** BD (1.56)	WL (2.29) *TL (2.21)* TR (1.32) BL (1.98) BF (2.90) BD (0.70	WL (1.35) *TL (1.82)* BL (3.23) BF (3.64) BW (1.08) BD (1.46) TF (1.00)
Mangrove (*n*=34)			TR (1.15) **BL (4.44)** **BF (4.26)**	**WL (4.20)** ***TL (4.46)*** TR (1.74) BF (1.00) BW (1.52)	WL (3.61) *TL (3.62)* BF (1.94) TF (1.84)
Tumbes (*n*=2)				**WL (4.95)** *TR (2.98)* **BL (5.16)** BF (3.42) BD (1.28)	**WL (4.59)** TR (1.88) **BL (5.26)** BF (1.98) BD (0.95)
White-rumped (*n*=20)					WL (1.31) BF (1.08) BW (1.60) TF (1.17)

B. Between Magdalena Swallow and White-winged Swallow populations

	Maracaibo (*n*=2)	**Llanos-Venezuela** (*n*=11)	**Guyana shield** (*n*=22)	**W & S Amazonia** (*n*=42)	**Atlantic-Cerrado** (*n*=12)
Magdalena (*n*=29)	None	TR (1.00)	TR (1.35) BL (1.09)	TR (1.45) BL (1.03)	WL (1.40) TR (1.69) BL (1.13) TF (1.24) *TL (1.85)*
Maracaibo (*n*=2)		None	None	None	*TL (2.13)*
Llanos-Venezuela (*n*=11)			None	None	*TL (2.11)*
Guyana shield (*n*=22)				None	*TL (1.63)*
W & S Amazonia (*n*=42)					*TL (1.50)*

Appendix 6: list and discussion of other specimens

Colombian collections

1. ICN-UN 20778 collected at Islas del Rosario, Cartagena, dpto. Bolívar by P. Bernal on 3 February 1971, marked 'Excursión Biología', presumably referring a university field trip. Locality is at 10°10'N, 75°46'W (Paynter 1997). The main label states that it is a female, but the inner side states it is a male with T.P. (testes pequeños = small testes). A circular label also states Male, T.P. The inner label states largo (total length) 140 mm, envergadura (wing span) 270 mm, iris moreno (brown iris), cara pico negro (black bill), patas negras (black legs). Illustrated in Fig. 17.
2. IAVH 223 unsexed, collected at Isla Salamanca by G. Toro García and W Perez on 20 August 1969. The specimen bears three labels. The first is of Inderena (former National Parks department), marked no. 0223. Locality: Magdalena, "Los Cocos", a orilla del caño clarín nuevo, Isla de Salamanca. 20/VIII/1969. Parques Nacionales y Vida Selvestre. Identified as Tachycineta albiventer. L.t. (largo total – body length) 135 mm. Env. (envergadura – wing span) 270 mm. Peso (mass) 17.5g. Iris negro (black). Patas negro (legs black). G. Toro G., Col. W. Perez. The second label states Col. W. Perez - Toro García. Los Cocos, Salamanca. Corporación Autonóma de los Valles del Magdalena y del Sinú C.V.M. Departamento de Parques Nacionales. 133 (meaning of this number unclear). Inside states same measurements and bare part coloration; VII-20-69. No. 0223. Third (newest) label. Claustro de San Agustin Villa de Leyva Boyacá Colombia. Instituto Alexander von Humboldt 0223. Tachycineta albiventer. According to Paynter (1997, p. 374), Toro García indeed studied this locality in 1969, which is at 10°59'N, 74°27'W. Mass 17.5 g (per specimen label). Illustrated in Fig. 20(i). The tertials are tipped white on the outer margin.
3. UIS-AV 085, Rio Cáchira, Cesar (N. Moreno & H. Romero &, 12 August 1971). Paynter (1997) refers to the locality as Rio Cáchira del Espitiro Santo (07°52'N, 07°52'W). Sex not known. Iris marrón. L.T. (largo total = total length) 13.5. E. (envergadura – wing span) 27.7. C.E. (contenidos estomacales insectos = stomach contents insects). n.c. Tachycineta albiventer. Illustrated in Fig. 20(ii). A bedraggled specimen, perhaps inexpertly prepared or with insufficient drying compounds, resulting in defeathering of the neck and head. The tertials are quite broadly tipped white on the outer web and tip.
4. UIS-AV-676, Rionegro, Santander (H. Romero & N. Moreno, 2 August 1973). Male. Gonadas TI 10.046 (Gonads: left testis 10.0 x 6.0). D (right) 10.0 x 50 mms, I. 11.8 (probably a remeasure of the left testis). LT (largo total = total length) 14.5. E (envergadura – wing span) 30.5 cms. CE Insectos. Tachycineta albiventer. The label is ripped with one corner partially missing, rendering the stated species name incomplete and another corner selotaped back together. Illustrated in Fig. 20(iii). The tertials are generally dark but it has a wing patch on the secondaries. The locality is not listed in Paynter (1997); it is at approx 07°29'N, 73°24'W, slightly north of Bucaramanga.
5. CSJ 0394 (formerly, 2365). Hacienda El Amparo, Remedios, Antioquia (18 December 1966). Collector stated as '3C'. Both labels incorrectly state 'Tachycineta bicolor', as did the collection's own database (before a recent correction) and Biomap Alliance Participants (2006). Illustrated in Fig. 21(i). This specimen has a moderate white patch on the secondaries and dark tertials. Its method of preparation has exposed the white bases to the neck feathers. The locality is at 07°02'N, 74°41'W (Paynter 1997).

Figure 20. Some of the paratypes of Magdalena Swallow. First row. Left to right: (i) IAVH 223 (photograph by Thomas Donegan); (ii) UIS-AV 085 (photograph by Enrique Arbeláez Cortés); (iii) UIS-AV 753 (photograph by Enrique Arbeláez Cortés); (iv) CM P42750, P42751, P42752, P42753 (photograph by Serina Brady). Second row. Left to right: (v) CM P52487, P52504, P52660 (photograph by Serina Brady); (vi) CM P52661, P52662, P52663, P52664 (photograph by Serina Brady).

6. CSJ 0395, as 0394. Male. 28 December 1966. Only label incorrectly states 'Tachycineta bicolor'; the newer label states only the genus name. Illustrated in Fig. 21(ii). This specimen has a bent neck in preparation. There is a moderate white patch on the secondaries, but the tertials and outermost two secondaries are mostly dark, with only thin white edges.
7. CSJ 0396, as 0395. Illustrated in Fig. 21(iii). There is a white patch on the secondaries which extends to the secondary covers. The tertials and outermost two secondaries are mostly dark, with only thin white edges.

United States of America collections

8. CM P42750 (old no. 12708), Fundación, Santa Marta, Magdalena, Colombia (coll. M.A. Carriker, Jr.). Locality is at 10°31'N, 74°11'W per Paynter (1997). Aug 10 1913. Iris Brown. Feet black. Bill black. Length 137. Immature female. Reverse label states Iridoprocne albiventer in printed ink. Illustrated in Fig. 20(iv). This specimen has somewhat disorderly white markings, broad on some tertials, secondary coverts and secondaries, but not forming a clear patch. It has bluish markings on the mantle but these are emergent on the brown base coloration typical of immature plumages.
9. CM P42751 (old no. 12709), as CM P42750, immature female. Length 135. Illustrated in Fig. 20(iv). This is browner than CM P42750 but has similarly disorderly white wing markings.

Figure 21. More paratypes of Magdalena Swallow. First row. Left to right: (i) FMNH 191000, 191001, 191002 (photograph by Mary Hennen / Field Museum of Natural History); (ii) UF 34877 (photograph by Andrew Kratter); (iii) MVZ:Bird:93917. Second row: (iv) MVZ:Bird:120603 (both, photograph by Libby Beckman, with the permission of the Museum of Vertebrate Zoology, University of California, Berkeley); (v) USNM 398046, 398045, 349874, 256240 (photograph by Paul Salaman); (vi) CUMV 9103 (photograph by Mary Margaret Laura Ferraro); (vii) BMNH 89.6.23.2 (photograph by Thomas Donegan © Natural History Museum).

10. CM P42752 (old no. 12710), as CM P42750, male. Length 128. Illustrated in Fig. 20(iv). The secondaries are essentially unmarked but it has fairly broad white fringes on the tertials only, with white edgings on the secondary coverts.
11. CM P42753 (old no. 12710), as CM P42752, male Length 132. Illustrated in Fig. 20(iv). Similar to CM P42752, this specimen has broad white markings on the tertials and white fringes to the secondary coverts, but the flight feathers themselves do not include a white patch.
12. CM P52487 (old no. 16698), Lorica, Dept. Bolívar [sic], Colombia (coll. M.A. Carriker, Jr.). The locality is at 09°14'N, 75°49'W per Paynter (1997) and now in Córdoba department. 14 Feb 1916. Iris Brown. Bill black. Feet blackish. Length 135. Immature male. Illustrated in Fig. 20(v). This is an immature with bluish green emergent feathering on the dorsal side on a brownish base. There is a broad white wing patch and the tertials are extensively tipped white on the tip and outer web.
13. CM P52504 (old no. 16715), as CM P52487 but Feb 15 1916. Feet black, length 136. Immature male. Illustrated in Fig. 20(v). Plumage generally similar to previous but tertials less extensively marked white.
14. CM P52660 (old no. 16912), as CM P52487 but Feb 23 1916. Length 137. Immature male. Illustrated in Fig. 20(v). Plumage generally similar to CM 52487 but tertials not as extensively marked.
15. CM P52661 (old no. 16913), as CM P52660. Length 123. Immature male. Illustrated in Fig. 20(vi). Plumage generally similar to previous.
16. CM P52662 (old no. 16914), as CM P52660. Length 139. Immature male. Illustrated in Fig. 20(vi). Plumage generally similar to previous.
17. CM P52663 (old no. 16915), as CM P52660. Length 151. Female. Illustrated in Fig. 20(vi). In adult plumage with blue mantle. Wing patch narrower than above specimens, encompassing some of the secondaries and a narrow mark only on the outermost web of the tertials.
18. CM P52664 (old no. 16916), as CM P52660. Length 138. Female. Illustrated in Fig. 20(vi). Wing is generally dark with no obvious patch on the secondaries and only some coverts edged narrowly with white marks.
19. FMNH 191000 (old no. 13726). Nechí, Antioquia, Colombia, 300 ft. The locality is at 08°08'N, 74°46'W per Paynter (1997). 6 August 1947. Collect. Kjell von Sneidern. Iridoprocne albiventer Iris dark brown. Bill black. Female. Illustrated in Fig. 21(i). The tertials and secondaries have relatively broad white tips and outer margins.
20. FMNH 191001 (old no. 13727), as FMNH 191000. Male. This specimen has the most extensive white feathering in the series, across all secondaries and broadly on the base and outer web of each tertial, being indistinguishable from Eastern birds in this feature. Illustrated in Fig. 21(i).
21. FMNH 191002 (old no. 13728), as FMNH 191000. 3 August 1947. Male. Also with relatively extensive white markings on the secondaries and tertials although not as extreme as in FMNH 191001. Illustrated in Fig. 21(i).
22. UF 34877, *ab* Atlantic coast of Santa Marta, Magdalena, Colombia. alt. 0 m. Iris café. 12 September 1967. (Coll. C. J. Marinkelle). Male. Label is originally of the Colección de Historia Natural UniAndes, Depto de Biología, Bogotá, Colombia. Reverse (photograph provided does not show full label) states 'Bradkorb 30.6' (serial number may be incomplete for same reason) and Tachycinera albiventer Boddaert (presumably, also incomplete on photograph). Illustrated in Fig. 21(ii). On the right wing, there is a white patch on the secondaries but the tertials are dark. The left wing unusually has white broadly across the base and left-hand side of its innermost tertial. The other tertials on both wings are dark. This pattern was not seen in any other specimen (nor on the bird's other wing) so appears to be an asymmetrical feature.
23. MVZ:Bird:93917. Villavieja, 435 m, Dept. Huila, Colombia. According to Paynter (1997) the locality is at 03°13'N, 75°14'W, making this the southernmost specimen. Adult male 5098. Adam H. Miller. Testis 11 mm Wt. 15 gm. January 24, 1945. Reverse side states *Iridoprocne albiventer*, with *Iridoprogne* struck out in pencil and *Tachycineta* written above that. Illustrated in Fig. 21(iii). It has almost no white visible in the wing, which has only narrow tips on a handful of secondaries and some of the wing coverts.
24. MVZ:Bird:120603, 5 km N of Villavieja, 1400 ft, Huila, Colombia. Female sk. ad. Adam H. Miller, February 14, 1949). Wt. 16.3 g. Ovum 1 mm. Reverse side states *Iridoprocne albiventer*, with *Iridoprogne* struck out in pencil and *Tachycineta* written above that. Illustrated in Fig. 21(iv). The white in the wing is concentrated in the secondaries, which a few narrowly tipped wing coverts.
25. MVZ:Bird:120753. Skeletal specimen. Two 'skeleton only' labels state essentially the same locality data, collector and date as for MVZ:Bird:120603. Original no. 7224. A third circular (field?) label states: 'o? 7224 AHM'. Illustrated in Fig. 23.

Figure 22. More paratypes of Magdalena Swallow. First row: (i) CSJ 394; (ii) CSJ 395; (iii) CSJ 396 (all three photographs by Andrea Bustamente Cadavid). Second row: (iv) AMNH 40237 (photograph by Thomas Donegan); (v) AMNH 133917, 133915, 133912, 13918, 133916 (photograph by Thomas Donegan).

26. USNM 398045 (original no. 9978) Norosí, Dept. Bolívar. M.A. Carriker, Jr. Mar, 3, 1947. The locality is at 08°32'N, 74°02'W (Paynter 1997). Label states Iridoprocne albiventer. Female (OE). Illustrated in Fig. 21(v). The secondaries form a white wing patch but the tertials are largely dark.
27. USNM 398046 (original no. 9711). Rio Viejo, D. Bolívar. M.A. Carriker, Jr. Feb 16. 1947. The locality is at 08°35'N, 73°51'W (Paynter 1997). Label states Iridoprocne albiventer. Female. Illustrated in Fig. 21(v). Similar plumage to previous.
28. USNM 349874 Cienaga de Guajaro, Atlántico (G. A. Dugand). The locality is at 10°34'N, 75°02'W (Paynter 1997). Label states Iridoprocne albiventer. Field label states H.126. Illustrated in Fig. 21(v). This specimen is inexpertly prepared, with elongated neck and body, unnatural extension of the wings and dirty underparts. It has white marks on the secondaries and also rather broad white markings on the tertials for the new subspecies, including on the distal margins.
29. USNM 256240 (formerly AMNH 133914) La Playa, near Barranquilla, Colombia. The locality is at 11°02'N, 74°52'W (Paynter 1997). The Smithsonian label is essentially blank except for the serial number. The old AMNH label states its former serial number, locality and sex. Miller & Boyle. Mar 25 1915. Small field label states 'La Playa 150 ft. Mar 25 1915. Female.' Illustrated in Fig. 21(v). It has a small white patch on the secondaries and the tertials are edged white on the distal margins.
30. CUMV 9103, Colombia: Magdalena R., Gamarra. May, 31, 1911. Louis Agassiz Fuertes. Male. Iridoprocne albiventer. Illustrated in Fig. 21(vi). An immature with emergent greenish blue on the mantle but otherwise brownish base coloration. It has white on the secondaries but only faintly tipped tertials.
31. AMNH 40237. Bogotá. Illustrated in Fig. 22(iv). This specimen has dark tertials and a white wing patch on the secondaries only.
32. AMNH 133912, La Playa, near Barranquilla, Col. (L.E. Miller & H. Boyle, 25 March 1915). A second small label states 'La Playa, 150 ft.' and the date. Female. Illustrated in Fig. 22(v). This specimen is unique in the series from northern Colombia in having green-blue dorsal plumage, indistinguishable from eastern specimens. It has fairly strongly marked tertials and a secondary wing patch.
33. AMNH 133915, as AMNH 133912. Illustrated in Fig. 22(v). An adult female with dark blue dorsal and almost entirely dark wings (with only a vestige of a speculum visible).
34. AMNH 133916, as AMNH 133912. Illustrated in Fig. 22(v).An immature bird with brownish overall plumage. The tertials and primaries are marked white on the outer margin.
35. AMNH 133917, as AMNH 133912. Illustrated in Fig. 22(v). The tertials and primaries are marked very faintly white on the outer margins, with a tiny secondary patch. This specimen uniquely has pale lores, suggesting intermediation with Mangrove Swallow.
36. AMNH 133918, as AMNH 133912. Illustrated in Fig. 22(v). Plumage as AMNH 133916.

European Collections

37. BMNH 89.6.23.2 Magdalena Valley. C.W. Wyatt. Labelled albiventris. A brownish juvenile. The innermost two tertials are relatively extensively marked white in the tip and outer web with the outermost tertial also tipped and a white secondary patch on the wing. Illustrated in Fig. 21(vii).

    BMNH 84.5.15.65. 'South America'. Museum Cat. 247a. Authority: Deyrolle. Hirundo albiventris (with the species name written on top of other text which had been covered by Tippex).

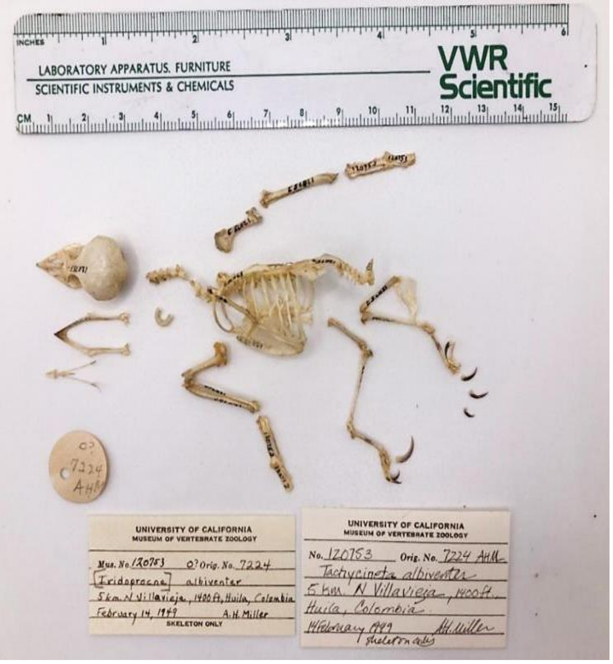

Figure 23. Skeleton paratype of Magdalena Swallow. MVZ:Bird:120753 (photograph by Libby Beckman, with the permission of the Museum of Vertebrate Zoology, University of California, Berkeley).

Figure 24. COP series from North of Táchira depression. Left to right: (i) COP 48916, (ii) COP 48915, (iii) COP 11895, (iv) COP 6873, (v) COP 6872. Note the bird on the right is close to *magdalenae*; those on the left have broader markings on the tertials and a greener shade dorsally

Figure 25. Example of: (i) an eastern White-winged Swallow (left) ICN-UN 3860, Meta, Macarena; and (ii) juvenile from Catatumbo (ICN-UN 15313).

38. Illustrated in Figs. 12(iii) & 16(i). This bird is an adult. The underparts are dark grey, possibly a result of dirt on collection or foxing in long-term storage. There is a wing patch on the secondaries, which is particularly visible on the left wing, with white edgings on the secondary coverts. The white edgings on tertial feathers are abraded, making them appear generally dark.

Other specimens which should be inspected.
The following specimens are likely of the new species but were not inspected or could not be located during limited time for visits:

1. USNM 374298, 374299, 374297, Puerto Sagoc, La Gloria, Cesar (M.A. Carrier, 20 May 1943). The locality is at 08°38'N, 73°49'W (Paynter 1997).
2. USNM B41134 (egg), 403042, La Raya, río Cauca, Achí, Bolívar (24 January 1948, M.A. Carriker). The locality is at 08°20"N, 74°34'W (Paynter 1997).

Specimens not of the new subspecies
The following 'Colombia', 'Bogota' or 'New Grenada' trade specimens were inspected or photographs were obtained and reviewed of them. Based on plumages, the following inspected specimens are likely to be eastern birds and so are not designated as paratypes: AMNH 500732, AMNH 500734, USNM 111032, BMNH 85.3.24.105, NML-VZ T2115 (1865), NML-VZ T14981, MHNN 92.10275, SMF 50432. Some other 'Bogotá' specimens were not inspected (e.g. CUMV 9104, Frank Wright collection).

Specimens from Táchira, Catatumbo and Maracaibo basin
These specimens are considered to have been collected in a zone of intermediates between new subspecies *magdalenae* and nominate populations.

1. ICN-UN 15313, Norte de Santander, Qatatumbo, Rio de Oro (Campamento Colpet, frontero Col.-Ven.). (P. Bernal & E. Barriga, 17 May 1965). Original field no. PB1725. Inner label states sex female; edad: joven (age: young); envergadura (wing span) 275; Iris pardo obscuro casi negro (dark brown almost black); Cara: pico negro (face: black bill). Patas negras (black legs). Fig. 25(ii).
2. COP 6872. Machiques, Perijá, 60 m (6 January 1940). Male. Has mostly dark tertials, with a small white wing patch and one or two white marks on the outermost wing coverts. Illustrated in Fig. 24(v).
3. COP 6873. La Sierra, Rio Negro, Perijá, 120 m ('A.F.Y.', 9 February 1940). Male. A brown juvenile, with moderately white-tipped tertials and patch on the secondaries. Illustrated in Fig. 24(iv).
4. COP 11895. Santo Domingo, Táchira, 300 m ('F.E.', 12 March 1947). Unsexed. Plumage as previous. Illustrated in Fig. 24(iii).
5. COP 48915. Laguna Tule, Zulia, 0 m (R. Urbano, 8 September 1949). Male. Dorsal is tinged greenish. Has broadish white tips to tertials and extensive white wing patch. Illustrated in Fig. 24(ii).
6. COP 48916. Laguna Tule, Zulia, 0 m (R. Urbano, 8 September 1949). Female. Dorsal is tinged greenish. Has broadish white tips to tertials and extensive white wing patch. Illustrated in Fig. 24(i).
7. AMNH 150572 Tucacas, Falcón, Venezuela (Geo K. Cherrie, 19 Oct 1918). Male. The specimen lacks extensive white wing markings, but has a greenish-blue dorsal typical of eastern populations. Not illustrated.

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Geographical variation in Tachycineta Swallows (Aves: Passeriformes: Hirundinidae), with description of a new subspecies from Colombia.

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