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CLUB ANNOUNCEMENTS

The 999th meeting of the Club was held via the online medium of Zoom on Monday 29 March 2021

Ron Summers spoke about *Abernethy Forest: its history and ecology*. Abernethy Forest is a nature reserve managed by the Royal Society for the Protection of Birds. The forest has more Caledonian pinewood than any other area in Scotland. The trees in these remaining fragments are lineal descendants of an ancient forest that once spread across the Highlands of Scotland. Since the Bronze or Iron Age, the forest has been used by people for hunting, exploitation of timber, farming and now nature conservation. The talk described the changes caused by people and the natural processes that have shaped the forest, providing an environment for an astonishing diversity of wildlife (3,800 species of plants, fungi and animals). The lives and status of the 'big three' birds of pinewoods were described: Western Capercaillie *Tetrao urogallus*, Crested Tit *Lophophanes cristatus* and crossbills (*Loxia* spp.). Comparisons were drawn with natural forests in continental Europe, revealing the conservation measures that need to be taken to restore lost features in an attempt to create a present-natural forest.

The 1,000th meeting of the Club was held via the online medium of Zoom on Monday 24 May 2021

Comparative ecophysiologist Steve Portugal, Reader in Animal Behaviour and Physiology at Royal Holloway University of London, described *Bird flight and co-operative aerodynamics*. The talk discussed how birds co-operate and the mechanisms they employ to save energy during flight. The distinctive V formation of bird flocks has long intrigued researchers and continues to attract both scientific and popular attention. Through the use of novel bio-logging technology, and by working with the reintroduction scheme for the Critically Endangered Northern Bald Ibis *Geronticus eremita*, studies have been performed on the relative positioning of individuals in a V formation, and the co-operative aerodynamic interactions that occur, at a level and complexity not previously feasible. The second part of the talk considered the seemingly more unstructured flocks formed by homing pigeons *Columba livia* var., and how individual personalities predict exploration and subsequent homing abilities, and flock positioning during homing flights.

FORTHCOMING MEETINGS

Given the uncertainty surrounding the timescale of the current Covid-19 pandemic, details of forthcoming meetings in 2021 will be announced online via the Club's website: https://boc-online.org/meetings/upcoming-meeting, or follow the Club's Twitter (@online_BOC) and Facebook accounts (https://www.facebook.com/onlineBOC). Be sure to keep an eye on them!

OBITUARIES

Storrs Lovejoy Olson (3 April 1944–20 January 2021)

Avian palaeontology lost one of its most influential and unprecedented contributors with the passing of Storrs Olson in January 2021. His career spanned more than five decades, and his legacy comprises in excess of 450 peer-reviewed papers covering a wide range of subject matter, including anatomy, evolution, island dynamics, early natural history collectors, taxonomic nomenclature, and specific bird specimens. His early life was equally colourful, and my summary here follows Ellen Paul's at Ornithology Exchange (https://ornithologyexchange.org/forums/topic/44891-storrs-olson-1944-2021/). I also discuss the man himself, not only as my mentor and great friend for over 30 years, but also as an inspirational giant of palaeontology who initiated and nurtured my and many other scientists' careers.

Storrs Lovejoy Olson was born to Beatrice Lovejoy Olson and Franklyn C. W. Olson on 3 April 1944, in Chicago, Illinois. His father was a physical oceanographer, so from an early age Storrs encountered various biologists, including fish and bird experts. In 1950, his father took a position at Florida State University where Storrs met prominent Florida ornithologist Henry Stevenson, who influenced his interest in birds. He later

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became a teenage assistant to Horace Loftin, at a time when the latter was studying shorebirds on the Gulf Coast. Storrs moved with Horace and his family to the Panama Canal Zone, where he continued to collect and study tropical fish and birds.

After graduating from Florida State University, he undertook a M.Sc. under Pierce Brodkorb, a renowned palaeontologist. Storrs' Panama bird records also led to his friendship with Smithsonian ornithologist, Alexander Wetmore, who at the time was writing a monograph on the *Birds of the Republic of Panamá* (1965–84). Via this connection, Storrs obtained temporary work at the Smithsonian, followed by a Smithsonian-supported Ph.D. placement at Johns Hopkins University, which he completed in 1972. His dissertation on fossil rails (Rallidae) of the South Atlantic islands gained considerable favour with Smithsonian Secretary S. Dillon Ripley, and he was asked to contribute to the latter's monograph *Rails of the world* (1977).

Storrs Olson and Johanna Humphrey (Julian P. Hume)

As a result, in 1975 Dillon Ripley invited Storrs to become Curator of Birds at the National Museum of Natural History, Washington DC. During his time at the Smithsonian, Storrs participated in dozens of field expeditions to collect fossils and modern birds (more than 6,000 specimens), including trips to the islands of Hawaii, the Caribbean, the Bahamas, Bermuda, Japan, and the South Atlantic, and continental locales in North, South and Central America, South Africa, Australia, and Europe. Along with his first wife, Helen James, Storrs made the sensational discovery of fossil birds on the Hawaiian Islands, which substantially increased the number of known species. His fossil bird work covered the Eocene until the historical period. He even wrote a paper on bryophyte taxonomy, a subject that was of great personal interest and which resulted in his building the largest, privately owned library on the subject anywhere. He eventually donated the entire collection to the now aptly named Storrs L. Olson Bryological Library at the Univ. of Connecticut.

Storrs rejoiced in the use of language, especially with Greek and Latin application, best exemplified in his and Helen James' Description of thirty-two new species of birds from the Hawaiian Islands (1991, *Orn. Monogr*. 45), in which all remaining letters of the alphabet not previously used for Hawaiian bird genera were included to create a new generic or specific epithet. The most notable examples are the more challenging letters of x, y and z, with *Xestospiza conica*, *Telespiza ypsilon and Aidemedea zanclops* filling the gaps. Storrs was never afraid to express his opinion and some of his colourful descriptions of fellow scientists left nothing to the imagination. He was totally opposed to the bird-dinosaur theory, despite the fact that it is now generally accepted, and savaged anyone's work he felt was inadequate, self-promoting or inherently wrong. His knowledge of avian skeletal anatomy was incredible, and he could identify almost any bird from just a quick glance at a leg or wing bone. On one occasion, he even did this with the bones behind his back! He always maintained that just looking at a bird skin was the equivalent of buying candy from a store and keeping the wrapper after throwing the sweet away. In this context, he never forgave a certain renowned ornithologist who, in 1929, discovered the unique specimen of the probably extinct Makira Moorhen *Pareudiastes silvestris* on San Cristobal in the Solomon Islands. After the bird was skinned its body was discarded. Unless another specimen is discovered, which is now highly unlikely, certain aspects of its morphology such as its degree of volancy will never be known.

I too was not exempt from criticism. My first book *Lost land of the dodo* (2008), co-authored with Anthony Cheke, contained 90 pages of endnotes to accompany the main text. This required much toing and froing through the book to utilise effectively, so in his review of it in Biohistory of the Mascarenes, *Science* (2008, 321: 913–914), Storrs, in exasperation, described cutting the endnotes out in order to make them easier to consult. I thought this was purely a symbolic gesture, but on his bookshelf was a copy of the book with the endnotes section cut out, just as he had said. That was Storrs at his inimitable best!

He received many accolades during his career, most notably the Loye and Alden Miller Research Award from the Cooper Ornithological Society in 1994, and he gave the Smithsonian Secretary's Distinguished Research Lecture in 2007. Unsurprisingly, towards the end of his life and with continuing bouts of ill health, the publications slowed somewhat, but he retained a great interest in palaeornithology and was always encouraging to a younger generation of students. During these latter years, he received incredible support from his second wife, Johanna Humphrey, who constantly encouraged him to forge ahead in often quite

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difficult circumstances. The final blow was diagnosis of oesophageal cancer in late 2020, which robbed Storrs of enjoying two of the things that he liked best, eating and drinking. He lost a courageous fight against the disease the following January. Storrs Olson is survived by Johanna, his sister Susan Olson-Wallace, children Travis and Sydney Olson, and his granddaughter Linnea Louise Olson.

For my part, our paths first crossed in 1988 when I was trying to establish myself as an artist specialising in illustrating extinct birds. Not knowing anyone in the USA, I addressed a letter (in those pre-internet days) to a 'Storrs Olson, curator of birds, Smithsonian Institution' with a personal introduction, which included some photos of my artwork, in the hope that I might get a break. Unbeknownst to me, Storrs and Helen James were on Hawaii having just discovered a multitude of new fossil birds, and Storrs was looking for an additional outlet to publicise the discovery. If ever good fortune was on my side, my letter arrived right at that moment. Within a week or two, I received an enthusiastic response from Storrs that would ultimately launch my art and scientific career. Via Storrs and Helen, in 1990 I received funding to visit nearly all of the Hawaiian Islands to paint various scenes of interest in preparation for artistic reconstructions of the extinct birds. Before I returned home, Storrs invited me to stay at his then home in Arlington, Virginia, and to work on fossil material held at the Smithsonian. This was our first meeting and our friendship was instantaneous.

Over the following decades, we spent time together on field trips, as well as researching specimens at the Smithsonian and elsewhere. Inspired by these experiences, I initiated my own scientific career, culminating in a Ph.D. on Mascarene bird palaeontology. It was also during this time that I became aware of his extraordinary ability as an author. When compiling a scientific paper, Storrs never made notes or drafts, but constructed it entirely in his head and wrote it down in completed form. Just as joyous to experience, and to indulge in, were his legendary cooking skills. Ingredients included just about anything that flew, swam or crawled, and he delighted in the fact that many of his culinary efforts could be reused and reinvented to provide exquisite meals for days ahead. Nothing was ever wasted. Closely linked to these abilities was our shared indulgence of 'neck oil', as we liked to call it, and on more occasions than I can remember (or often cannot!), we sampled into the early hours, discussing extinct birds, scientific papers, future plans and just about any other subject. I regularly stayed with Storrs, initially in Arlington with Helen, and later in Fredericksburg with Johanna, and joined the Olsons at their residence on Cape Breton Island, Nova Scotia, which for Storrs provided the perfect retirement and recuperation getaway.

Covid kept us apart for the last year, but we still had many post-pandemic plans, including a road trip from Fredericksburg to Nova Scotia, and another around the UK. His daughter told me that just a few days before he passed he spoke of our friendship and was really looking forward to meeting again. Alas, it was not to be! For me, Storrs' passing has a left a gaping hole in my life, but I rejoice in the memories of our time together and that I learnt so much from the experience. So for now my dear friend I bid you farewell; keep the neck oil on hold, and I'll join you at some point for a tipple.

Julian P. Hume

David Calder (21 December 1925–25 January 2021)

BOC Committee was sad to learn of the death of David Calder aged 95. David was a long-term member of the BOC, and served as its Chair during 1980–83.

David was born in Durban, South Africa, in December 1925 and attended Hilton School from 1939 to 1942, where he was awarded the Highbury Closed Scholarship. In 1944, prior to completing undergraduate law studies (Natal Univ., Pietermaritzburg), he enlisted in the South African Artillery, serving in North Africa, the Levant and Italy. His undergraduate studies were completed in 1946, gaining a merit for Politics, and in 1947 David was awarded a Rhodes scholarship to attend Merton College Oxford, where he read jurisprudence.

He returned to Durban and joined the family law firm, becoming an attorney in 1953. It was at this time that he met and married an Englishwoman, Joey Wright, and they subsequently had six children. His time as a soldier and at university had a profound impact on his political and social views, so in 1964 the family migrated to England where David enrolled as a student at the College of Law in Guildford. The same year he gained entry as an associate in the Chartered Institute of Secretaries, and he won the W. G. Hislop prize for the top student.

In 1966, David joined a firm of solicitors in London, became a partner in 1969, and retired in 1985. During the 1970s, David's appearance as the quintessential Englishman was confirmed when a group of American tourists stopped to photograph him outside the Law Courts. Unusually tall, he cut an impressive figure in a pinstripe suit and bowler hat, an umbrella over his arm and a copy of *The Daily Telegraph* under it. His legal upbringing evoked a lively intellect and a memorable store of anecdotes. Living in Surrey, he was able to indulge his interest in ornithology and assembled a significant library, learnt the art of traditional book-binding and used his skills to preserve his many books and ornithological journals, as well as a copious collection of his own notebooks.

His notes from the 1990s list any species seen and or heard, however common, on numerous trips to South Africa, as well as to Egypt and different parts of Central America. His attention to detail enhances many of his records, describing the number seen, behaviour or plumage. David also had a passion for opera, specifically Wagner, and his children bemoaned the fact that he played his hi-fi at a greater volume than they did.

Following the death of his first wife, David married the South African, Jean Barbara Lambert, and together they enjoyed an active social and travelling life. The aim of much of David's travel was to observe the natural world and he was seldom without his binoculars. He made frequent visits to numerous destinations during his retirement until age and frailty prevented this. In later years, David made a number of charitable bequests to educational institutions to support future generations of students and academic scholarship.

David is survived by six children, 15 grandchildren and five great-grandchildren. Very sadly, his wife Jean died on the same day as David, following a brief spell of ill health.

Philippa Luker and Tony Statham

ASSOCIATE EDITORS

We are pleased to welcome two new Associate Editors to the Bulletin's editorial team. Bruce Beehler (see *Bull. Brit. Orn. Cl.* 135: 281) has been a member of the Editorial Board since 2015, and he will continue to manage papers pertaining to the New Guinea region. In contrast, Chris Sharpe is a completely new member of the team. He has worked on the conservation of Neotropical birds for more than 30 years, particularly in Venezuela, where he is a Research Associate of the Phelps Ornithological Collection (COP) and the NGO Provita, a founder member of the Venezuelan Ornithologists' Union, and editor of birds for the *IUCN Red Data book of Venezuelan fauna*. A former editor of *HBW Alive* and author—with Guy Kirwan—of *Birds of the West Indies* (Lynx Edicions, 2019), he is now an Associate Editor of the Cornell Lab of Ornithology's *Birds of the world*. Chris is a consultant on Latin American conservation, focusing primarily on biodiversity data management and monitoring, conservation planning and assessment, and (increasingly) shorebird conservation.

Friends of the BOC

The BOC has from 2017 become an online organisation without a paying membership, but instead one that aspires to a supportive network of Friends who share its vision of ornithology—see: http://boc-online.org/. Anyone wishing to become a Friend of the BOC and support its development should pay UK£25.00 by standing order or online payment to the BOC bank account:

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Friends receive regular updates about Club events and are also eligible for discounts on the Club's Occasional Publications. It would assist our Treasurer, Richard Malin (e-mail: rmalin21@gmail.com), if you would kindly inform him if you intend becoming a Friend of the BOC.

The *Bulletin* and other BOC publications

Since volume 137 (2017), the *Bulletin* of the BOC has been an online journal, published quarterly, that is available to all readers without charge. Furthermore, it does not levy any publication charges (including for colour plates) on authors of papers and has a median publication time from receipt to publication of five to six months. Prospective authors are invited to contact the *Bulletin* editor, Guy Kirwan (GMKirwan@aol.com), to discuss future submissions or look at http://boc-online.org/bulletin/bulletin-contributions. Back numbers up to volume 136 (2016) are available via the Biodiversity Heritage Library website: www.biodiversitylibrary.org/bibliography/46639#/summary; vols. 132–136 are also available on the BOC website: http://boc-online.org/

BOC Occasional Publications are available from the BOC Office or online at info@boc-online.org. Future BOC-published checklists will be available from NHBS and as advised on the BOC website. As its online repository, the BOC uses the British Library Online Archive (in accordance with IZCN 1999, Art. 8.5.3.1).

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Breeding records of Dunlin *Calidris alpina* in China

by David S. Melville, Qing Chang, Wei Liu & Nathan H. Rice

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http://zoobank.org/urn:lsid:zoobank.org:pub:2C51E934-384A-425D-A7A9-BA48729205EC

Summary.—Dunlin *Calidris alpina* has been recorded as breeding in China based on a pullus collected on 7 May 1927 at Tsingtao, Shandong province; a remarkably early date for a nearly fledged young. The record appears highly unlikely to be an example of deliberate fraud, and there is no obvious evidence of mislabelling. We have been unable to determine the validity of the claimed breeding record, however, based on a review of available information, it appears certain that the species does not currently breed in China.

Dunlin *Calidris alpina* was reported as breeding in China by Greenwood (1980), based on the skin of a pullus in the collection of the Academy of Natural Sciences, Philadelphia, USA (ANSP; now the Academy of Natural Sciences of Drexel University). The specimen (ANSP 108004) was collected by R. H. LeFevre at Tsingtao [Qingdao], Shan-tung [Shandong], China on 7 May 1927. Greenwood (1980) stated that: 'R. M. de Schauensee (Academy of Natural Sciences) assures me that the specimen label is reliable, so there can be no doubt as to the authenticity of the specimen'. Subsequently, Meyer de Shauensee (1984) stated: 'Breeds in Shantung Pen. (*pullus*)'. The specimen is a pullus, and bears a LeFevre label similar to those of other Dunlins in the collection (Fig. 1).

Figure 1. Specimen of pullus (centre) Dunlin *Calidris alpina* reg. no. ANSP 108004, at the Academy of Natural Sciences of Drexel University, with two adult specimens reg. nos. ANSP 108007 (above) and ANSP 107997 (below) (Nathan H. Rice, Academy of Natural Sciences of Drexel University)

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Figure 2. Underwing of pullus Dunlin *Calidris alpina* reg. no. ANSP 108004, at the Academy of Natural Sciences of Drexel University, showing extensive waxy sheaths to the bases of the primaries, indicating that these were still growing (Nathan H. Rice, Academy of Natural Sciences of Drexel University)

Greenwood (1980) considered the bird to be 'about 2½–3 weeks old and incapable of flight'. The bird has extensive waxy sheaths to the primaries (Fig. 2), indicating that the feathers were still growing, and that it would have been incapable of sustained flight. Dunlins typically fledge when 16–24 days old (Heldt 1966, Meltofte *et al*. 2007, van Gils *et al*. 2020, Warnock & Gill 2020), which suggests that the specimen would have hatched on about 17 April. Incubation usually lasts 20–24 days (Soikelli 1967, Cramp & Simmons 1983, van Gils *et al*. 2020, Warnock & Gill 2020), so laying would have been around 27 March. This is exceptionally early, being nearly a month prior to any other Dunlin breeding record. For the southern race *C. a. schinzii*, Witherby *et al*. (1940) noted 'usually about second or third week May onward in Brit. Is. [British Isles], but exceptionally in first week of May', whilst in southern Finland Soikelli (1967) recorded two clutches being initiated on 24 April, but most in early May. In the Russian Far East, Tomkovich (1998) reported first egg dates between late May and mid June for *C. a. sakhalina*, *C. a. kistchinski* and *C. a. actites*, whilst North American *pacifica* and *arcticola* may start from late May (Warnock & Gill 2020). There do not appear to have been any unusual weather conditions (temperature or rainfall) in 1927 that might have promoted exceptionally early breeding by Dunlin in Shandong; indeed annual minimum temperatures were comparatively low during 1913–38 (Guo *et al*. 2018) which, if anything, might be expected to delay onset of breeding (Soikelli 1967).

It appears that Greenwood had not seen the privately published volume by LeFevre (1962). In it, LeFevre summarises his own observations and records, including 2,658 bird specimens he collected in Shandong between 1923 and 1927. LeFevre (1962) stated: 'All of my collection, except a few skins to Lebanon Valley College, Annville, Pennsylvania, and a few skins to Cornell University, Ithaca, New York, are deposited in the Academy of Natural Science (*sic*), Philadelphia, Pennsylvania'. The entry for Dunlin includes the following:

> 'EROLIA ALPINA SAKHALINA – (Vieillot)
> Pacific Dunlin
> Migrant – recorded March 10 up to May 26 and August 25 to November 29.
>
> Eastern Shantung: I secured 14 birds at Tsingtao from May 7 to May 19 and also one on August 31, 1925.
>
> Central Shantung: On the Wei River, I secured four birds from March 10 to March 19, 1925.'

It thus appears that in total LeFevre collected 18 Dunlins in Shandong. Of these, 12 from 'Tsingdao' and two from the 'Wei River' are at ANSP. The Cornell collection only has one specimen from China, but collected by H. W. Hubbard, not LeFevre (CUMV 2375, taken 1 August 1931 at 'Peitaiho, Hopei' [Beidaihe, Hebei], https://webportal.cumv.cornell.edu/cumvbirds/). The Lebanon Valley College formerly had some bird specimens but these no longer exist (D. Erskine & S. Goodman *in litt*. 2020), so it is unknown if any of LeFevre's Dunlins went there. There is, however, one LeFevre specimen in the Field Museum of Natural History, Chicago (FMNH 406566) collected on 10 March 1926 at the Wei River (https://collections-zoology.fieldmuseum.org/catalogue/1681412).

LeFevre (1962) recorded the following for north-east Shandong: 'Jones [1911] found them [Dunlin] near Wei Hai Wei [Weihai] from the middle of August until October. At the latter time they were quite numerous. There is a possibility of a few breeding here'. It is thus remarkable that LeFevre made no mention of obtaining a pre-fledging juvenile in May.

Greenwood (1980) also noted that: 'Jones (1911) … suggested that Dunlin may breed in the locality of Wei Hai Wei (Shantung peninsula), although proof of this has been lacking'. Jones (1911) reported: '…on the 9th of June, to the west of Wei Hai Wei, a Dunlin was obtained in full breeding-plumage, its foot being in a snare attached to a small withy, which it had pulled up when it escaped. As the Chinese set these snares near the nests of birds, there is every likelihood that this Dunlin was breeding in the neighbourhood'. Snares are widely used to catch various birds in China (Cheng 1964) and for shorebirds in Asia and the Pacific, not only at breeding sites (Kannan & Pandiyan 2012, Naves *et al*. 2019), thus any inference regarding the status of the Dunlin reported by Jones is extremely speculative. Moreover, the appearance of first-summer Dunlin varies, with many attaining plumage similar to adult breeding (Cramp & Simmons 1983), although it appears that most do not breed until their second year (Cramp & Simmons 1983, Warnock & Gill 2020). Small numbers of non-breeding (probably immature) Dunlins oversummer in the northern Yellow Sea / Bohai (Q. Q. Bai pers. comm.) making the presence of one in breeding plumage in early June at Wei Hai Wei not unexpected.

Swinhoe (1875) recorded several species of shorebird at Chefoo (Yantai, Shandong), but did not mention Dunlin. Hemmingsen & Guildal (1968) noted Wilder & Hubbard (1924) as recording Dunlin to be 'found all summer [in north-east China] but breeds in arctic region', but Wilder & Hubbard (1924) actually stated: 'Seacoast only. Recorded in eight years April 10th to Oct'. LaTouche (1931–34) recorded Dunlin as a migrant in Shantung. Shaw (1938) collected 99 specimens from Tsingdao and reported: 'As a migrant, the Pacific or Eastern Dunlin is very common along the coast. Large flocks of one hundred or more birds were frequently met from the middle of March to the first half of May, and again from the end of September to October'. Caldwell & Caldwell (1931) stated: 'Recorded from Chihli [Hebei], April to October' and, rather mysteriously, also noted 'This bird has never been definitely reported as breeding in south China', but they provided no information regarding any 'unconfirmed' reports, or reports from elsewhere in China. Sowerby (1923) collected four specimens at Pei-tai Ho [Beidaihe], Hebei on 14, 16 and 18 July, and noted 'There can be little doubt that the specimens that I secured at Pei-tai Ho had been breeding in the vicinity, as the possibilities of their being either belated stragglers from the south, or early returning birds that accomplished their breeding in the far north, are remote'. However, Hemmingsen & Guidal (1968) recorded Dunlin at Beidaihe on seven dates in July noting 'More or less dark spotting on underparts, of which some may be remnants of the black patch of adults, some the spotting of young in autumn, was seen in July…'.

Subsequent Chinese publications have made no mention of Dunlin breeding in Shantung, or elsewhere in China (Cheng 1987, Sai 2013, 2017, Xiang-Yu *et al*. 2009, Zhang &

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Zhang 2018), however Zheng (2017) noted the species as 'occasional breeders (?)', apparently based on Jones (1911) and mention of LeFevre's specimen in Meyer de Schauensee (1984).

The only other record of Dunlin breeding far south of the normal range is that of Chapman & Buck (1893: 73), who reported 'discovering the Dunlin (*Tringa alpina*) nesting at a point over a thousand miles south of any previous record of its breeding range' in southern Spain, but proffered no further details. This record is referred to by Greenwood (1980); a clutch of four eggs collected on 24 April 1872 at Jerez de la Frontera, Spain, which he noted 'is in the Seebohm collection at the British Museum (Natural History) … and was recorded by Seebohm (1888)'. However, Seebohm (1887) referred to '*an* [emphasis added] egg in my collection out of a clutch of four from which the bird was shot by Mr. Abel Chapman in the marshes of the Guadalquivir [Spain]'. Dresser (1871–81) also mentioned '*an* [emphasis added] egg from a clutch of four' in the collection of H. Saunders. It is unclear why there is a discrepancy in the number of eggs. Of the four eggs, currently in the Natural History Museum, Tring (NHMUK 1901.1.1.5002–05) collection, one is labelled: 'Tring (sic) variabilis nr Jerez, Spain 24 April 72 4 eggs. bird shot'.

Tsingtao is at *c*.36º06'N, whereas the Guadaquavil marshes, Spain, are at *c*.37º86'N. The southernmost breeding population of Dunlin in Europe is at *c*.50ºN (Holloway 1996, Clark & Gromadzka 1997, Balmer *et al*. 2013, Calladine 2020), with occasional nesting attempts at about 47ºN (Cramp & Simmons 1983, Clark & Gromadzka 1997). In the Russian Far East, the southernmost breeding populations are of *actites* in northern Sakhalin (*c*.53ºN) and *kistchinckii* in southern Kamchatka (*c*.51ºN) (Lappo *et al*. 2012).

LeFevre (1895–1974) was a missionary of the United Brethren Church in China (1923–27). En route to the USA in June 1927 LeFevre visited Hong Kong where he collected a few bird specimens, but no shorebirds (LeFevre 1930); it is not known where these specimens were deposited; they are not at ANSP. In addition to birds, he also collected ants (Formicidae) in both Shandong and Hong Kong (Wheeler 1929, 1930).

Upon his return to the USA he transferred to Geneva Presbytery, New York state, and published a short account of birds in China (LeFevre 1929). He returned to China where he was Dean of Agriculture at Huping Agricultural School, Yuangling, Hunan, in 1941–43 (Anon. 1941, 1974), but there is no evidence that he collected birds during this period. Back in the USA he was professor of biology at Sampson College, Sampson, New York state, in 1946, then at Hopewell Presbyterian Church, York county, Pennsylvania (Anon. 2020).

It is notable that LeFevre did not draw attention to this record (see above) and there are no other particularly unusual or extreme records or specimens in his collection. As such, it seems very unlikely that the record is fraudulent. A labelling error is possible (Rasmussen & Prŷs-Jones 2003), but the label is similar to other LeFevre bird specimens in ANSP (Fig. 1).

It may not be possible to determine the validity of the claimed 1927 Tsingtao breeding record definitively, but what does appear certain is that Dunlin does not currently breed in China.

Acknowledgements

We are grateful to Qing Quan Bai for information about oversummering Dunlin in the northern Yellow Sea; Richard Lewthwaite for assistance with historical literature; and Dale Erskine and Stacy Goodman for information about the Lebanon Valley College collection. Douglas G. D. Russell, Natural History Museum, Tring, UK, very kindly provided information regarding the Chapman eggs, as well as photographs. We thank Robert Prŷs-Jones and an anonymous reviewer for helpful comments that improved the manuscript.

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The history of the sole surviving mount of Tahiti Sandpiper *Prosobonia leucoptera*

by Justin J. F. J. Jansen, Pepijn Kamminga & Marc Argeloo

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Summary.—The only known museum specimen of Tahiti Sandpiper *Prosobonia leucoptera*, held at Naturalis, Leiden, until now has been considered to be the type collected by J. R. Forster during the second voyage of Captain James Cook (1772–75). However, using archival and published sources, we were able to trace the specimen only back to 1848. Nevertheless, based on a comparison of its taxidermy with material of known provenance, we conclude that it is likely that Anders Sparrman, a member of Cook's second voyage, was involved in mounting the specimen.

Tahiti Sandpiper was first mentioned by Latham (1785: 172–173, pl. LXXXII) who examined at least two 'specimens', prepared a description in English and named the species White-winged Sandpiper. Gmelin applied a scientific name (*Tringa leucoptera*, J. F. Gmelin 1789: 678, no. 35) and added a description in Latin. Today, one specimen of *Prosobonia* survives from Tahiti / Moorea (Sharpe 1906), RMNH.AVES.87556, at the Naturalis Biodiversity Center, Leiden, the Netherlands; it has no original label, but was subsequently labelled as being from Tahiti. Zusi & Jehl (1970) made an extensive study of the Naturalis specimen (including X-rays), but did not publish their X-rays, nor did they search the museum's written archives. Here we explore additional historical material, to shed light on the possible provenance of Leiden's Tahiti Sandpiper. A new X-ray was taken of the specimen's internal contents to reveal the shape of the metal wires inside it, the presence of heavy metals used for preparation (outside or inside the skin) and the skeletal remains. The Naturalis specimen's X-ray was compared to material at the Naturhistoriska Riksmuseet, Stockholm, Sweden (NRM) and Georg-August-Universität Göttingen, Germany (GAU). This approach was in line with previous examinations (Jansen & Steinheimer 2017, Jansen 2018: 202–204).

History of the Naturalis *Prosobonia*

No written record for this specimen can be traced in the Naturalis archives. It is also not mentioned by Temminck (1807, 1820–40). The specimen's presence in the museum was first noted by Westerman (1848: 51–52). He described it as having arrived with the collection of Coenraad Jacob Temminck. The latter's collection was archived in batches between 1820 and 1838 (Holthuis 1995: 18), but no contemporaneous inventory of its contents was made. The *Prosobonia* was illustrated (Fig. 1) in Westerman (1848) by Hermann Schlegel and reproduced in Schlegel (1857) (Finsch & Hartlaub 1867: XXIX), but in a pose different compared to the mounted specimen. Schlegel (1864: 18–19) also mentioned the specimen without information as to its origin. Van den Hoek Ostende *et al*. (1997: 76) designated it a syntype of the species.

The following description of the specimen is based on Zusi & Jehl (1970) and our own examination (see also Figs. 2–4). ***Size and structure***: a rather plain-coloured bird (pale and dark sooty brown and russet) except barring on the tail. Six primaries extend beyond the

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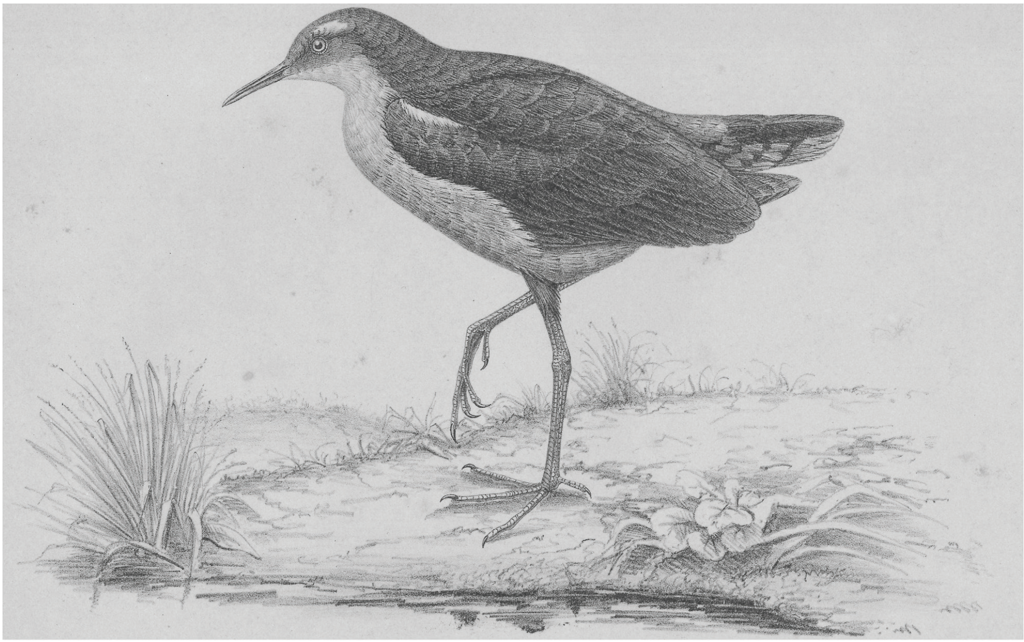

Figure 1. Tahiti Sandpiper *Prosobonia leucoptera*, from Westerman (1848), by Hermann Schlegel; note the different posture of the bird compared to the specimen at Naturalis (see Fig. 4).

Figure 2. Tahiti Sandpiper *Prosobonia leucoptera*, RMNH.AVES.87556; note the gap in the bill, the shape of the nostrils, and the feathering on the mandible (© Naturalis Biodiversity Center, Leiden)

tertials. Wings level with the tail tip. ***Head***: russet-coloured from submoustachial region to breast. Bill base, throat and part of lores buff. Narrow eye-ring also buff. A small curved supercilium partially coloured (buff-)white (5–6 feathers) behind the eye. Crown, hindneck and neck-sides pale sooty brown. ***Upperparts***: upper mantle similar to hindneck, sooty brown, lower mantle and back dark sooty brown, and rump and uppertail-coverts russet / ferruginous (like underparts). ***Underparts***: breast to undertail-coverts russet-

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Figure 3. Tahiti Sandpiper *Prosobonia leucoptera*, RMNH.AVES.87556; note the minimal supercilium in this species, and the pale bill base (© Naturalis Biodiversity Center, Leiden)

Figure 4. Tahiti Sandpiper *Prosobonia leucoptera*, RMNH.AVES.87556; note the pale head compared to Fig. 1 (© Naturalis Biodiversity Center, Leiden)

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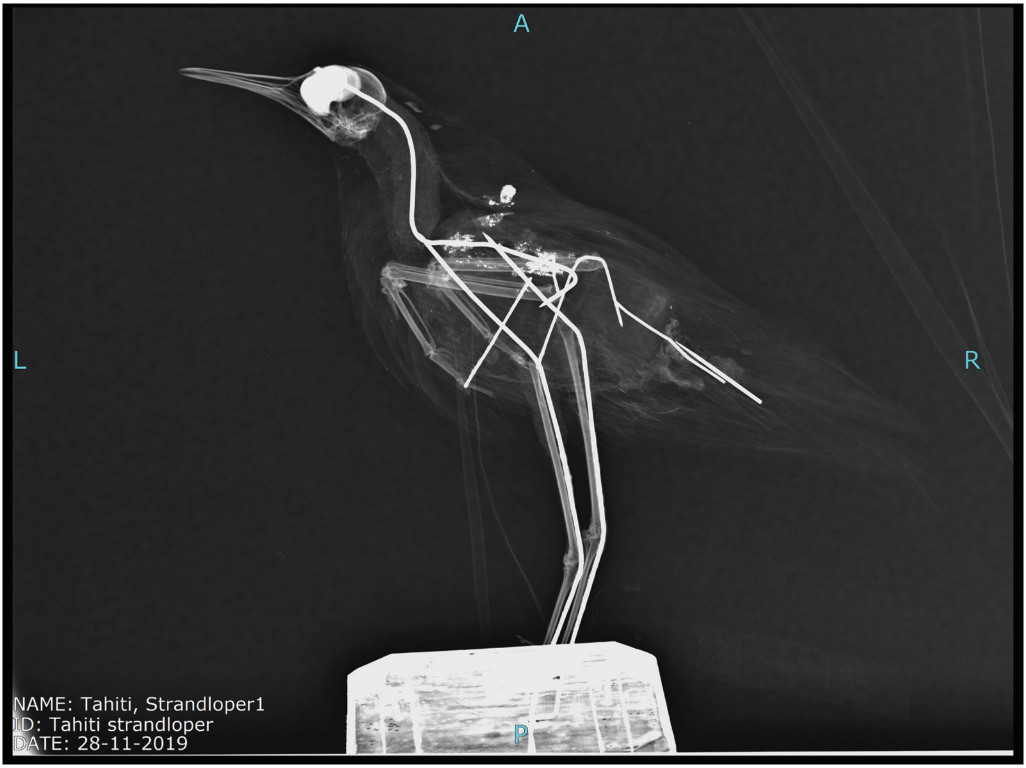

Figure 5. Tahiti Sandpiper *Prosobonia leucoptera*, RMNH.AVES.87556; note the dense substance on the outside of the skin, and clearly visible is the complete tibiotarsus (rare in specimens from this era). L = left, R = right, and P + A = postero-anterior; the latter indicate the angle at which the X-ray passed through the body. Between the skull and body, the neck has a filling, and the body also contains a second (larger wad) of artificial stuffing (© Naturalis Biodiversity Center, Leiden)

coloured (uniform). Tibia unfeathered. ***Wing***: crescent-shaped patch of white on lesser coverts, the rest sooty brown. Remainder of coverts dusky brown, some with russet edges, especially prominent on greater coverts. Underwing-coverts have pale edges, rest of underwing sooty brown. ***Tail***: rounded, 12 rectrices. Central feathers sooty brown with russet tips, others have prominent russet tips and become progressively more heavily barred russet towards the lateral pair. In 2020 only five tail feathers remained. ***Bare parts***: bill straight (thicker at base) with a gap near bill tip. Maxilla blackish, mandible slightly paler, with feathering on the underside of the basal 30% of the mandible. Egg-shaped nostrils. Feet / legs (now) straw-coloured, slightly greenish. The anisodactyl toes are short, especially in toe one, longer in four, two, and toe three is longest. Toe one has two joints, toe two has three joints, toe three four joints and toe four five joints. No webbing between toes two and three, and slight membrane between three and four. Claws now look brownish, laterally compressed, sharp and curved. Borders of scutes dark and clear. Tibiotarsus has 22–23 scutes.

X-ray (see Fig. 5). ***Skeleton***: the radius, ulna, carpometacarpus and wing phalanges are present, as well as other bones such as tarsometatarsus, pedal phalanges and the complete skull. Also, part of the synsacrum and pygostyle are present. Surprisingly (as nearly all specimens prior to the 1820s have this part broken) the tibiotarsus is complete, but no femur is present. ***Wires***: the longest pin is bent in the neck and extends from the skull midway down the back. ***Filling***: the cervical vertebrae are replaced by a hard filler, similar to the rest

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of the body. These form two separate stuffed body parts. ***Eyes***: the concave glass lenses are joined by some dense material (probably clay or wadding).

Measurements: see Zusi & Jehl (1970: 769). ***DNA***: Genbank JQ012744 (ND2) / JQ12743 (Cyt*b*) (Cibois *et al*. 2012: 766, De Pietri *et al*. 2020).

Provenance of the sole specimen.—Two origins for the Naturalis specimen are possible. (1) The style of its taxidermy resembles that of a White Tern *Gygis alba* (NRM A569927) collected by Anders Sparrman (a participant on the second Cook voyage, 1772–75). Likewise, a Tui *Prosthemadera novaeseelandiae* (NRM A533743; ex-Museum Paykull), Piopio *Turnagra capensis* (NRM A568806; coll. A. Sparrman) and Red-crowned Parakeet *Cyanoramphus novaezelandiae* (NRM A569923; coll. A. Sparrman) (Jansen & Steinheimer 2017, Jansen 2018) show similarities in their taxidermy. Finally, it resembles the taxidermy of an I'iwi *Drepanis coccinea* (GAU 345) (Jansen & Steinheimer 2017). However, the latter is from the third Cook expedition (1776–80). All birds collected during Cook's second voyage were probably taken by Johann & Georg Forster. We consider it likely that Georg Forster donated some (duplicates) to Sparrman when he left the *Resolution* on 21 March 1775. We also consider it probable that these specimens were then mixed with others Sparrman collected in South Africa. When Sparrman arrived in Gothenburg (Sweden), the majority were donated to the Swedish Academy (Åhlander *et al*. 1997; E. Åhlander *in litt*. 2019). There is a chance that the specimen now in Naturalis arrived via exchange or purchase with the Swedish Academy. Many specimens, particularly from the third Cook circumnavigation, were traded (Whitehead 1978, Jansen & Steinheimer 2017).

(2) At the Bullock auction in London in 1819, we know that Temminck bid for lots on behalf of both Leiden University and his private collection (Jansen & van der Vliet 2015: 115), but there was no specific mention of a *Prosobonia* in the Bullock Museum (King & Locheé 1979, *contra* Walters 1991: 219, van Lynden-de Bruïne 2001: 56). Not only was the Bullock auction attended by Temminck, but he might also have been at other auctions during this period, such as those by J. Hullet and George Reddell (Steinheimer 2011: 90–91).

It seems probable that, like the Naturalis and Vienna Hawaiian Rails *Porzana sandwichensis* (Jansen & Roe 2013: 66), which are likely to have been collected during one of Cook's voyages, the ultimate provenance of this specimen must remain uncertain.

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Taxonomic implications of the original illustrations of *Prosobonia* from Tahiti and Moorea made during the second and third Cook expeditions

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Summary.—Two extinct taxa, Moorea Sandpiper *Prosobonia ellisi* and Tahiti Sandpiper *P. leucoptera*, once occurred on Moorea and Tahiti, respectively. Four illustrations of *Prosobonia* from the second and third Cook expeditions (1772–75 and 1776–80) exist, of which one was the model for *P. ellisi*, whilst two others depict *P. leucoptera* and one Kiritimati Sandpiper *P. cancellata*. Considerable confusion exists as to whether *P. ellisi* is a valid species or an intraspecific variant of *P. leucoptera*. We examined the Tahiti / Moorea illustrations and original notes by crew of the Cook expeditions. We conclude that *P. ellisi* should be regarded as a junior synonym of *P. leucoptera*, as the differences between them may represent age-related, sexual, seasonal or even inter-island variation.

Four illustrations made by artists on the second (1772–75) and third (1776–80) Cook circumnavigations depict shorebirds referred to the genus *Prosobonia* (Scolopacidae), which is currently considered to comprise five species of very rare or extinct Polynesian endemics. The first was drawn by Johann Georg Adam Forster (1754–94) during Cook's second voyage, in either August 1773 or April–May 1774, when Tahiti was visited. It illustrates what is considered the type of Tahiti Sandpiper *P. leucoptera* (J. F. Gmelin 1789) (Sharpe 1906b, Hume 2017: 150–151). The second and third illustrations were made by William Wade Ellis and John Webber during Cook's third voyage. Both were made at Moorea (visited between 30 September and 11 October 1777) (*cf*. Walters 1991: 224, Hume 2017: 151), and much later the bird depicted in the Ellis drawing was described as Moorea Sandpiper *P. ellisi* (Sharpe 1906b). The fourth illustration was made at Kiritimati, during the third circumnavigation, and shows Kiritimati Sandpiper *P. cancellata* (J. F. Gmelin 1789) (Latham 1785: 274, Walters 1993, Jansen & Cibois 2020). The other two species were discovered after Cook's expeditions: Tuamotu *P. parvirostris* (Peale 1849) and Henderson Sandpipers *P. sauli* (De Pietri *et al*. 2020).

In addition to these illustrations, there are descriptions by Johann Reinhold Forster (Lichtenstein 1844: 174–176) and a brief description made by William Anderson (Anderson *c*.1780). As part of a wider study of the history of Naturalis specimen of *P. leucoptera* (Jansen *et al*. 2021), we examined these original illustrations and descriptions.

Material and Methods

JJFJJ studied the following material at the Natural History Museum, London, UK (NHMUK) and British Museum, London (BM): Forster's illustration (now held in the R. B. R. Forster collection, Banksian MSS. 6–7, pl. 117), Ellis's illustration (in the collection of William Wade Ellis, 1751–85, Banksian MS. 33, pl. 65) and Webber's illustration (among the John Webber prints, British Museum, Prints and Drawings Dept.), as well as the Solander catalogue (Solander *c*.1780), at NHMUK, Tring. This catalogue documents the illustrations in the library of Joseph Banks at the time (Whitehead 1978, Medway 1979), and a list

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TABLE 1

Variation in original artwork executed during the second (1772–75) and third (1776–80) expeditions commanded by James Cook, and the description made during the second Cook circumnavigation by J. R. Forster. Only the relevant parts from the Forster description are noted (for the full description see Lichtenstein 1844).

	Johann Georg Adam Forster / Fig. 1	**William Wade Ellis / Fig. 2**	**John Webber / Fig. 3**	**Johann Reinhold Forster's description (*in* Lichtenstein 1844: 174–176)**
Text on plate / origin	Torowé / Torowé / Tringa pyrrhetraea / Tringa leucoptera J.N. XIII 678.	Signed in ink: 'W. Ellis'. In pencil is written 'Prosobonia ellisi, Sharpe / Tete / Te Te / Tringa pyrrhetraea Forster'.	The name 'Te-te' is noted in pencil. In ink, 'Tringa pyrrhetraea G. Forster, 1844'.	'Tringa pyrrhetraea' and Georg Forster's illustration is mentioned ('Fig. pict. G.'). Inhabits the island of Otaheitee near small rivers; it is called Teetee.
Literature	Giebel (1877: 664), Sharpe (1906a: 190–191), Sharpe (1906b), Lysaght (1959: 300, no. 120), De Pietri *et al*. (2020: fig. 2).	Latham (1785: 172), Sharpe (1906a: 205, 1906b), Lysaght (1959: 333, no. 65), De Pietri *et al*. (2020: fig. 2).	Lysaght (1959: 340, no. 116).	
Size and structure	Heavy built scolopacid, with six primaries visible beyond tertials, and wingtips reaching past tail tip.	A rallid-shaped bird, with six primaries visible beyond tertials, and wings equal to tail in length.	Anatomically incorrect (i.e. body too large, legs incorrectly positioned), five visible primaries beyond tertials, and tail extends clearly beyond wings.	Tringa [= sandpiper] body about size of Common Ringed Plover *Charadrius hiaticula* or slightly larger.
Head	Small compared to body; black with white supercilium from mid-forehead towards the nape, and longer behind eye than in front of it.	Brownish, with a paler area around eye (no marked supercilium), back of head and crown darker.	Small (compared to body) dark (brownish), paler brownish supercilium above eye, small paler area around eye, throat pale whitish, and nape and hindneck darker.	Head black, eyebrows white.
Upperparts	Uniform blackish.	Blackish or greyish, with a (paler) brownish rump. Black spot (as dark as bill) on hindneck.	Blackish or dark, with (pale) brownish rump.	Back black, rump rufous.
Underparts	Brick-red.	Throat to at least vent pale orange brownish, paler on undertail-coverts; chin whitish and the palest tract, after the white wing-coverts.	Brownish with blackish fringes, and undertail-coverts pale (whitish).	Throat, breast and belly rufous, undertail ochre-white.

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Wings	Blackish, scapulars with a row of all-white feathers and a whitish lesser covert.	Part of scapulars white, rest black; lesser, median and greater coverts orange brownish, and tertials and primaries blackish.	Scapulars, primaries and tertials all dark, a few white lesser coverts; median and greater coverts show a mix of pale brownish and blackish feathers.	Wings black and reach tip of tail; shoulders, above and below, white; one or more of the central greater coverts white, and remiges and rest of wings with black shafts. In the examined specimen, the 15th and 16th flight feathers were white in the right wing, black in the left wing.
Tail	The visible feathers have a brownish background with black bars (rr2–5).	Dark with brownish outer rectrices (rr4–5) barred black.	Dark with brownish outer rectrices (unbarred)	Tail short, rounded, with 14 rectrices, the two central ones entirely dark brown; the next pair dark brown with rufous tips and outer webs stained rufous; the rest barred dark brown and rufous.
Bare parts	Long straight bill, broadest at base and straight. Legs look all greenish, with long toes (as long as bill). Thick long legs and long feathers covering half of tibia. Tarsus 39% longer than bill. Central toe 16.5% longer than bill. Slit-like nostrils.	Long, black, curved and tapering bill. Legs and toes greenish. Clear tibial feathering (half length of tibia), tarsus 45% longer than bill. Central toe as long as bill. Claws uncoloured. Slit-like nostrils.	Bill straight and slender. Legs and toes greenish. Short legs, unfeathered tibia, Tarsus twice as long as bill; central toe 20% longer than bill. Slit-like nostrils.	Smooth straight bill, as long as head, somewhat cylindrical, blunt and dark, with thick base. Mandibles equal; upper with slightly depressed base, broader, otherwise convex, with blunt tip; lower half-cylindrical, blunt. Nostrils linear, straight, in front close together, at base more apart, with upper border slightly prominent. Feet tetradactylous, with separated toes, slender, green, length of half the body. Thighs half-bare. Tibiae slender and compressed. Toes very slender, the middle of the three fore toes almost as long as tibia; the hind [toe] short, uniarticular, with nail just reaching ground.

of specimens compiled by Jonas Carlsson Dryander (Whitehead 1978, Medway 1979).

Review of original material

Two illustrations are of birds from Moorea and one from Tahiti. It is unknown if the illustration from Moorea depicts the same bird as that from Tahiti. To understand the morphological and anatomical differences in the illustrations we analysed the original Forster, Ellis and Webber illustrations, and the Forster description in Lichtenstein (1844: 174–176) (Table 1), but we excluded two *c.*1780 manuscripts.

Anderson.—In Anderson's (*c.*1780) manuscript describing animals observed on Captain Cook's second and third voyages, *Charadrius tardus* (Anderson's manuscript name) is mentioned with a short description (our translation): 'Head/body black above, with a stripe above the eyes, a wing mark, the belly and the undertail white; the breast and rump reddish or brown.' It was mentioned alongside two other species of '*Plover*' (Hooded Plover *Thinornis cucullatus* from New Zealand and a 'blackish plover' from Terra del Fuego (possibly Magellanic Plover *Pluvianellus socialis*). However, from the manuscript it is impossible to determine if the '*Charadrius tardus*' was actually collected (*contra* Stresemann 1950: 76, Hume 2017: 151).

Solander.—Herein (Solander *c.*1780), Tahiti Sandpiper is mentioned as: '93 / 1 / *Webber Ellis* / (*Te-te*) / *Otaheite Eimeo*' (Otaheite = Tahiti, Eimeo = Moorea).

Discussion and Conclusions

The three illustrations examined all differ (Table 1), and none exactly matches the sole surviving mount, RMNH.AVES.87556. The Webber illustration (drawn at Moorea) shows a bird very similar in appearance to the *Prosobonia* specimen at Naturalis (Jansen *et al.* 2021). The Ellis illustration, which is not quite finished (i.e. the nails are uncoloured), was used to describe the Moorea taxon. Sharpe (1906b) described

Figure 1. Tahiti Sandpiper *Prosobonia leucoptera*, Tahiti, August 1774 or April/May 1774; the bird shows at least two groups of white wing feathers (Georg Forster, © Natural History Museum, London)

Ellis' illustration as differing from that by Forster in having a circlet of rufous around the eye; a double patch of white on the wing-coverts, and the median and greater wing-coverts pale ferruginous, like the rump. However, the Webber illustration, also made on Moorea (Fig. 3), was not mentioned by Sharpe (1906a,b). According to Walters (1991), the Ellis (Fig. 2) and Webber (Fig. 3) depictions are of the same species. However, they differ in at least

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Figure 2. Moorea Sandpiper *Prosobonia ellisi*, Moorea, August–December 1777; the claws are not coloured, indicating that the illustration was unfinished, and the annotation *Prosobonia ellisi* was added by Sawyer (Sawyer 1949) (William Wade Ellis, © Natural History Museum, London)

ten points: bill shape and thickness, ear patch colour, throat colour, tibia feathering, tail pattern, wing-coverts pattern, tail and wing lengths, and leg and underparts colorations. The Webber illustration differs in having a supercilium (absent in Ellis'), only a single patch of white on the wing-coverts (not two), and differently patterned median and greater coverts. The rump is ferruginous, but the same feature is present on the surviving specimen (Jansen *et al*. 2021).

At that time illustrators were less accurate, especially in details, than now; for example, virtually all depictions of Dodo *Raphus cucullatus* differ in some respects (Fuller 2002) as

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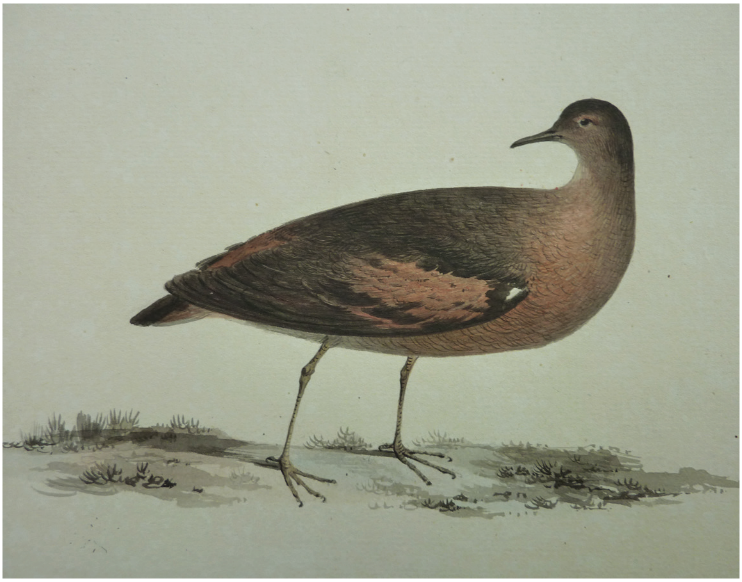

Figure 3. Moorea Sandpiper *Prosobonia ellisi*, Moorea, August–December 1777; anatomically incorrect (John Webber © British Museum, London)

Figure 4. Tahiti Sandpiper *Prosobonia leucoptera*, from Latham (1785); note the pale undertail-coverts and rufous supercilium (© Smithsonian Institution, Washington DC)

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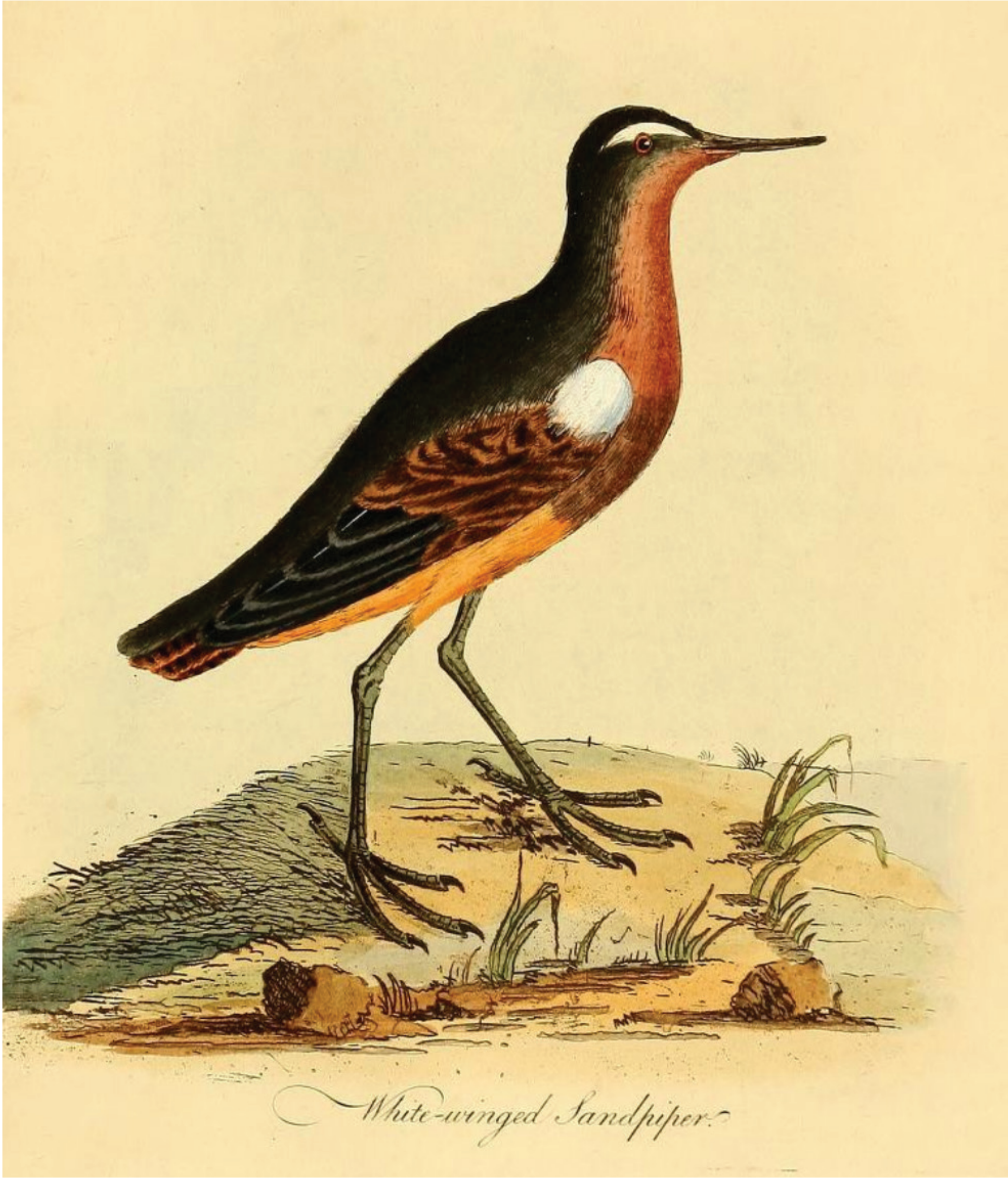

Figure 5. Tahiti Sandpiper *Prosobonia leucoptera*, from Latham (1824); note the white supercilium, rufous wing-coverts, and pale belly and undertail-coverts (© University Library, Univ. of Illinois). Latham added a plate to his first publication (Latham 1785: 172–173, pl. LXXXII) and reused it in 1824 (Latham 1824: 296, pl. CLII). The plates differ notably in, for example, the supercilium, breast and undertail colorations (see Figs. 4–5) (both volumes on the Biodiversity Library are held in the Smithsonian Library). These differences may be attributable to the colourists who worked on the relevant copies during the publication process.

do known illustrations of the sole Tahiti Sandpiper specimen in Joseph Banks' collection (Figs. 4–6). It is very unlikely that birds from Moorea were morphologically distinct from those on Tahiti (as these islands are separated by just 18 km). Also, there is evidence of individuals exhibiting patchy white feathers in several Polynesian *Acrocephalus* warblers (Thibault & Cibois 2017), which could be evidence of a limited gene pool and explain the minor variation in the meagre sample of sandpipers.

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Figure 6. Tahiti Sandpiper *Prosobonia leucoptera*, from the Latham MS collection; note the all-rufous tail (Justin J. F. J. Jansen, © Natural History Museum, London). The plate is unsigned and by an unknown artist; it is annotated with a cross-reference to the description in Latham (1824: 296) and appears to be a copy of Forster's plate (Fig. 1), albeit with some differences, e.g., tail length, posture, bill length and leg colour. Latham's 888 original illustrations of birds in six volumes were acquired by the British Museum from Mrs E. Wickham on 24 November 1920 and are now at the Natural History Museum (NHMUK) (Latham n.d., Sawyer 1949, Jackson 1999, Jackson *et al*. 2013).

We consider the differences between Moorea and Tahiti birds to represent age, sex, season or inter-island variation, rather than evidence of a separate taxon. It is possible that future work testing ancient DNA of archaeological remains on Moorea may resolve this issue, but until then we conclude that *Prosobonia ellisi* Sharpe, 1906b, is a junior synonym of *Tringa leucoptera* J. F. Gmelin, 1789.

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Update on status and records of Blue Swallow *Hirundo atrocaerulea* and other hirundines from Mozambique

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Summary.—We update knowledge of the status of seven hirundines in southern Africa, with special focus on Mozambique. Records in Mozambique of the globally threatened Blue Swallow *Hirundo atrocaerulea* have not previously been fully collated, but it is estimated that *c*.50 pairs breed, or 4–10% of the global breeding population, with key sites at Serra Choa, 'Penhalonga' farm near Manica and, probably, around Chimanimani. Further surveys of this species are urgently required to evaluate its status more fully. The first documented record of Pearl-breasted Swallow and details of a recent record of Greater Striped Swallow in Mozambique are presented (both species have been reported previously). The status of White-throated *H. albigularis* and Red-breasted Swallows *Cecropis semirufa*, both of which are poorly known in Mozambique, are updated and recent records discussed. The first documented record of Eastern Saw-wing *Psalidoprocne orientalis* in South Africa and a recent sighting in southern Mozambique are presented. The status of Mascarene Martin *Phedina borbonica* in southern Africa is also reviewed and details of a record in South Africa presented.

Of the 21 species of Hirundinidae (swallows and martins) in the southern African subregion (as defined by Hockey *et al*. 2005) 15 have been recorded in Mozambique. We update the status of seven of these species here. Four are regular in immediately adjacent parts of South Africa and Zimbabwe but are rare, little known and poorly documented in Mozambique: White-throated *Hirundo albigularis*, Pearl-breasted *H. dimidiata*, Red-breasted *Cecropis semirufa* and Greater Striped Swallows *C. cucullata* (Hockey *et al*. 2005). Another three are known to occur in Mozambique but are also poorly documented—Eastern Saw-wing *Psalidoprocne orientalis*, Blue Swallow *H. atrocaerulea* and Mascarene Martin *Phedina borbonica*.

With increasing focus on Mozambique by field ornithologists and ease of documentation with digital photography and sharing of observations via citizen science portals such as BirdLasser (https://www.birdlasser.com) and eBird (https://ebird.org/), there have been recent records of all seven of these little-known species. The purpose of this paper is to review and update existing information concerning their status in Mozambique and, in some cases, South Africa and the wider subregion. Blue Swallow *Hirundo atrocaerulea* is globally threatened (BirdLife International 2020a), present in important numbers in Mozambique and breeds at key sites amenable to protection, making the species of particular interest.

Methods

The main body of field work underpinning these records was undertaken in Mozambique by GA (for locations and other details, see Allport 2018; and Appendix), with additional observations by OH & ZH. Other records were drawn from eBird and the Southern African Bird Atlas Project (SABAP) and, where significant, the observers involved were contacted for details. Localities mentioned in the text are in Mozambique unless

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otherwise stated (see Appendix). Nomenclature largely follows Dickinson & Christidis (2014), with amendments from other authorities where relevant, including Hockey *et al*. (2005; the most comprehensive ornithological summary for the southern African subregion), and Gill *et al*. (2020; followed by most birders in the subregion).

BLUE SWALLOW *Hirundo atrocaerulea*

Blue Swallow is an intra-African migrant with a disjunct breeding range across Afromontane mist-belt grasslands in south-east DR Congo, Tanzania, far north-east Zambia, Malawi, eastern Zimbabwe, eastern South Africa and Eswatini (Evans & Barnes 2000, Evans & Bouwman 2010, Evans *et al*. 2015). It breeds in October–March in southern Africa and this population migrates north to spend the non-breeding season on the shores of Lake Victoria in DR Congo, Uganda and Kenya (Evans *et al*. 2015). The global population is small, just 1,000–2,499 mature individuals, with a declining trend and it is considered globally Vulnerable (BirdLife International 2020a). It occurs in Mozambique (Clancey 1996) but is poorly known and its conservation status has been assessed as Critically Endangered at the national level (Little 2013).

Breeding range and records.—To nest the species requires natural montane grassland at 890–2,300 m, typically above 1,500 m, with sinkholes, Aardvark *Orycteropus afer* burrows or disused mine shafts, in which the birds nest, usually solitarily. There are also a few records of nesting in barns and under bridges (Meikle 2010, Matsvimbo & Wachi 2014, Evans *et al*. 2016). Montane grassland is being converted to agriculture, potentially a major driver of the species' decline (Combrink & Little 2012, BirdLife International 2020a). Breeding density reaches 3–4 pairs/km^2 in prime habitat, e.g. in eastern Zimbabwe (Snell 1969, Wakelin *et al*. 2018) and efforts to improve existing nest sites and to create new ones, mimicking Aardvark holes, have proven successful (Maclean 1993).

In the southern African subregion the breeding range extends from the KwaZulu-Natal Midlands north through Mpumalanga, Eswatini and the eastern highlands of Zimbabwe

Figure 1. Blue Swallow *Hirundo atrocaerulea*, Mount Tsetserra, Manhica province, Mozambique, 12 December 2017; one of a pair prospecting a potential nest site at this location (Zak Pohlen)

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(Evans & Bouwman 2010, Evans *et al*. 2015). In Mozambique limited information is available, but it is known from, suspected or possibly occurs in, four regions as follows.

1. 'Eastern Highlands of Zimbabwe': the most significant and best-known area of occurrence in Mozambique lies in the uplands at the border with Zimbabwe, and considered to be part of the 'Eastern Highlands of Zimbabwe' breeding subpopulation by Evans *et al*. (2015), who estimated 620 birds in total. Clancey (1996) described it as 'relatively common' in Manica and Sofala provinces, occurring locally in suitable habitat from Espungabera north to the headwaters of the Pungwe River. However, no sources were cited by Clancey (1996) and no quantitative data were presented.

In the south of this region Beasley (1995) reported Blue Swallows in Chimanimani, but it is unclear if these were inside Mozambique. Jackson's (1973) visits were not in the breeding season, while Little (2013) did not visit Chimanimani but suggested that the species would not be found there due to disturbance; he did, however, flag one unnamed locality (19°37'30.8712"S, 32°52'30.0432"E; 1,780 m) as suitable, but probably also heavily disturbed. The account of Important Bird & Biodiversity Area 'Chimanimani Mountains (Mozambique)' (IBA MZ006: Parker 2001, BirdLife International 2020b) lists Blue Swallow as a trigger species for site selection. Timberlake *et al*. (2016) reported suitable habitat for Blue Swallows in the Chimanimani area but did not record any (their survey was possibly not in the right season); however, numerous Aardvark burrows were noted as potential nest sites. They considered there to be as much suitable habitat on the Mozambique side of Chimanimani as on the Zimbabwe side of the massif, suggesting that the breeding population there could be significant. Searches of apparently suitable short grasslands on the Mozambican side in December 2019 found no Blue Swallows or sinkholes (C. Gesmundo & Z. Pohlen *in litt*. 2020; https://ebird.org/checklist/S62136659). It may be that the quartzite sand soils in this part of the massif are unsuitable for sinkhole formation; Blue Swallows elsewhere on the massif, in Zimbabwe, were found in grasslands on schist (which are less common on the Mozambique side; Z. Pohlen *in litt*. 2020). There is, however, an anecdotal report of breeding in the buffer zone of the Reserva Nacional de Chimanimani in high-altitude grasslands (1,700 m) at Tantara (Z. Pohlen *in litt*. 2020). At least five were found slightly further north at Mt. Tsetserra in December 2017 (K. Coetzer *in litt*. 2017, https://ebird.org/checklist/S53126655; C. Gesmundo & Z. Pohlen *in litt*. 2017, https://ebird.org/checklist/S41246173). Two were apparently paired and were seen entering a hole in grasslands at 2,000–2,250 m, but no nest was found in a rapid and cautious inspection of the site.

Further north, there is a significant breeding population of Blue Swallows on a farm, 'Penhalonga', above an active bauxite mine operated by Mina Alumina Ltda., in the mountains north-west of Manica. The farm is in Mozambican territory but is usually accessed from Mutare, in Zimbabwe, with the result that its Blue Swallows have been reported via Zimbabwean channels but are little known in Mozambique (Meikle 2010, Matsvimbo & Wachi 2014; J. Meikle *in litt*. 2020). Little (2013) surveyed the area in November 2013 (mostly at 1,800 m) finding 43 Blue Swallows on transects. Three active nests were found (although locating nests was not the object of the survey) and the estimated population was 25–30 pairs. No sinkholes or Aardvark holes were found, and all active nests were in prospective mine holes; these may be the reason that this population has persisted, perhaps after the local Aardvarks were extirpated by hunting. Matsvimbo & Wachi (2014) visited the site in October 2013–March 2014 reporting *c*.20 swallows around the farm buildings, including juveniles. There has been no systematic survey of the breeding population at this important site, making this a priority.

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Further north, at least two were seen near Catandica in March 2003, with breeding considered possible (Parker 2005). Cizek (2009) gave more details concerning this area and suggested that Parker's records were more likely from the Serra Choa north-west of Catandica, where possibly as many as ten were seen hawking with Eastern Saw-wings over tall *Protea* grasslands on 17–19 March 2008, some of them juveniles (Cizek 2009). Little (2013) visited this area and found the majority of the 'isolated plateau' had been converted to agriculture, but he saw 13 birds in a remote grassland (18°02′26.63″S, 33°02′30.40″E) and two pairs, one of which was breeding at 1,403 m. The total population was estimated at 10–15 breeding pairs. Most recently 5–6 Blue Swallows, including a juvenile, were seen there on 5 December 2020. The area was considered to comprise suitable breeding habitat, not significantly converted for agriculture, and local breeding was considered probable. Local observers report the species is present every summer; that land use change is restricted to areas accessible via the limited network of access tracks; and that there is still a significant area of intact mist-belt grassland (P. Stramandinoli Branco & E. Marais *in litt*. 2021; https://ebird.org/checklist/S80242328).

Parker (2005) commented that all suitable habitat in the border region south of Catandica lies within Zimbabwe, but historical and recent observations, as reported above, suggest otherwise.

In summary, the potential area of occurrence in this border region is significant, stretching 175 km north to south and including several local areas of upland habitat within Mozambique mostly delimited to the west by bordering Zimbabwe. The key sites in this region are: Serra Choa, considered by Cizek (2009) to be the most significant area of suitable montane breeding habitat (above 1,200 m) for the species in Mozambique; the area was in pristine condition in 2008, more degraded by 2013 (Little 2013) but suitable breeding habitat remains in 2020; 'Penhalonga' farm above Manica; and the Chimanimani Mountains. A large part of the latter site is now protected within Reserva Nacional de Chimanimani (established 2003; Biofund 2020a). The records from Mt. Tsetserra reported above fall outside this reserve but within the Chimanimani Trans Frontier Conservation Area Buffer Zone (Ghiurghi *et al*. 2010).

2. Mt. Gorongosa (part of Gorongosa National Park since 2010; Biofund 2020b) is *c*.100 km east of the area described above. Tinley (1977) reported 40 km^2 of montane and submontane grassland above 1,400 m there, and it has been speculated that Blue Swallow breeds on its upper slopes (Parker 2001, Evans & Bouwman 2010). Access has been and still is difficult due to local security concerns, and as a result avifaunal data are few. Little (2013) reported third-party sightings of Blue Swallows from the mountain 'suspected [to be] on passage' but without details. Its presence is confirmed by a sight record of one on 12 December 2012 from an agricultural area on its lower slopes (E. Marais *in litt*. 2019). This site probably holds a breeding population of Blue Swallows and, based on the extent of suitable habitat, a potentially significant one. However, it should be noted that the species is clearly absent from Mt. Namuli where the rocky or peaty soils mean that rainwater immediately waterlogs the ground, depriving it of safe nest sites in the form of dry holes and burrows (Timberlake *et al*. 2009, Timberlake 2017), so it is possible that Mt. Gorongosa, a granitic inselberg like Mt. Namuli, is also unsuitable for breeding Blue Swallows.

3. The Kirk Range: Blue Swallow was recorded in the south-west Malawi / Mozambique frontier area centred on Mt. Tsangano in the early 1940s (Benson 1942; see Fig. 3 in Evans *et al*. 2015) but not since. There are no protected areas in Mozambican territory within this region (https://ibat-alliance.org/) and a cursory examination of Google Earth suggests there is little or no remaining natural high-altitude grassland, so the likelihood of a breeding

population appears low, but surveys have been recommended (Evans *et al*. 2015) and would still be valuable.

4. Mulanje Mountains: 40–60 pairs breed in the Mulanje Mountain Forest Reserve in southern Malawi (Little 2013, BirdLife International 2020c) and there are small areas of suitable uplands (>1,200 m) on two mountains south-east of the massif, inside Mozambique; Mt. Milanje and a small peak north of Nacarre (15°42′33.4″S, 35°50′15.8″E). On Google Earth imagery, these areas each show *c*.5 km^2 of relatively pristine natural habitat, and could support a few pairs of Blue Swallows. Surveys of both sites in the breeding season would be of value.

Migration.—There is just one documented record of a Blue Swallow not in breeding habitat in Mozambique, which is undated but pre-1980, on the Indian Ocean coast at the Zambezi River mouth (Brown & Britton 1980); the record has been queried (Little 2013). However, it is very likely that a large percentage of the Blue Swallows breeding in southern Africa pass through Tete province en route north to spend the non-breeding season on the shores of Lake Victoria (see Fig. 6 in Evans & Bouwman 2010). There are, however, no sight records from well-watched localities such as Kruger National Park to suggest the route of overland passage (T. Hardaker *in litt*. 2020). There is no evidence that Blue Swallows possess any specific habitat preference on migration, so concentrations of migrants seem unlikely.

Numbers.—The estimate of *c*.100 breeding pairs in Mozambique (Evans & Barnes 2000) was thought too generous by Cizek (2009), an assertion partly based on Parker's plausibly incorrect statement that no suitable habitat lies within Mozambique borderlands (see above). Evans & Bouwman (2010; Table 2) estimated *c*.50 pairs/100 individuals in Mozambique, of which 30 pairs nest in 'strictly protected areas' and 20 pairs at unprotected sites, but gave no details of the locations concerned either in their text or in the supplementary materials online; it is presumed that the first group might be in the Reserva Nacional de Chimanimani. The only survey work enumerating populations in Mozambique was by Little (2013), who undertook a brief survey in November 2013 and estimated 35–45 pairs, based on his field data and reviews of known sites (Table 1).

TABLE 1
Estimated numbers of breeding Blue Swallows *Hirundo atrocaerulea* at sites in Mozambique.

Breeding site	**Pre-2013 estimates (Little 2013, Evans *et al*. 2015)**	**2013 estimate (Little 2013)**	**Updated estimate (this study)**
Catandica and Serra Choa	3–10 birds	10–15 pairs	Confirmed still present, breeding likely 2020
Manica, 'Penhalonga'	Unknown	25–30 pairs	No further data
Mt. Tsetserra	Unknown	0	1–3 pairs
Chimanimani	Unknown	Not visited	Breeding probable
Mt. Gorongosa	Unknown	Not visited	Single bird; breeding likely
Kirk Range	30 pairs	0	No further data; likely zero
Totals	**33–40 pairs**	**35–45 pairs**	***c*.50 pairs**

Based on Little (2013) and new information reported herein an estimate of at least 50 breeding pairs at known sites is reasonable. However, this does not include any birds from Chimanimani. Thus, given the species' range in Mozambique and its possible breeding density (Snell 1969) the estimate above of 50 pairs/100 individuals is probably a minimum and, despite this being an apparently small number, it nevertheless represents 4–10% of the global breeding population.

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It is also worth noting that Mozambican montane habitats may be of particular long-term value for the species as its higher altitude grasslands have generally not been planted with alien exotic pines *Pinus* sp. and *Acacia pycnantha*, which in Zimbabwe invade disturbed ground, including potential nest sites. Therefore, in the absence of these alien invasive plants, grasslands in Mozambican parts of the Eastern / Manica Highlands could be even more important for the species' conservation, although they encompass smaller areas than in Zimbabwe (A. Cizek *in litt*. 2020).

Targeted surveys of the key areas outlined above—especially Serra Choa and surrounding plateaux, the uplands around Manica, Reserva Nacional de Chimanimani and the Mt. Gorongosa section of Gorongosa National Park—are needed to update the status and numbers of this globally threatened species in Mozambique, and to formulate conservation measures at the key sites where it breeds.

EASTERN SAW-WING *Psalidoprocne orientalis*

Treated as a species by Hockey *et al*. (2005) comprising four subspecies across Africa (Hall & Moreau 1970) of which two occur in the southern African subregion. *P. o. percivali* occurs in southern Malawi, eastern Zimbabwe, and central Mozambique south to the Save River, adjacent to the Eastern Highlands and eastern Mashonaland Plateau of Zimbabwe (Hockey *et al*. 2005, Parker 2005; A. Cizek *in litt*. 2020). It is distinguished from the more widespread (and sometimes considered conspecific) Black Saw-wing *P. prisoptera holomelas* by its white underwing-coverts (Sinclair & Ryan 2010).

Records from the SABAP2 database (http://sabap2.birdmap.africa/) show *P. o. percivali* to be more frequent within its known range during the austral summer (November–March) while the extent of its non-breeding grounds is not certainly known, although speculated to be in Mozambique (Irwin 1981, Harrison *et al*. 1997). Clancey *et al*. (1969) reported it at Inhaminga in June–July with many other aerial feeders (including Mascarene Martin; see below), one of the few non-breeding season records of this subspecies (Hockey *et al*. 2005).

Figure 2. Eastern Saw-wing *Psalidoprocne orientalis percivali*, Phinda Private Game Reserve, KwaZulu-Natal, South Africa, 8 October 2016; note distinctive white underwing-coverts. The first record of this subspecies for South Africa (Daryl Dell)

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Two recent records of *percivali* are from October/November 2016. The first was in northern KwaZulu-Natal, South Africa, where one in mid-primary moult was photographed by DD at Imagine Pan, Phinda Private Game Reserve on 8 October 2016 (Fig. 2). This is the first documented record of this taxon in South Africa. Another was seen in Maputo on 5 November 2016 feeding alone, flying low over the short grass of a school playing field, showing its clean white underwing-coverts. The bird was watched for 30 minutes in early morning but was not seen subsequently despite searches (https://ebird.org/checklist/S68432656; G. Allport *in Bull. Afr. Bird Cl*. 24: 108–109).

These two records were 500–700 km south of the previous southernmost localities and at a season when this taxon might be expected to be returning to its breeding areas. Whether these records indicate an as yet undocumented regular southerly movement within southern Mozambique and eastern South Africa in the non-breeding season or if they were simply 'nomadic' movements with other hirundines is unclear (a Mascarene Martin was also recorded on the same day at Phinda; see below).

MASCARENE MARTIN *Phedina borbonica*

Two subspecies are recognised; the nominate on Mauritius and Reunion, and *P. b. madagascariensis* breeds in Madagascar and makes local movements, as well as long-distance migrations in the non-breeding season (mainly June–August) when it has been found at widely scattered sites mainly in coastal East Africa; south-east Kenya, Pemba Island (off Tanzania), Malawi, and central Mozambique (Safford & Hawkins 2013; D. A. Turner *in litt*. 2020).

Benson (1944) was first to document the species on mainland Africa where 'hundreds' were observed at Lake Chilwa, southern Malawi, on 28 June 1944. Clancey *et al*. (1969) were next to record the species in the southern African subregion at Inhaminga, Sofala province, during 16 June–13 July 1968 (note that the subregion is confusingly referred to as the 'South African region' by Clancey *et al*. 1969). Nine specimens were collected and it

Figure 3. Mascarene Martin *Phedina borbonica*, Macaneta, Maputo Province, Mozambique, 18 May 2020; note this bird shows streaking on the undertail-coverts, a feature given for Brazza's Martin *P. brazzae*, a possible vagrant to the subregion (Sinclair & Ryan 2010), but which was excluded by its larger size compared to nearby Lesser Striped Swallows *Cecropis abyssinica* and call (https://www.xeno-canto.org/475668) (Gary Allport)

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was subsequently reported as having been present 'in large numbers' (Clancey 1996). It was not recorded in the subregion again until 5–9 July 1997 when 20–100 per day were seen in groups of 3–10 between Dondo and Inhamitanga (Cohen *et al*. 1997), followed by sightings in Vilanculos Coastal Wildlife Sanctuary of three in June 2002 and another individual there in winter 2004 (Read *et al*. 2014). An area of more regular occurrence was then found in the lowlands between Beira / Dondo and the Zambezi Delta inland to Inhaminga, in April–September, with an estimated 1,000 or more birds in a wide range of habitats (Parker 2005).

None was recorded during atlas work further south in Mozambique (Parker 2000) but it was later found south of the Save River in *Brachystegia* woodland near Panda in July 2001 (Spottiswoode & Ryan 2002), with subsequent irregular anecdotal reports from the same area, but no more documented records. Further west, one was seen in a mixed group of hirundines at Crooks Corner, Kruger National Park, on 1 August 2002, the first record for South Africa (S. L. James *in litt*. to C. Cohen 2002, Hockey *et al*. 2005, but was not submitted to the BirdLife South Africa National Rarities Committee; T. Hardaker *in litt*. 2019). To the south, a flock of *c*.20 was in the Limpopo floodplain, south-west of Xai-Xai on 28 July 2014 (M. Booysen *in litt*. 2015; https://www.facebook.com/photo.php?fbid=855274861151821&set=a.855274844485156&type=3&theater&ifg=1) and there were a small number of reports in the adjacent littoral in the austral winter, mostly without details, except one at Zona Braza, near Xai-Xai on 11 August 2018 (K. Coetzer *in litt*. 2018; https://ebird.org/checklist/S54040448). A single was recorded from a fishing vessel at sea *c*.100 km east of Inhambane on 27 September 2015 (Rollinson 2018)—presumably on return migration to Madagascar—and most recently a bird in advanced primary moult was at Macaneta on 18–19 May 2019 (GA, OH & ZH *in Bull. Afr. Bird Cl*. 26: 241; https://ebird.org/checklist/S56490728; Fig. 3).

The bird at Macaneta is the southernmost record in Mozambique, but there is one other undocumented record from further south, a single seen by DD in Phinda Private Game Reserve, northern KwaZulu-Natal, South Africa, on 8 October 2016 (see Eastern Saw-wing above). There are no photos, but the bird was seen well in a mixed flock of swallows and swifts, and noted as larger than the accompanying Lesser Striped Swallows (thus too large to be Brazza's Martin), medium brown above, and paler and heavily streaked below. This is the second report for South Africa.

WHITE-THROATED SWALLOW *Hirundo albigularis*

Uncommon to locally common breeding visitor to southern Africa's uplands, arriving late July–September, with peak breeding activity in October–December. It departs in mid April and May, moving north and north-west to Angola, Zambia, south-east DR Congo and, possibly, Tanzania (Hockey *et al*. 2005).

A breeding record reported from Beira (mentioned by Clancey 1996, and detailed in Sclater 1911) seems likely to reflect confusion with Wire-tailed Swallow *H. smithii* (Parker 2005). The first documented record for Mozambique was by Jackson (1973) who found it common along upland watercourses in the Mucrera watershed of Chimanimani in August–September (ten collected; Natural History Museum, Bulawayo). Clancey (1996) described it as marginal in southern Mozambique, with a few records on the border with Zimbabwe in the breeding season (Beasley 1995). Most recently, 4–6 birds were seen at two localities in Chimanimani in December 2019 (Z. Pohlen *in litt*. 2020; https://ebird.org/checklist/S62136659, https://ebird.org/checklist/S62165776).

Further north, it was reported by Parker (2005) in south-west Tete Province in January, July and August 1992 (S. Edwards *per* V. Parker), in flocks of up to 35 at Cahora-Bassa Dam in June 2000 (Douglas 2002), and a single at nearby Dongo in December 2017 (M. Costeira da Rocha *in litt*. 2017; https://ebird.org/checklist/S41043124). These birds all seem likely to

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be non-breeders or on passage and, like Blue Swallow (see above), this species probably crosses the Zambezi Valley in Tete Province on its north–south migration.

There are four recent records from the littoral (Table 2), which suggest it is a rare migrant. These are most likely to be birds on passage from breeding areas further south-west, and were detected as a result of increased observer coverage rather than due to a change in status. It is notable that the records from Macaneta in May 2019 coincided with a single Pearl-breasted Swallow *H. dimidiata* and Mascarene Martin at the same site.

TABLE 2
Recent records of White-throated Swallow *Hirundo albigularis* from the Mozambique littoral.

Date	Location		Source
14 October 2011	Beira	1	C. Randler (*in litt*. 2011; https://ebird.org/checklist/S59244273)
8 February 2015	Maputo	1 juv	GA (pers. obs.; https://ebird.org/checklist/S21721550)
15 September 2016	Machangulo	1	R. Swart (*in litt*. 2016; https://ebird.org/checklist/S53562167)
19 May 2019	Macaneta	1	OH & ZH (pers. obs. 2019; https://ebird.org/checklist/S56478522)
20 May 2019	Macaneta	2 ad/juv	GA (pers. obs. 2019; https://ebird.org/checklist/S21721550)

PEARL-BREASTED SWALLOW *Hirundo dimidiata*

Occurs in Angola, Zambia, south-east DR Congo, south-west Tanzania (just one record), Malawi (west of the Rift Valley) and in five fairly discrete areas of southern Africa, north Botswana, north-east Zimbabwe, central Namibia, and north-east and southern Cape province of South Africa (Urban *et al*. 1992, Hockey *et al*. 2005). It is probably mainly resident, with some post-breeding movements in the north, but is migratory in the Cape south of *c*.26°S. There is an apparent influx to northern Botswana, Zambia and DR Congo in the non-breeding season (mainly May–July), with a notable peak in Zimbabwe in July (Tree 1986). It occurs in varied habitats including grassland, scrub, broadleaf woodland, miombo edge and clearings, cultivation, and habitations, often near water, normally in pairs or small groups, rarely up to *c*.100 (Hockey *et al*. 2005).

Its status in Mozambique is unclear. Clancey (1996) noted that the species was recorded by Kemp at Pafuri on the South Africa / Mozambique border, stating that it 'Almost certainly occurs occasionally as a non-breeding visitor' but no records in Mozambique were known at the time. The species was not recorded by Parker (2000), while an undocumented report from Beira was considered unlikely (Parker 2005), and it has not been recorded by the SABAP in Mozambique. However, Urban *et al*. (1992) stated that Pearl-breasted Swallow occurs in western Mozambique and mapped its range as including all of the western Zambezi Valley, mostly in Tete province. None of the references cited by Urban *et al*. (1992) mentioned records for this area, indeed in a comprehensive review of the species Benson (1949) stated 'I have failed to trace any records from Basutoland or Portuguese East Africa [Mozambique]', and none was mapped by Hall & Moreau (1970) in Mozambique. Possibly presence was assumed by Urban *et al*. (1992) based on confirmed records both to the north, in Zambia and Malawi, and south in Zimbabwe, of the Zambezi Valley, but extensive field work in Tete province by Parker (2005) yielded no records. Hockey *et al*. (2005) did not include Mozambique in the species account under Distribution, but confusingly it is mentioned in Geographical Variation under subspecies *marwitzi* '…Zimbabwe, extreme w Mozambique, and e Limpopo province…' and 'Extralimitally to Angola, Zambia, n Mozambique…' but no specific sources were given to underpin reports in Mozambique.

However, there are three recent records in eBird, of which one is supported by field notes and photographs that document the first record for Mozambique. On

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19 May 2019 OH & ZH were searching for a Mascarene Martin seen the previous day at Macaneta. Several hirundines were seen perched on overhead wires, including Lesser Striped Swallows *Cecropis abyssinica*, a White-throated Swallow, the Mascarene Martin and a Pearl-breasted Swallow. The latter resembled a Northern House Martin *Delichon urbicum* but lacked a white rump. It conveniently lifted its wings to reveal the distinctive white underwing-coverts confirming the identification (Fig. 4). The bird was not seen again despite searches the next day. Its occurrence fits with the timing of the northbound post-breeding movement outlined above (Tree 1986).

In addition, there is a sighting of two at Pafuri, just 200 m inside Mozambique, on 31 March 2017 (A. Hogue & H. Stevens *in litt*. 2017; https://ebird.org/checklist/S37103572) and four at Massinghir Dam, near Limpopo National Park, on 8 August 2018 (K. Coetzer *in litt*. 2018; https://ebird.org/checklist/S49230616). These two records lack supporting details but fit the expected pattern of occurrence in the South Africa border region of Mozambique as predicted by Clancey (1996).

Figure 4. Pearl-breasted Swallow *Hirundo dimidiata*, Macaneta, Mozambique, 19 May 2019; the first documented record for Mozambique (Olivier Hamerlynck)

RED-BREASTED SWALLOW *Cecropis semirufa*

Widespread in equatorial Africa and a migrant to northern and western parts of southern Africa, nesting in the austral summer (September–April). Irwin (1981) noted that Mosque Swallow *C. senegalensis* generally replaces it at lower elevations in Zimbabwe, notably in the major river valleys of the Southeast Lowveld.

National and subregion accounts (Clancey 1996, Parker 2000, 2005, Hockey *et al*. 2005) report this species to be of very restricted distribution in Mozambique (*contra* the map in Urban *et al*. 1992). It was first recorded in Rio Savane, near Beira, on 15 August 1968 when O. E. Baddeley collected two at a nest (Clancey 1996) and 1–2 pairs were found breeding by R. K. Brooke at Vila Pery (= Chimoio; no year given; Clancey 1996). More recently, Parker (2000) found the species along the Mozambique border with South Africa abutting Kruger National Park, at two localities on the south side of the Save Delta, and at three in the Save and Gorongosa basins slightly further north (Parker 2005). He also cited two further records, from near the Zimbabwe border in Tete province and the southern Zambezi Valley, but discounted others from Ocitene and Villa Ulungue, Tete province (Herdam 1994), suggesting they involved confusion with Red-rumped Swallows *Hirundo daurica*. Parker (2005) found the latter to be an uncommon summer migrant around marshes on the Angonia Plateau of north-east Tete province. There is a recent record from the Maputo area of a pair attempting to nest in a culvert at Macaneta on 31 October 2015 (GA & J. Allport; https://ebird.org/checklist/S25669150), but the species was not seen thereafter despite regular coverage of the site until 2019.

Across its range Red-breasted Swallow is mostly encountered in pairs where suitable nest sites are available, usually in road culverts or other concrete structures; the species is quite

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striking and not easily overlooked. It is likely, therefore, that recent records in Mozambique indicate a range expansion probably in response to infrastructure development, resulting in increased availability of man-made nest sites (especially road culverts using concrete pipes), and also possibly due to woodland clearance and fragmentation, creating more of its favoured open areas (Jackson & Spottiswoode 2004). In South Africa there has been a significant range extension into the littoral plain of north-east KwaZulu-Natal, with birds occupying man-made structures for breeding (Hockey *et al*. 2005).

This species is therefore likely to have extended its range into the Mozambique littoral during the last 50 years, but it remains very uncommon. There is a sharp contrast in frequency along the border with South Africa, especially abutting Kruger National Park, where there is a high reporting rate in SABAP from the park's lowlands, but this rapidly falls away to nothing within a few kilometres across the Mozambique border (SABAP2 database). There is sufficient observer coverage in this part of Mozambique to be confident that it is a true difference in abundance.

GREATER STRIPED SWALLOW *Cecropis cucullata*

This intra-African migrant is a near-endemic breeder to the southern African subregion, nesting in the austral summer across open montane and coastal lowland grasslands of central and southern South Africa. It also breeds in Lesotho and western Eswatini, Namibia, and widely across the Zimbabwean plateau above 1,200 m, but is numerous only in the Manica Highlands (Irwin 1981, Hockey *et al*. 2005). It spends the austral winter in southern DR Congo and Zambia (Urban *et al*. 1992), and the latest arrivals in the austral spring are in the south-east of the breeding range, e.g. September–October in Eswatini (Parker 1994) and KwaZulu-Natal (Cyrus & Robson 1980); migration probably follows a westerly route (Harrison *et al*. 1997).

Status in Mozambique is unclear. It was reported breeding on the Mozambique / Zimbabwe border at 'Inyanga' by Snell (1969; now Nyanga, Zimbabwe, the nearest border area being adjacent to Serra Choa; see Blue Swallow above) and has been seen as a migrant in adjacent South African Kruger National Park and in northernmost KwaZulu-Natal (Harrison *et al*. 1997, SABAP2 database). Based on this—and along with several other species—Clancey (1996) reported that it 'Almost certainly occurs occasionally in Mozambique', which may be true but there are no documented records in Parker (2000, 2005), the SABAP2 database or eBird. Cizek (2009) reported a single, in rolling grasslands of Serra Choa in March 2008, as the first record for Mozambique. The observer is familiar with the species and there is no reason to doubt the sighting, but there is no documentation. Also, the species is included without details in the bird list for Chimanimani (Timberlake 2017).

The only detailed report is recent. On 31 March 2019, two adults were seen in a mixed group of aerial feeders around a small river bridge on the main road (N1) north of Manhica (25°09′3.6″S, 32°48′25.2″E). Behaving as a pair, they were seen entering a culvert under the main road several times. The birds were seen well and their larger size was clearly discernible alongside Lesser Striped Swallows, while the smaller stripes on the breast and overall paler coloration made the identification clear (J. Buggs-Balmer *in litt.* 2019). This sighting appears to be of a breeding pair late in the season.

The species' westerly migration route makes it less likely that Greater Striped Swallow would wander into Mozambique than might be expected based on its abundance and migratory habits in the subregion; but a vagrant spring overshoot in September–October seems the most likely period for the species in Mozambique, making it perhaps surprising that this record involved a breeding pair.

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Discussion

The distributional limits of all of the species discussed above, except Mascarene Martin and Eastern Saw-wing, coincide with southern Mozambique's international borders with South Africa and Zimbabwe in this part of their ranges, and this boundary is characteristic of a suite of other bird species too. These limits follow the boundary between two of the eight biogeographical regions identified in Africa based on cluster analyses of bird distributions (Linder *et al*. 2012). The 'South African' region lies inland on uplands to the west, and the 'Zambezian' savanna region covers the Mozambique littoral to the east; the boundary represents a step-change in climate, elevation and vegetation types.

The position of the current political borders of Mozambique with South Africa and Zimbabwe were determined in the late 19th century by the British and Portuguese governments. The borderlands were surveyed in detail by both parties and the delineation was based on the prevailing realities of colonial power (Pakenham 1990, Roque 2010). Portuguese colonisation was effectively maritime at that time, based around a series of coastal settlements, with expeditionary, piecemeal occupation of the littoral, maintaining agricultural interests inland but with a strong focus on coastal trading. In contrast, British occupation was focused on lucrative mineral interests in the Highveld of modern-day Mpumalanga and Gauteng provinces, South Africa, and Britain had the upper hand in negotiations with the Portuguese state, which was then near-bankrupt (Pakenham 1990). It is a remarkable coincidence that these two competing colonial interests met at a border coinciding with a clear biogeographical boundary.

All the species reported here are members of the guild of aerial insectivores, however, it is still notable that there have been several records of locally rare species together in very short periods of time at certain sites. Clancey *et al*. (1969) first noted Mascarene Martin in the region at Inhaminga among a huge concentration of aerial feeders, but records of Eastern Saw-wing and Mascarene Martin at Phinda were not apparently part of larger movements with no notable influxes of other species (DD pers. obs). Records of Mascarene Martin, White-throated and Pearl-breasted Swallows at Macaneta were the only hirundines present at the time (except locally breeding Lesser Striped Swallows). These exceptional rarities used a short section of wire over three days, with no similar records at this well-watched locality before or since. Co-occurrence of this sort is hard to explain.

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Appendix: Gazetteer of localities mentioned in the text.

Locality	**Coordinates**
Mozambique	
Catandica	18°03′40.0″S, 33°10′58.0″E
Dondo	19°36′54.7″S, 34°43′43.9″E
Espungabera	20°26′55.7″S, 32°46′30.5″E
Inhaminga	18°25′04.1″S, 35°01′45.4″E
Inhamitanga	18°13′12.0″S, 35°09′55.4″E
Maputo	25°56′38.8″S, 32°36′54.9″E
Mt. Gorongosa	18°25′37.6″S, 34°06′07.3″E
Mt. Milanje	16°05′02.4″S, 35°48′09.7″E
Mt. Namuli	15°22′14.4″S, 37°03′01.8″E
Mt. Tsetserra (or Tsetsera)	19°23′34.3″S, 32°47′32.9″E
Panda	24°03′56.5″S, 34°43′50.7″E
'Penhalonga' Farm	18°49′43.47″S, 32°43′21.20″E
Serra Choa	*c*.17°59′17.6″S, 33°01′13.4″E
Tantara	19°37′29.47″S, 32°52′36.27″E
South Africa	
Crooks Corner, Kruger National Park	22°25′34.5″S, 31°18′27.1″E
Imagine Pan, Phinda Private Game Reserve	27°48′30.6″S, 32°20′45.6″E
Malawi	
Lake Chilwa	15°19′47.1″S, 35°42′35.3″E

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Ethno-ornithological notes and neglected references on the Harpy Eagle *Harpia harpyja* in western Venezuela

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Summary.—Harpy Eagle *Harpia harpyja* has been documented only recently (2004) in the Lake Maracaibo basin of western Venezuela, specifically in the central Sierra de Perijá, at 1,100 m. Observations in the southern plains of the basin are reported from heretofore neglected sources published in 1599, 1889 and 1893. Two overlooked photographs of dead birds dating from 1947–51 (Perijá Mountains) and 1959 (Santa Bárbara del Zulia) are reproduced. Several other records are established (in 1974, the 1980s, 1994/95, 2002 and 2006), based on empirical observations and material evidence collected by anthropologists who have visited the still heavily forested area inhabited by the Barí people since the early 1960s. Circumstantial evidence of the use of Harpy Eagle bones and feathers by the indigenous Barí provides additional ethno-ornithological information. Although Harpy Eagle is currently categorised as Vulnerable in Venezuela, the cumulative historical evidence coupled with Species Distribution Modelling analysis predictions of suitable habitat locally available to the species suggests it might still be frequent in the western and southern Lake Maracaibo basin, where considerable expanses of tropical forest are conserved within four major protected areas and an indigenous reserve.

> '*Griffons I have never felt to exist, although in the land of Veneçuela they vouchsafe that, in ancient times, one followed a man who was hunting on horseback, who approached it to see what it was, and as he drew close, it threw itself suddenly over him, and when he recognised it he fled with his horse, and it followed him half flying, up to a river into which this man threw himself with his horse, swimming, and the Griffon remained on the shore; and telling of this case he gave the natural features of a Griffon*' (Vargas Machuca 1599: 154; translated by ALV & CJS)

This ancient Spanish chronicle referring to an encounter with a 'griffon' in the 'land of Veneçuela' has a claim to be the earliest record in the country of Harpy Eagle *Harpia harpyja*. This assumption of identity can be supported on environmental and behavioural grounds: first, the anecdote probably occurred in the lowlands, where rivers are of sufficient width and depth for a horse to swim through. A bird of similar imposing size, like Andean Condor *Vultur gryphus*, could not have been the subject, as it almost exclusively inhabits the high Andes (Fjeldså & Krabbe 1990). Second, the horseman was attacked and followed by the animal, and managed to get a close enough look at the bird to 'recognise it', which is not easily achieved with most of the largest Neotropical raptors, except *Harpia harpyja*, whose lack of wariness around humans is proverbial and has long been known to attack people (e.g., Linnaeus 1758, Rettig 1978). In contrast, another very large, rather similar and partially sympatric raptor, the Crested Eagle *Morphnus guianensis* does not share this behaviour. This allegedly makes Harpies easy and irresistible targets for hunters, who are considered the main cause of the current decline (Álvarez-Cordero 1996, Stattersfield & Capper 2000, Hilty

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2003, Trinca *et al*. 2008, Bierregaard *et al*. 2015, BirdLife International 2017, Schulenberg 2020).

If correctly interpreted, the record is especially interesting, for it illustrates the mythological dimension that Europeans afforded animal species in the Americas that lacked equivalent to any commonly found in the Old World. Furthermore, the historical context to this incident raises interesting zoogeographical questions, as four centuries ago the name 'Veneçuela' was applied to a province today represented by central and western parts of Venezuelan territory, a region where modern records of the species are very scarce and hitherto rather local.

Harpy Eagle, the largest Neotropical accipitrid and the world's most powerful bird of prey, occurs from southern Mexico to extreme north-east Argentina and southern Brazil (Rettig 1977, Hilty & Brown 1986, Sick 1988, Álvarez-Cordero 1996, Bierregaard *et al*. 2015, Schulenberg 2020). The species is distributed in lowland tropical forests, usually below 800 m, with a handful of documented sightings to 1,700 m (Bierregaard *et al*. 2015, Dove *et al*. 2018), including a previous record in Venezuela at 1,100 m (Ascanio & León 2004, Ascanio *et al*. 2017; see below). Some early records for Venezuela are from Bolívar state (Kavanayén and Salto Pará) and the north Coastal Range (Cumbre de Valencia, Rancho Grande, Caracas and río Chico) (Röhl 1956, Phelps & Phelps 1958, Meyer de Schauensee & Phelps 1978, Phelps & Meyer de Schauensee 1979). The rare presence of the species in the latter region has recently been confirmed (Ascanio *et al*. 2017, eBird 2020). Later, radio-tracking and sight records of Harpy Eagles have come from north of the Orinoco River in the Interior Range in Guatopo (Vargas *et al*. 2006), the *llanos* (Gómez Carredano 1994) and Caño Colorado (Redman 2008, Urbani *et al*. 2012). South of the Orinoco the species is widely distributed in Bolívar, Amazonas and the Orinoco Delta (Álvarez-Cordero *et al*. 1996, Lentino & Colvée 1998, Hilty 2003, Blanco 2009, Ascanio *et al*. 2017, eBird 2020).

Most comprehensive and recent ornithological works, to the start of the 21st century, do not mention the species for western Venezuela and adjacent Colombia (Hilty & Brown 1986, 2000, Hilty 2003), and none has provided documented records (Restall *et al*. 2006).

Distributional records given by Röhl (1956) relied mainly upon historical sightings by foreign travellers in Venezuela, such as Schomburgk (1840) and Appun (1871). A detailed scrutiny of both accounts reveals that Appun did obtain two old, stuffed specimens of Harpy Eagle from inhabitants of the village of San Esteban, in the foothills of the Coastal Range.

Röhl, an outstanding scholar of Venezuelan natural history, was interested in the contributions of European naturalists and travellers in Venezuela, particularly Germans (Röhl 1948). Despite his deep knowledge of the scientific work of Anton Goering (1836–1905), Röhl apparently failed to document (or rejected) Goering's observations concerning the presence of Harpy Eagle in the lowlands of the southern Lake Maracaibo basin. This news first appeared in the relatively obscure cultural magazine, *El Zulia Ilustrado*: 'Needless to say, raptors abound in that region, and during our journey we had occasion to witness their deadly fights. We even managed to see the largest of all, called the Harpy, which establishes its dwelling in the highest crowns of the trees of the virgin jungle, whence it probably lies in wait for a sloth…' (Goering 1889: 42). Goering's first report was cited the same year in an illustrated article devoted to the species (Fig. 1): 'Although it is not common, this bird also is found in the vast forests of Zulia; the German traveller Goering talks about it…', '…an individual captured in the headwaters of one of our great rivers can be seen in the menagerie in the beautiful house of Mr. C. Witzke, Consul of Denmark in this city [= Maracaibo]' (López-Rivas 1889: 108). On a second occasion Goering referred to an alleged Harpy Eagle in the forests of Onía, near Caño del Padre (1893: 26, 1962: 68): 'before dawn, I

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Figure 1. Engraving by an unknown artist, illustrating an article by Eduardo López Rivas about an encounter with a Harpy Eagle *Harpia harpyja* in western Venezuela (from *El Zulia Ilustrado*, Maracaibo 1889). The specimen depicted might represent a juvenile Harpy Eagle or possibly that of a Crested Eagle *Morphnus guianensis*, a species also found in the region.

saw in the heights, describing circles in the air, a *Harpya destructor* [*sic*], the most powerful eagle of South America. This majestic bird that surpasses our Royal Eagle [= Golden Eagle *Aquila chrysaetos*] in size, first seemed to me to be sighting a prey; however it later dropped, perching on a bare branch of a gigantic tree; I took advantage of the fortunate moment to observe as I pleased with my field glasses as if it were in front of me, its position and movements. Not long afterwards it lifted off again and disappeared in the thick vegetation'. In this case the behaviour described does not fully accord with that of Harpy Eagle. Goering perhaps misidentified a Crested Eagle, another very large predator, which does routinely soar and has a similar juvenile plumage. It is even rarer in the Lake Maracaibo basin, having only been documented on the east side in 2017 (eBird 2020). This is not unlikely, even if Goering was reputably well acquainted with birds; he was a professional collector for European museums and menageries, a taxidermist and world-famous natural history illustrator. His narrative is illustrated with a lithograph clearly representing a Harpy Eagle based on his own painting (Goering 1893: 25; Fig. 2).

A report by the late E. Mondolfi (pers. comm. to E. Álvarez in 1982) of a fledgling shot in 1959 near Santa Bárbara del Zulia in the southern Lake Maracaibo basin is supported by a photograph (Fig. 3; see also Álvarez-Cordero 1996).

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Figure 2. Lithograph of a Harpy Eagle *Harpia harpyja* from the lowland forest of the southern Lake Maracaibo basin, based on a painting by Anton Goering (Goering 1893).

Further documentary research has also yielded an impressive photograph of a group of Yukpa natives from the middle río Atapsi on the east slopes of the Sierra de Perijá (*c*.800–1,300 m, at the western border of the Lake Maracaibo basin) holding a dead Harpy Eagle (Fig. 4). It was taken by H. Ginés during an expedition of the Sociedad de Ciencias Naturales La Salle to these remote mountains, sometime during 1947–51 (Hoyos 1988). It is somewhat puzzling, however, that as Ginés was an ornithologist he did not mention the species in his comprehensive, annotated list of birds of the Perijá Mountains (Ginés *et al*. 1953).

More than 50 years later, on 18 July 2004, D. Ascanio photographed two Harpy Eagles at 1,100 m in the Lajas River basin, *c*.50 km north-northeast of the río Atapsi (Ascanio & León 2004). This record permitted López-O. *et al*. (2014) and Ascanio *et al*. (2017) to include the Venezuelan side of the Perijá Mountains within the species' known distribution.

On 27 October 2006, while conducting field work in the southern Perijá Mountains, one of us (PAB), found an abandoned nest of Harpy Eagle nearly 30 m above ground on the main branch of a *Ceiba* tree in premontane forest, near one of the northern tributaries of the río del Norte (09°23′1.18″N, 73°01′33.25″W; 210 m). It was identified by its dimensions (diameter 305 cm, depth 95 cm) and situation, in a main fork, and being constructed of thick branches mean 8.6 cm in diameter. Such a nest is clearly bigger than, and different from,

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Figure 3. Photograph taken by an officer of the Venezuelan Ministerio de Agricultura y Cría in the airport of Santa Bárbara del Zulia (1959). Local people holding a recently shot grown juvenile Harpy Eagle *Harpia harpyja* (with permission of E. Mondolfi† to PAB)

that of Crested Eagle (e.g., diameter 220 cm, depth 42 cm, branch thickness 3.5 cm, usually sited in secondary forks; PAB unpubl.). Associated with this nest were bones of several mammal species: White-fronted Capuchin *Cebus albifrons* (one skull), Venezuelan Red Howler *Alouatta seniculus* (one skull each of a juvenile and an adult), Northern Tamandua *Tamandua mexicana* (one skull), Hoffmann's Two-toed Sloth *Choloepus hoffmanni* (two skulls, three humeri, two femurs); and the pelvic girdle of a large bird, possibly a Yellow-knobbed Curassow *Crax daubentoni*.

In this region, the Barí, another indigenous people in the Sierra de Perijá, have reported killing several Harpy Eagles in the last 38 years. Anthropologists visiting their territory since the early 1960s learnt of the presence of this species not only via cultural reference but also occasional observations of the bird itself. An individual was seen by one of us (ML) and his father, R. Lizarralde, in July 1974 atop the Serranía de Abusanqui, north of the Aricuaisá River, on the trail from 'Hacienda el Rodeo' to the village of Saimadoyi. In interviews with the Barí of Saimadoyi in April 1990, ML questioned them about the names of different birds using the illustrations in Meyer de Schauensee & Phelps (1978) as reference. They recognised the Harpy Eagle and named it 'bakóoba' or 'banko-banko'.

In addition to these anecdotal reports, ML was able to collect empirical evidence in their support. Firstly, in the late 1980s a Barí man (names of informants are not revealed for their protection) possessed a 7–8 cm-talon of a Harpy Eagle he had hunted in *c.*1983 in the community of Aruutatakae (at the south-west corner of Ciénagas del Catatumbo National Park and 20 km north of the río Catatumbo from the village of Campo Rosario). The difference in talon size between Harpy and Crested Eagles is significant: that of a Harpy can be twice or three times the size of a Crested Eagle's, based on measurements

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Figure 4. Photograph taken by Hermano Ginés during an expedition of the Sociedad de Ciencias Naturales La Salle to the Sierra de Perijá (at the western border of the Lake Maracaibo basin, *c.*1947–51), showing a group of natives (Yukpa) from the Atapsi River valley holding a recently shot adult Harpy Eagle *Harpia harpyja* (from Hoyos 1988, with permission)

taken of live birds by PAB, who has measured 47 Harpy (mean 8.6 cm for $n = 20$ males; 12.3 cm for $n = 27$ females) and 12 Crested Eagles (mean 3.5 cm for $n = 5$ males; mean 4.8 cm for $n = 7$ females).

The Barí informant explained that in his culture, this talon is a talisman that helps improve their aim while hunting, invoked by cupping their hands around the talon while closing their eyes and chanting their 'secrets'. These specialised chants are known only by a few elders. 'Secrets' are similar to Buddhist mantras that are whispered and repeated many times. This Barí stated that the Harpy Eagle's vision is very powerful and the one holding its talon acquires exceptional vision with the help of the 'secrets' (R. Lizarralde pers. comm. 2004).

Also, twice ML witnessed a feather-fan being used to blow air on kitchen fires. The first was in the home of a Barí at Saimadoyi (at the confluence of the Baksarani and Bachichida Rivers) in January 1995. This fan comprised the tail and primary feathers of two Harpy Eagles, one adult and one juvenile, identified by P. W. Trail (see Fig. 5). The feathers of the adult were harvested in August 1994, 15 km south of Saimadoyi in the headwaters of the río del Norte (at the foot of the Sierra de Perijá). According to this Barí, while carefully aiming his shotgun at a curassow high in the forest canopy, a Harpy Eagle struck the target with its talon. The shotgun blast hit both birds, killing the Harpy Eagle too. This hunter kept one of the eagle's talons as a talisman. The second occasion was in June 2002, in the northern headwaters of the río Lora, when ML saw a different feather-fan in a kitchen owned by another Barí. This fan was made of 15 or 18 tail and wing feathers of another Harpy. When asked about these feathers, he claimed they were from an eagle he had hunted in the upper

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Figure 5. Top to bottom: two fresh rectrices of Harpy Eagle *Harpia harpyja*, a smaller worn tail feather or secondary of a Harpy or Crested Eagle *Morphnus guianensis*, and a Harpy Eagle primary (P. W. Trail *in litt*. to CJS, September 2016). These are from at least one or more large eagles taken by Barí people in the headwaters of the río del Norte, south of the village of Saimadoyi, in the Sierra de Perijá, Venezuela, August 1994.

Serranía de Abusanqui, a few km west of his house. Identification in this case was based on standard ethnozoological methods, in which the witness determined the species concerned using an illustrated field guide.

The locations of the sightings described are similar, with little human presence and abundant fauna, especially spider (*Ateles*), howler (*Alouatta*) and capuchin (*Cebus*) monkeys, and several species of cracids (Lizarralde 2002, 2019, 2020). Therefore, Ciénagas del Catatumbo National Park, the southern Serranía de Abusanqui, and the upper Barí part of the Sierra de Perijá possess abundant food for Harpy Eagles (Beckerman & Lizarralde 2013, Lizarralde 2019, 2020).

Conclusions

The historical and recent data presented here (Fig. 6) reveal that the occurrence of Harpy Eagle in the Lake Maracaibo basin was overlooked by ornithologists during the 20th century, particularly in the Perijá Mountains and the Catatumbo lowlands despite the production of several avifaunal monographs during that period (Phelps 1943, Ginés *et al*. 1953, Seijas 1984, Viloria & Calchi 1993).

The lack of awareness of such a large bird of prey is unsurprising, as several other large and conspicuous vertebrates frequent in those regions remained either unknown or unconfirmed until recently. Notable are other raptors such as Andean Condor (Calchi & Viloria 1991) and Solitary Eagle *Buteogallus solitarius* (CJS unpubl.), as well as Spectacled Bear *Tremarctos ornatus* (Viloria *et al*. 1997), the endemic Zulia Toad-headed Sideneck *Mesoclemmys zuliae* (Pritchard & Trebbau 1984, Trebbau & Pritchard 2016), and the fish Dorada *Brycon polylepis* (Moscó-Morales 1988).

Harpy Eagle is rare and declining throughout the Neotropics (Vargas *et al*. 2006, Bierregaard *et al*. 2015, BirdLife International 2017). It generally requires large, uninterrupted expanses of rainforest to survive, although it will nest in areas disturbed by logging, intermixed with patches of pristine vegetation (Blanco 2007). Its range has been contracting (and population probably decreasing) over the last few decades, and in addition to having been extirpated locally, it is now very scarce over most of Middle America and at the southern

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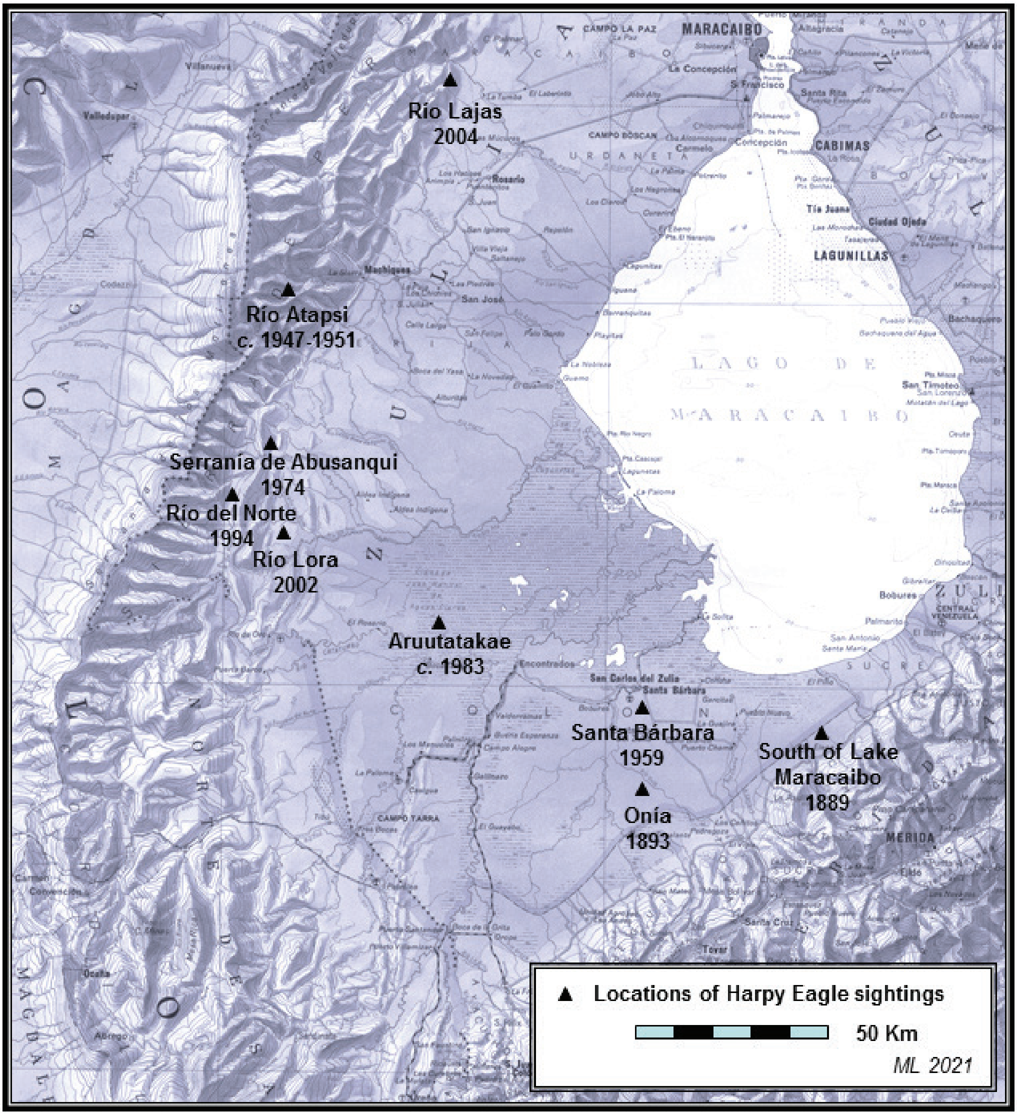

Figure 6. Map of the western and southern Lake Maracaibo basin in northern South America (Venezuela and Colombia) showing the location of Harpy Eagle *Harpia harpyja* records mentioned in the text.

edge of its range in north-east Argentina and Paraguay. The main threats are a combination of reduction of habitat and direct hunting (Álvarez & Ellis 1994, Álvarez-Cordero 1996, Stattersfield & Capper 2000, Blanco 2007, 2009, Trinca *et al*. 2008, Blanco & Álvarez 2009, Bierregaard *et al*. 2015, BirdLife International 2017, Schulenberg 2020). As a result, the species is considered globally Near Threatened, nearly meeting criteria A2cd+3cd+4cd (a reduction in range and/or habitat quality plus elevated levels of exploitation; IUCN 2001, BirdLife International 2017).

In Venezuela, Harpy Eagle is considered Vulnerable at the national level (Sharpe 2008, Sharpe *et al*. 2015), a status enshrined in national legislation (Venezuela 1996a,b). The records presented here and predictions based on Species Distribution Modelling (SDM) analysis (Miranda *et al*. 2019) suggest that the species might still be frequent in the

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southern and western Lake Maracaibo basin, where considerable areas of tropical forest are conserved within four strict protected areas and an indigenous reserve: Catatumbo-Barí Natural National Park (IUCN Cat. II; 1,581 km^2) in Colombia; Sierra de Perijá (IUCN Cat. II; 2,953 km^2) and Ciénagas del Catatumbo (IUCN Cat. II; 2,694 km^2) National Parks, Ciénagas de Juan Manuel Wildlife Reserve (IUCN Cat. IV; 715 km^2) and the Barí Indigenous Reserve (2,320 km^2; Lizarralde & Lizarralde 2002, Lizarralde & Lizarralde 2015, expanding Barí territory from 2,000 km^2 first decreed by the government [Venezuela 1961]) in Venezuela. We recommend that local ornithologists urgently instigate a population assessment plan in western Venezuela and search for the species in neighbouring Colombia.

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The holotype of *Diomedea fusca* Hilsenberg (Diomedeidae) and its fate

by Jiří Mlíkovský

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Sooty Albatross *Phoebetria fusca* (Hilsenberg, 1822a) is a widespread but uncommon bird of the South Atlantic and Indian Oceans (Carboneras *et al*. 2020). My search of the literature showed that the circumstances of its discovery and original description are incorrectly reported in major reference works. However, after my paper on the correct original description, the type of the species and its type locality had been accepted for publication, Bruce (2021) dealt with the same issues and reached the same conclusions. However, Bruce (2021) was unaware of the possible fate of the holotype, which is discussed here.

As correctly noted by Bruce (2021), *Diomedea fusca* was described by Hilsenberg (1822a). This was part of a letter written by Hilsenberg on 16 August 1821 from 'Isle de France' (= Mauritius) and addressed to Sieber, who forwarded it to the editors of *Zeitung für die elegante Welt*, published in Leipzig, Germany. Karl (or Carl) Theodor Hilsenberg (1802–24) was a German collector then working for Franz Wilhelm Sieber (1789–1844), a Czech botanist, traveller and collector (Leng 1825, Legis-Glückselig 1847, Weitenweber 1852, Dietrich 1881, Ducker 1990).

Hilsenberg (1822a: col. 1163–1164) explicitly stated that he had just one specimen of his new *Diomedea fusca*, which was shot on 23 June 1821 in the 'Kanal von Mozambique' (= Indian Ocean south of Madagascar). Furthermore, Hilsenberg (1822a: col. 1164) reported that he had prepared the specimen according to Natterer's instructions and that he would send it to Sieber with his first shipment ('mit der ersten Sendung'). Sieber was based in Prague, Bohemia, at the time (Hilsenberg 1822b). The shipment including a number of unspecified birds arrived at Marseille, France, on 7 August 1822 (Legis-Glückselig 1847: 38). Sieber checked it there, then forwarded it to Prague, but its fate thereafter is unknown. Sieber continued from Marseille to Australia, circumnavigated the world, and returned to Prague only in August 1824 (Legis-Glückselig 1847). It is unknown if the albatross was among the birds that reached Marseille with the above-mentioned shipment. In any event, the specimen is not in the natural history museums of Prague (Mlíkovský 2010, Mlíkovský *et al*. 2011; unpubl.) or Vienna, Austria (Schifter *et al*. 2007), then the central museum of the Habsburg monarchy, where Joseph Natterer (1786–1852) worked.

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Breeding ecology of Rufous Casiornis *Casiornis rufus* in south-east Brazil

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Summary.—We present new reproductive information for the Rufous Casiornis *Casiornis rufus*, based on studies undertaken during 1991–99 and in 2018, in the municipality of Arcos, Minas Gerais, south-east Brazil. We found eight nests, all sited in cavities of dead trees or wooden fence posts, on average 62.8 cm above ground. Clutch size was usually three eggs, pale beige overlain with complex markings throughout, similar to those of the genus *Myiarchus*. Eggs measured on average 22.8 × 16.96 mm, mass *c*.3 g. Incubation lasted *c*.15 days, and nestlings remained in the nest 15–17 days, being fed by both adults, mainly with orthopterans. Three of the eight nests produced young that fledged. One nest was predated by both a Black-striped Capuchin *Sapajus libidinosus* and a Crane Hawk *Geranospiza caerulescens*, and another by a Black-tufted Marmoset *Callithrix* cf. *penicillata*. Nests were constructed in August, and the last nestlings fledged in late October. Most aspects of the breeding ecology of *Casiornis* are identical to those of other members of the Myiarchini.

The genus *Casiornis* comprises just two species confined to South America (Dickinson & Christidis 2014). Ash-throated Casiornis *C. fuscus* is endemic to Brazil and is broadly distributed across the north-east of the country. Rufous Casiornis *C. rufus* occurs from northern Argentina and Uruguay (Claramunt & González 1999, Vizentin-Bugoni *et al*. 2015) to Tocantins in northern Brazil, also in Maranhão and Piauí (although it is largely absent from the Caatinga), and west to Acre, as well as Bolivia and (as a migrant) south-east Peru (de la Peña 1996, Sick 1997, Pacheco 2004, Pedroza *et al*. 2020, Scholes 2020, Scholes *et al*. 2020).

Both species are migratory. *C. fuscus* vacates the Caatinga, where it presumably breeds, during the dry season (April–October) moving into the Cerrado and eastern Amazonia (Lees 2016). *C. rufus* tends to migrate north during the austral winter (June–September) (Chesser 1994, Lees 2016, Capllonch 2018).

Nothing has been published on the reproductive behaviour of *C. fuscus* and very few data are available for *C. rufus* (Eisentraut 1935, Lanyon 1985, de la Peña 2005, Crozariol 2016), for which just one nest with a three-egg clutch has been described in detail, from Argentina (de la Peña 2005). There is no information on the species' incubation and nestling periods. Here we describe several previously unknown facets of the breeding ecology of *C. rufus*, as well as nest predation, based on observations made in south-east Brazil.

Materials and Methods

The nests described here were found during 1991–99 ($n = 4$) and in 2018 ($n = 4$) at various localities in the rural municipality of Arcos, in the Cerrado of central Minas Gerais (20°17'S, 45°32'W; 700–850 m). This area, in general, is heavily impacted by human activity, and the main natural vegetation are remnant secondary forests bordering cattle pastures. The avifauna and habitats found in this region were described by Lopes *et al*. (2017).

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Once an active nest was located, it was subject to brief visits every two days. At two nests containing young the interval between adult arrivals was recorded, by measuring the period between two consecutive visits to the nest, even if an adult individual was already inside it. In total, these two nests were observed for 967 minutes (274 minutes at the nest with three nestlings and 693 minutes at the nest with two nestlings). Observations were made from hides sited between 4 and 8 m from the nests. Two nests were monitored using a camera trap, which enabled us to identify predators. None of the nests was collected.

Results

Breeding season.—Eight nests were found, all active between the second half of August and the second half of October, with observations of nest construction and nests with eggs in August and the last young fledging in October (Fig. 1). Specifically, nests were located on 20 August 1991 (with three eggs), 15 September 1997 (three nestlings, *c*.2 days old), 20 August 1998 (two eggs, incomplete clutch), 23 August 1998 (building), 27 August 2018 (three eggs), 12 September 2018 (three eggs), 24 September 2018 (three nestlings, a day prior to fledging), and 5 October 2018 (two eggs, apparently complete clutch).

Nest characteristics.—Sites used for nesting were edges of secondary forests bordering pastures or around clearings, mostly in regenerating forests, with many broken, cut and fallen old trees. The understorey was generally rather open.

All nests were open cups, constructed of soft materials, and sited within cavities, either in tree stumps (*n* = 6) or wooden fence posts (*n* = 2) (Fig. 2A). Both stumps, usually broken off naturally at the top, and posts, had cavities in their upper portions caused by natural decay. In most cases, the cavity opening was positioned above the nest chamber. Twice, however, the nest was almost level with the entrance. One nest was constructed in a large log that had been cut and left lying on the ground, with one of its cut branches pointing up.

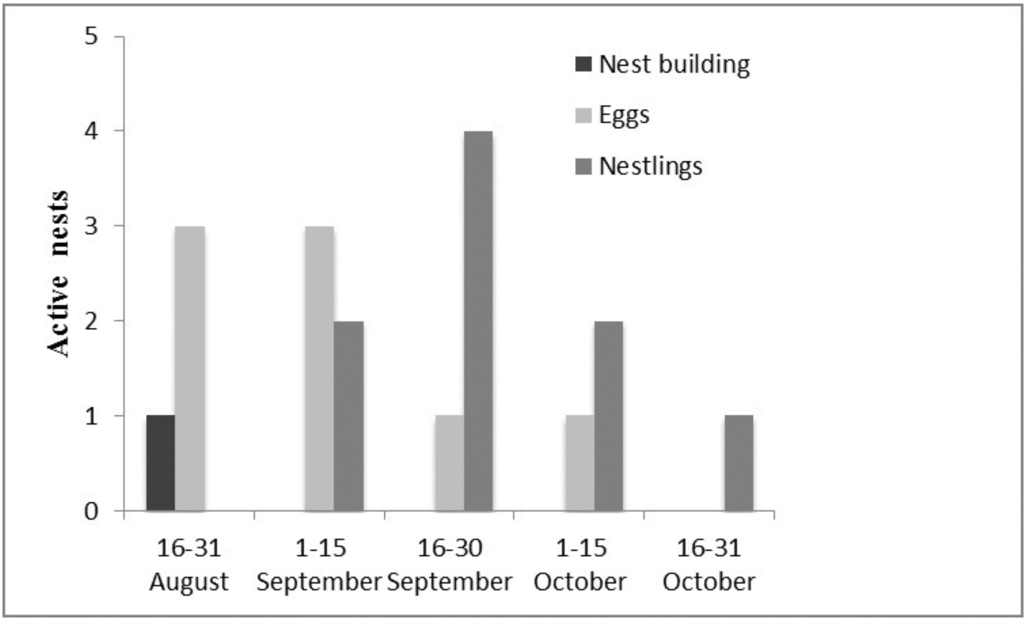

Figure 1. Reproductive period of Rufous Casiornis *Casiornis rufus* based on eight active nests found in Minas Gerais, Brazil; note that data from an individual nest may cover more than a single phase and two-week period.

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Figure 2. (A) Internal view of a Rufous Casiornis *Casiornis rufus* nest; (B) eggs of *C. rufus* from another nest.

A cavity had formed, as in other cases, due to the wood decaying, and this nest was closest to the ground. One of the stumps used for nesting was at the edge of a swampy area.

Nests generally were not very high above ground, between 22 and 120 cm (mean 62.8 ± 34.7 cm; $n = 6$). The diameter of the opening at one nest was 9 cm, and another 12 cm, whilst the access tunnel, measured from the cavity entrance to the nest, was 25–60 cm long (mean 41.6 ± 17.5 cm; $n = 3$). The internal diameter of one nest cup was 4 cm. The base of those cavities we could access ($n = 3$) was lined with soft materials such as mammal hair (e.g. of Tapeti *Sylvilagus brasiliensis* and rodents), shed snakeskin ($n = 2$), mammal skin ($n = 1$) and feathers ($n = 1$).

Eggs and incubation.—One nest was destroyed and of the remaining seven nests, one had two eggs, whilst the other six each had three eggs ($n = 4$) (mean 2.8 ± 0.44 eggs) or nestlings ($n = 2$), with a total mean of 2.85 ± 0.37. Egg size, based on two clutches ($n = 6$), was 21.0–24.2 mm (mean 22.8 ± 1.11 mm) × 16.6–17.2 mm (16.96 ± 0.29 mm), and mass was 2.9–3.1 g (mean 3.0 ± 0.07 g; $n = 5$). Shape was oval, and the ground colour was pale beige, overlain with complex markings throughout, especially irregular and narrow dark purple-brown streaks and larger blotches of a slightly paler colour (Fig. 2B). At two nests that were

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TABLE 1
Food items brought by adults of Rufous Casiornis *Casiornis rufus* to a nest with three nestlings during 274 minutes of observation, according to the age of the nestlings.

	Age (days)			
Food item	**7**	**12**	**17**	**Totals**
Spiders	1	1		2
Lepidoptera (adult)	1		1	2
Lepidoptera (caterpillar)	1		1	2
Homoptera	2	2	1	5
Orthoptera	8	5	2	15
Unidentified	4	3		7
Berry fruits	2			2

followed, the incubation period was apparently *c*.15 days, but both already had three eggs when found; in both cases the eggs hatched on the same day (synchronous hatching).

Nestlings.—Approximately 1–2 days after hatching, nestlings have pink skin with long but sparse blue-grey down, whitish commissure and yellowish mouth lining. At *c*.12–13 days, the feathers are similar in colour to those of the adult, but the throat region is slightly orange. At the two nests followed from hatching, the young fledged at 15 and 17 days, respectively. In a nest with three nestlings, which fledged on day 17, the first left the nest at 08.10 h accompanying an adult, whereas the others both fledged two minutes later, landing on a nearby vine.

Parental care.—In this species, in common with many Tyrannidae, there is no visible sexual dimorphism, so we were unable to distinguish the contribution made by each sex. We can affirm, however, that both individuals provisioned the young, because when one arrived with food in its bill and entered the nest, not infrequently the other also brought food to the nest simultaneously or it would wait nearby, taking its prey to the nest as soon as the other bird departed. This latter situation, when both individuals are in the nest or close to it, occurred in 11.1% of observations (from a total of 63 visits).

Two nests were followed, one with two and the other with three nestlings. At the nest with two young intervals between visits were longer (mean 16.72 ± 12.65 minutes; $n = 24$) compared to that with three nestlings (mean 7.58 ± 6.90 minutes; $n = 29$). We were unable to follow the nest with three nestlings in more detail because observation time was shorter (274 minutes). However, at the nest with two nestlings (693 minutes) intervals between visits tended to decrease as the young developed, from a mean 22.11 ± 18.38 minutes when they were two days old, to 15.63 ± 10.73 minutes at six days old and 12.66 ± 5.07 minutes when nine days old.

At the nest with three chicks, we observed 35 food items brought by the adults, most of which were invertebrates, especially Orthoptera (Table 1). We did not record the length of time adults stayed in the nest on each visit to provision the nestlings. Once, however, a visit lasted three minutes when an adult arrived with a cicada, which was torn apart and fed incrementally to each chick in turn. At this nest, we could partially view inside via a small hole in the broken bark. Usually, when food was delivered the adult immediately departed again, with some visits as short as 2–8 seconds. At times, however, an adult would remain longer in the nest, thereby increasing the interval to the next visit. Occasionally, adults vocalised nearby on arrival, giving the species' common call (a weak *psee* note; Scholes 2020), but most visits were silent. Adults carried faeces away from the nests following most visits, and sometimes on three consecutive occasions.

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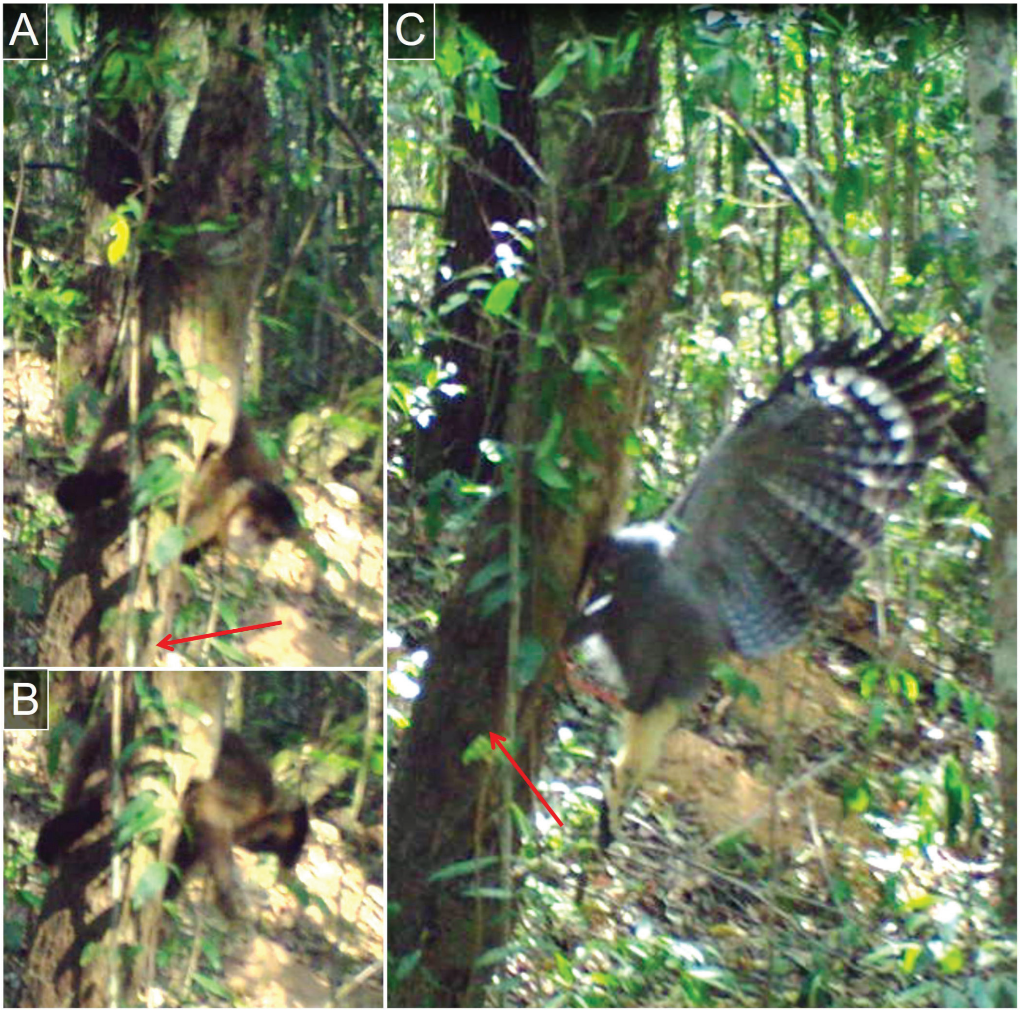

Figure 3. Evidence from a camera-trap of predation of the same nest of Rufous Casiornis *Casiornis rufus* by (A) Black-striped Capuchin *Sapajus libidinosus*, with its arm inserted in the nest cavity; (B) and examining the contents removed from the cavity interior; and on the same date by (C) Crane Hawk *Geranospiza caerulescens* with its right talon inserted into the cavity. Arrows indicate the nest's approximate location in the cavity.

Predation and loss of nests.—Of the eight nests found, three were successful, of which two fledged three nestlings each, and the remaining nest two. Of the five unsuccessful nests, one was found destroyed while still under construction (possibly after the first egg was laid, although this is not certain) and at another all three eggs disappeared. The other three nests failed during the nestling phase. In one of these, just one of the three eggs hatched, and the single nestling, already with well-developed feathering, was subsequently found dead with a thorn stuck in its throat, which the young had apparently attempted to swallow.

A nest with two nestlings was predated by a group of apparently three individuals of Black-striped Capuchin *Sapajus libidinosus*, at *c.*08.15 h. One of the monkeys inserted its arm into the cavity and with its hand seized a nestling, which was taken to the ground, next to the tree, and consumed. The animal then climbed the tree again, removed most of the nest material from the cavity, but apparently did not take any more nestlings (Fig. 3A–B). The monkeys remained in the vicinity for *c.*5 minutes. Subsequently, at 13.42 h, a Crane

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Figure 4. Evidence from a camera-trap of predation of a Rufous Casiornis *Casiornis rufus* nest by Black-tufted Marmoset *Callithrix* cf. *penicillata*: (A) the monkey entering the nest via the opening at the top of the stump, and (B) eating the nestling, head first. The arrow indicates the nest's approximate location in the cavity.

Hawk *Geranospiza caerulescens* landed at the entrance to the same nest and, from an upright position, inserted its head into the cavity, seemingly trying to detect any noise inside. After *c*.30 seconds, the raptor inserted its left leg completely into the cavity but, on failing to capture anything, reinserted its head. The hawk continued this behaviour for *c*.10 minutes, variously inserting either leg into the cavity (Fig. 3C). A few times it removed a considerable amount of material from the cavity, threw this to the ground, and then dropped down to investigate the contents. It proved impossible to confirm that a nestling was taken by the hawk, but as there were originally two chicks in the nest, and only one was seen to be eaten by the monkey, we suspect that the second was predated by the raptor.

Finally, another nest, also with two nestlings, was predated by two Black-tufted Marmosets *Callithrix* cf. *penicillata*, at 09.30 h. They were able to completely enter the large cavity where the nest was sited, seizing the nestlings at its base, and eating them, head first. From the video, one chick continued to flap its wings while being eaten (Fig. 4). The marmosets remained for *c*.10 minutes.

Ectoparasites.—In the same nest just described, prior to their predation both chicks were found to be infested by the larvae of flies of the genus *Philornis*. Some 28 larvae were removed from under the skin of the two nestlings.

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Discussion

The breeding period of *C. rufus* in this region of Minas Gerais appears well delimited, considering the span of observations between 1991 and 2018. Nest construction occurs mainly in the first half of August, and nestlings fledge principally in October or early November. In the state of São Paulo, a female with an enlarged ovary was collected in late August (Krabbe 2007), whilst in Argentina males were collected with well-developed gonads (5 × 4 mm, 9 × 5 mm; $n = 2$) in November (Darrieu & Camperi 1992), the same month when a nest was found with three eggs (de la Peña 2005). The WikiAves (WA) website has records of active nests in late August in Goiás (C. S. Rodrigues; WA2091799) and mid October in Minas Gerais (G. A. Serpa; WA747431), and fledglings in early September in Minas Gerais (M. T. Castro; WA153647) and late October in Goiás (F. R. Pina; WA834846).

The nests described here are consistent with the generally brief descriptions already available for the species (Eisentraut 1935, Short 1975, Lanyon 1985, Sick 1997, de la Peña 2005, Scholes 2020), although there is just one reasonably detailed description (de la Peña 2005; repeated in de la Peña 2013, 2016). Three eggs have been described previously, also from Argentina (de la Peña 2005), and these were similar in size and colour to those described here.

We present the first data on incubation period, a description of the nestlings, and the fledging period. Parasitism of nestlings by *Philornis* fly larvae had already been documented for the species in Argentina (Salvador & Bodrati 2013).

Almost nothing is known concerning other aspects of the natural history of *C. rufus*, and our dietary records, although limited in scope, are the most complete to date. In ten adult stomachs sampled in Mato Grosso do Sul, Brazil, nine contained insects alone, and one insects and fruits (Piratelli & Pereira 2002), with no details of the insects involved; contents of ten specimens reported by Vasconcelos *et al*. (2006) were similar. In Argentina, consumption of *Psychotria carthagenensis* fruit has been reported (Bodrati & Haene 2006, *apud* de la Peña 2016).

Monkeys of the genus *Sapajus* have previously been documented predating bird nests in cavities (Cockle *et al*. 2016), as have *Callithrix* (Gomes & Lima-Gomes 2011, Alexandrino *et al*. 2012). Crane Hawk *Geranospiza caerulescens* is also a known predator of animals in cavities or other places of concealment (Bokermann 1978a), including nestlings (Bierregaard *et al*. 2020).

Animal behaviour can provide valuable indication of evolutionary relationships (Whitman 1898, Wenzel 1992, Prum 1990) and, in birds, nest architecture is of proven value in this respect (Winkler & Sheldon 1993, Zyskowski & Prum 1999, Hall *et al*. 2015). For genus *Casiornis*, some earlier authors suggested that better knowledge of nests could inform its systematic placement (e.g. Snow 1973, Lanyon 1982, Lanyon & Fitzpatrick 1983). The nest of *C. rufus*, of the type 'cavity/with tunnel/low basket' (*sensu* Simon & Pacheco 2005), as well as use of hair, feathers and, principally, snakeskin to line the egg chamber, are closely aligned with the nests of most *Myiarchus*, as well as those of the genera *Ramphotrigon*, *Deltarhynchus* and *Rhytipterna* (Traylor 1977, Lanyon 1978, 1982, Parker 1984, Tostain 1989, Lebbin *et al*. 2007, Gomes & Barreiros 2011, Snow *et al*. 2017). Egg colour, incubation and nestling periods, are also consistent with these other genera (Bokermann 1978b, Lanyon 1982, Tostain 1989, Snow *et al*. 2017).

The genus *Casiornis* was long placed in the Cotingidae alongside the genus *Attila*, forming a subfamily Attilinae, based on the morphology of the tarsus (see Snow 1973). Subsequently, based on syringeal morphology, the genus *Casiornis* was removed with others from the Cotingidae, to the Tyrannidae, where it was grouped with *Myiarchus*

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(Ames 1971). Based on anatomical and behavioral studies (Lanyon 1982, 1985, Lanyon & Fitzpatrick 1983, Birdsley 2002, Donegan 2013), as well as molecular phylogenetics (Chaves *et al*. 2008, Ohlson *et al*. 2008, 2013, Tello *et al*. 2009), the genus *Casiornis* is now placed alongside the genera *Myiarchus*, *Rhytipterna* and *Sirystes* in the tribe Myiarchini. From the perspective of breeding ecology, our observations are consistent with the latter placement, although very few data are available for the genera *Sirystes* and *Rhytipterna* in this respect (see review in Crozariol 2016).

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A revised bird checklist for the oceanic islands of the Gulf of Guinea (Príncipe, São Tomé and Annobón)

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Summary.—We present an updated bird checklist for the oceanic islands of the Gulf of Guinea. Their avifauna comprises 146 confirmed species, an increase of 19% in 15 years. Of these, 66 are resident landbird species (32 on Príncipe, 50 on São Tomé and 11 on Annobón), including 29 endemic species, 17 endemic subspecies and 17 possibly non-native species. The remaining avifauna consists of six breeding seabird species, four non-breeding migrants, 62 vagrants and eight species of uncertain status. An additional 51 species have been reported but lack confirmation. Most recent changes reflect increases in observer activity and involve vagrant and unconfirmed species, but a few result from previously overlooked historical records and taxonomic changes. Of the three islands, most changes affected the avifauna of Príncipe, whereas little new information has come from Annobón. Future changes are predicted to arise from new reports and confirmation of vagrants, but also from further taxonomic revision of residents.

The oceanic islands of the Gulf of Guinea have long been known as a global priority for biodiversity conservation due to the outstandingly large number of endemic species (e.g., WWF & IUCN 1994–97, Le Saout *et al*. 2013, BirdLife International 2020a). In particular, their avifauna is unique and threatened (e.g., Collar & Stuart 1988, Stattersfield *et al*. 1998, Buchanan *et al*. 2011, Le Saout *et al*. 2013, BirdLife International 2020b, IUCN 2020).

Although one of the first descriptions of the islands provided a rather extensive list of bird species (Valentim Fernandes 1506–10 *in* Henriques 1917), ornithological research only started on the islands in the 18th century, when the first endemics, São Tomé Green Pigeon *Treron sanctithomae* and Príncipe Starling *Lamprotornis ornatus*, were described. Most of the endemic birds were described during the 19th and 20th centuries (Table 2). In recent decades, use of molecular techniques has revolutionised the systematics of the islands' birds. In addition to clarifying the taxonomic status of many bird populations (e.g., Melo 2007), these techniques have also afforded a better understanding of their evolutionary history and biogeography (e.g., Melo 2007, Valente *et al*. 2020).

Despite the acknowledged biological importance of these islands, much remains unknown, even among birds, the best-studied taxonomic group (Jones 1994). New endemic birds are still being identified, such as the putative Príncipe Scops Owl, whose presence was confirmed as recently as 2016 (Ryan 2016, Verbelen *et al*. 2016), and whose evolutionary distinctiveness is supported by multiple lines of evidence (Freitas 2019). Further studies might also prove other populations are best treated as endemic species, including the local population of Band-rumped Storm Petrel *Oceanodroma* cf. *castro* (Flood *et al*. 2019) and the distinctive São Tomé endemic subspecies of Barn Owl *Tyto alba thomensis* (Uva *et al*. 2018, Alves 2019), Lemon Dove *Columba larvata simplex* (Pereira 2013) and Chestnut-winged Starling *Onychognathus fulgidus fulgidus* (Christy & Clarke 1998). In addition, since much of the importance of these islands is based on the endemic-rich resident avifauna, less

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attention has hitherto been paid to other groups of species, namely aquatic and migrant species (de Lima & Martins 2020).

The most up-to-date bird checklist for the oceanic islands of the Gulf of Guinea mentions the occurrence of 118 species on the three islands of São Tomé, Príncipe and Annobón, their offshore islets and surrounding seas (Jones & Tye 2006). These include 28 endemic species among 62 resident landbirds, six breeding seabirds, seven non-breeding migrants, 34 vagrants, and nine species of uncertain status. Additionally, there were 45 unconfirmed species and 21 endemic subspecies. The present contribution revises the

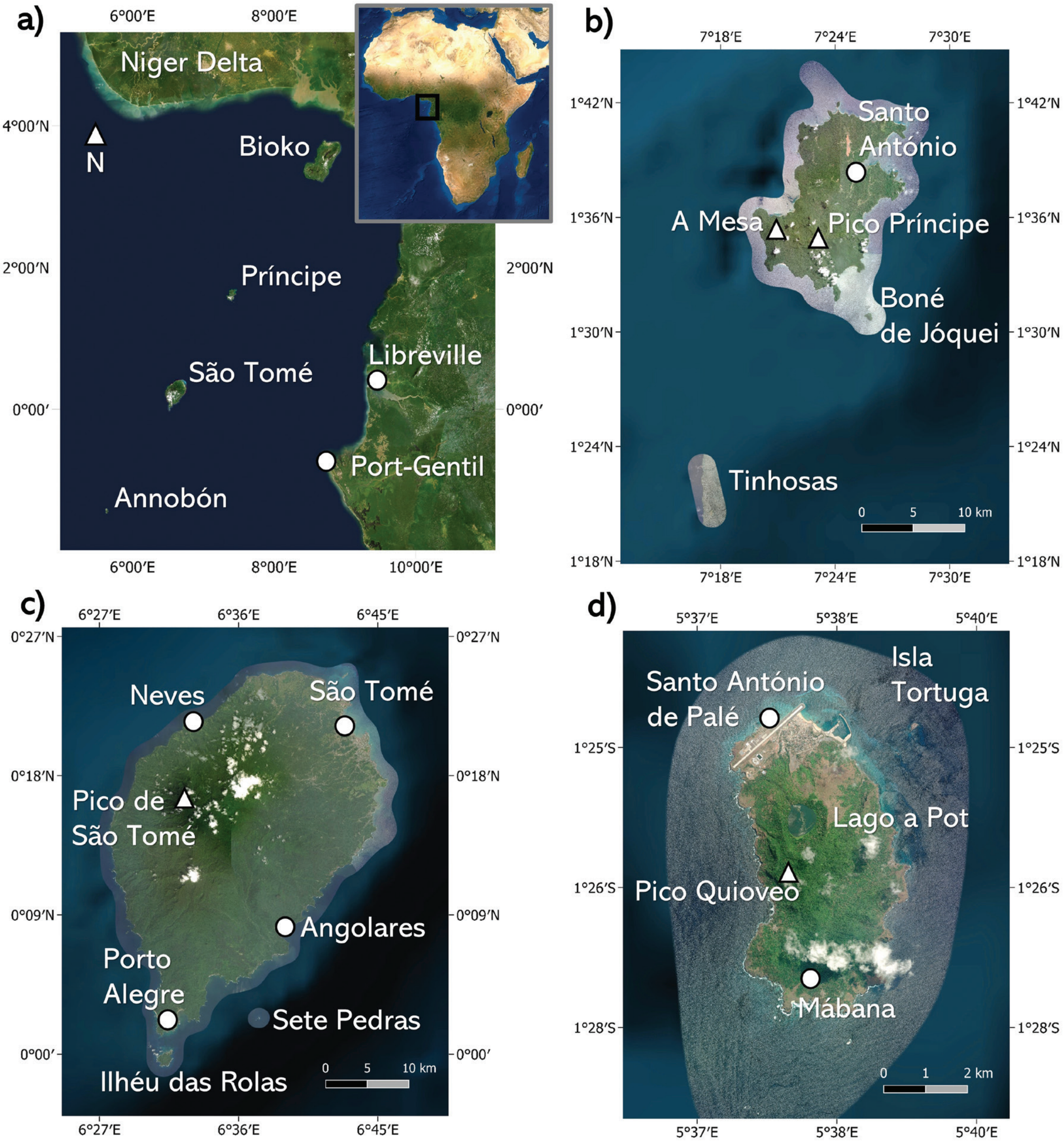

Figure 1. Map of (a) part of the Gulf of Guinea showing the oceanic islands and (b) Príncipe, (c) São Tomé and (d) Annobón. The inset in the top right of (a) shows the islands' location in relation to the African continent.

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regional checklist, based on a critical review of older literature and many recent records, most of them the result of casual observations.

Study area

The oceanic islands of the Gulf of Guinea, off the Atlantic coast of Africa, form the southern portion of the Cameroon line of volcanoes, which stretches 1,600 km from Annobón to the Mandara Mountains on the African mainland (Fitton & Dunlop 1985). They include three main islands: Príncipe and São Tomé (the Democratic Republic of São Tomé and Príncipe), and Annobón, which is administered by the Republic of Equatorial Guinea. They also include numerous associated islets, such as Boné de Jóquei, Tinhosas, Sete Pedras, Rolas and Tortuga (Fig. 1). Bioko is not included because it is a continental island, and its avifauna is very different to that of the oceanic islands, being much closer to that of mainland Africa (Jones 1994).

The climate of the three islands is similar (Jones & Tye 2006). Their high relief intercepts prevailing moist south-westerly winds, creating a rain-shadow. Annual rainfall is thus greatest in the south-west of each island, exceeding 7,000 mm on São Tomé and 5,000 mm on Príncipe, but probably much less on Annobón (there are no data for the relevant part of the island), and lowest in the north-east, receiving just 600, 2,000 and 1,000 mm, respectively. All three islands have long rainy seasons, and humidity is very high for most of the year. The main dry season runs from mid May to late August, with a short and unreliable dry season that may last for a few weeks during December–February (Chou *et al*. 2020). The precise timings and durations of the seasons vary between islands, and strongly within them, but the dry seasons tend to be most marked in the north of each island, whereas south-western and central parts are wet year-round (Jones & Tye 2006). Daily max. temperatures at sea level vary between 22 and 33°C. Mean max. temperatures may be similar at higher elevations, but absolute minima are much lower, falling below 10°C at 700 m. Winds are generally light and more prevalent during the dry season, but strong winds can accompany storms that tend to occur during the change of seasons. Light levels can be very low, especially in the centre and south of each island, where cloud cover during the day can be near-permanent.

Príncipe (01°32–01°43′N, 07°20–07°28′E; 139 km^2) is 220 km west of the coast of Central Africa and 146 km north-east of São Tomé (Jones & Tye 2006). It comprises a relatively flat, low-lying basalt platform in the north, with a rugged mountainous southern region, where the main peaks are located, including Pico do Príncipe (948 m), Mencorne (935 m) and Carriote (830 m). Once completely covered by rainforest, most accessible areas have been cleared and planted, although some have reverted to secondary forest. Remaining native forest is mostly restricted to rugged terrain, including some lowland forest in the south and montane forest around Pico do Príncipe.

São Tomé (00°25–00°01′S, 06°28–06°45′E; 857 km^2) is 255 km west of Gabon (Jones & Tye 2006). The equator passes through Ilhéu das Rolas, just south of the main island, which is cone-shaped, typical of islands marked by recent volcanism. Its highest point is Pico de São Tomé at 2,024 m, although a multitude of high peaks and volcanic plugs is scattered across São Tomé, of which Cão Grande (663 m) is the most impressive. The north-east of the island slopes gently to the sea, while the remainder is cut by deep river valleys that disgorge into mostly rocky beaches on the west coast, and into mainly sandy or marshy areas elsewhere over the island. Apart from very small areas of mangrove and sand dune along coasts, and some dry woodland in the north, rainforest was the native vegetation in São Tomé. Currently, native vegetation is, as on Príncipe, mostly restricted to the rugged

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centre and south-west of the island. Nevertheless, only a few areas have entirely lost their forest cover, such as the fire-prone savannas in the north, around the few human settlements mostly along the coast and in the north-east, the horticultural areas at higher elevations on the north-east slopes, coconut groves on the coast and oil palm monocultures in the south. Most agricultural areas are agroforestry systems with dense canopy cover, such as forest gardens or shade plantations of cocoa and coffee. Extensive parts of the island are covered by second growth.

Annobón (01°24–01°28′S, 05°36–05°38′E; 17 km^2) is 340 km west of the mainland and 180 km south-west of São Tomé (Jones & Tye 2006). The island's centre comprises the crater of Quioveo (640 m), and Santamina, the highest point at 700 m. Other geological landmarks include Pico do Fogo, a trachyte plug rising to 450 m, and Lago a Pot, a small crater lake at 220 m, which dries up during prolonged droughts. Only three valleys hold permanent streams, and the north has savanna-like formations and dry bush, with dry lowland forest to the south (Jones & Tye 2006). The south of the island is characterised by taller mist-forest covered by epiphytes. Vegetation is reported to have been less modified by humans than on São Tomé and Príncipe, and there is little sign of former cocoa and coffee plantations, now abandoned and colonised by regrowth rich in non-native plants. The north has been most affected by human activity, and the majority of level-ground areas up to the Lago a Pot crater are cultivated.

In 2015, Príncipe had 7,344 human inhabitants (52/km^2), São Tomé 171,395 (200/km^2; INE 2020) and Annobón 5,314 (313/km^2; INEGE 2017). Most people live in the north of the islands, especially the flattest coastal areas, whilst the south and centres retain most of their forest cover (Norder *et al*. 2020). Despite international recognition of the global importance of the avian diversity of these islands, conservation efforts are limited (BirdLife International 2019). Each island has a protected area, i.e., Annobón Nature Reserve (17 km^2), created in 2000, and Príncipe Obô Natural Park (45 km^2) and São Tomé Obô Natural Park (262 km^2), both established in 2006 (UNEP-WCMC & IUCN 2020). These areas include most remaining native forest (Fundação Príncipe 2019, Soares *et al*. 2020). The laws by which the São Tomé and Príncipe parks were created envisaged the establishment of buffer zones, which would function as transition zones to minimise the impact of human activity (Direcção Geral do Ambiente 2006a,b). Unfortunately, the boundaries and regulation of these buffer zones remain undefined, and effective management is lacking (BirdLife International 2019). Since 2012, all of Príncipe has been a UNESCO Biosphere Reserve (UNESCO 2020).

Revised checklist

We compiled all available bird records for the Gulf of Guinea oceanic islands, including offshore records (Tables 1–2). English names, taxonomy, and information concerning distribution and migration were taken from *Birds of the world* (Clements *et al*. 2019, Billerman *et al*. 2020). Records were identified to the lowest taxonomic category possible.

Species were considered resident if they completed their life cycle in the study area. Resident species were considered native if there was no indication that their presence in the region was due to anthropogenic interference, otherwise they were considered possibly non-native. These include species that might have been introduced deliberately or accidentally, or could have expanded their range naturally, benefitting from new environments that have appeared on the islands as a result of human activity. Native taxa were considered endemic if their distribution is restricted to the oceanic islands of the Gulf of Guinea. Migrants were classified as one of three types: (i) breeding, which included all migrant species that breed on the islands (all of which are seabirds); (ii) non-breeding, which do not breed but are

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recorded most years; and (iii) vagrant, which are not recorded most years but their presence has been confirmed. Species were considered confirmed when at least one record involved a museum specimen, ringing or tracking device, photo, video, or sound-recording. If a species' occurrence was based solely on unsubstantiated observations (i.e., without photo or other documentation), it was considered unconfirmed. We elected to list all unconfirmed species, because details of these records might be helpful to guide future work. Taxa were considered extinct or extirpated on São Tomé and Príncipe if there was no reliable record of occurrence this century (during which the islands have been extensively surveyed: Fundação Príncipe 2019, Soares *et al*. 2020). On Annobón all recorded breeding species are known to persist.

TABLE 1

Number of species known from the oceanic islands of the Gulf of Guinea. Totals are indicated for each island and for the entire region, including offshore records. * Includes the subspecies of Príncipe Seedeater *Crithagra rufobrunnea* endemic to Boné de Jóquei Islet; ** includes the subspecies of Príncipe Seedeater endemic to São Tomé; *** assumes that Annobón does not share the subspecies of Emerald Cuckoo *Chrysococcyx cupreus* with Príncipe and São Tomé; **** includes extinction of the endemic subspecies of Olive Ibis *Bostrychia olivacea rothschildi*, and extirpation of Red-headed Lovebird *Agapornis pullarius* and Red-headed Quelea *Quelea erythrops*.

	Príncipe	São Tomé	Annobón	Total
Confirmed	90	96	30	146
Resident	32	50	11	66
Endemic species	11	20	2	29
Shared	3	3	1	3
Single-island	8	17	1	26
Endemic subspecies	9*	8**	2	17
Shared	2	2	0***	2
Single-island	7*	6**	3	16
Possibly non-native	5	17	3	17
Extirpated	3****	0	0	1
Breeding seabirds	5	3	4	6
Regular migrant	3	4	1	4
Vagrant	44	32	11	62
Uncertain status	6	7	3	8
Unconfirmed	30	45	10	51
Erroneous	0	2	0	2

TABLE 2

Annotated bird species checklist for the oceanic islands of the Gulf of Guinea. English names, taxonomy, and information concerning distribution and migration taken from *Birds of the world* (Clements *et al*. 2019, Billerman *et al*. 2020). Occurrence and status by island indicated as follows: Príncipe (P), São Tomé (S), Annobón (A) or offshore (O): endemic species (E), endemic subspecies (S), possibly non-native (I), native resident (R), breeding seabird (B), regular non-breeding migrant (M), vagrant (V), uncertain (?), unconfirmed (U), extinct (X) or misidentification (-). Capital letters indicate status in previous checklist (Jones & Tye 2006), while lower case indicate current status, where different. 'Possibly non-native' species are classified as such herein, based on information in the previous checklist. Superscript letters indicate the type of evidence used to classify vagrants (S: museum specimens, T: tracking devices, P: photos or

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videos, R: ringing records, or A: sound-recordings). For example, 'v^{S}' in the 'P' column = a vagrant taxon confirmed by museum specimen on Príncipe since the previous checklist, while 'V^{P}' in 'S' = a taxon that was already listed as a vagrant for São Tomé based on photographic evidence, and 'i' in 'A' a taxon that has only recently been identified as possibly non-native on Annobón. Where known, subspecies are shown only for confirmed breeding species. The right-hand column references updates to the previous checklist and explains uncertain statuses, using the island column codes. In a few cases this column also provides additional details or clarifies taxonomic changes from the previous list.

Taxa	P	S	A	O	Reference
FAMILY ANATIDAE					
Knob-billed Duck *Sarkidiornis melanotos* (Pennant, 1769)		V^{S}			
African Pygmy Goose *Nettapus auritus* (Boddaert, 1783)	v^{P}	v^{P}			Pv^{P}: Correia *et al*. (2021). Sv^{P}: Hansson & Thomasson (2014), ebird.org/checklist/S52109208.
FAMILY NUMIDIDAE					
Helmeted Guineafowl *Numida meleagris* (Linnaeus, 1758)	U	i	i		PU: no proof of presence. Ai: Sloan (2017).
FAMILY PHASIANIDAE					
Harlequin Quail *Coturnix delegorguei histrionica* Hartlaub, 1849	u	S			Pu: N. Borrow & R. Demey *in Bull. Afr. Bird Cl.* 5: 74, N. Borrow *in Bull. Afr. Bird Cl.* 11: 77.
Red-necked Francolin *Pternistis afer afer* (Statius Müller, 1776)		i			Si: tentatively first recorded in the 1980s.
Red Junglefowl *Gallus gallus* (Linnaeus, 1758)			i		
FAMILY PHOENICOPTERIDAE					
Greater Flamingo *Phoenicopterus roseus* Pallas, 1811		U			
Lesser Flamingo *Phoeniconaias minor* (E. Geoffroy Saint-Hilaire, 1798)	V^{S}				
FAMILY COLUMBIDAE					
Rock Dove *Columba livia livia* J. F. Gmelin, 1789	i	i			
Maroon Pigeon *Columba thomensis* Bocage, 1888		E			
São Tomé Pigeon *Columba malherbii* J. & E. Verreaux, 1851	E	E	E		
Lemon Dove *Columba larvata* Temminck, 1809					
C. l. inornata (Reichenow, 1892)			r		Endemic *C. l. hypoleuca* (Salvadori 1903) no longer considered valid.
C. l. principalis (Hartlaub, 1866)	S				
C. l. simplex (Hartlaub, 1849)		S			Sometimes treated as a species (e.g., Baptista *et al*. 1997).
Laughing Dove *Streptopelia senegalensis senegalensis* (Linnaeus, 1766)	i	i			
São Tomé Green Pigeon *Treron sanctithomae* (J. F. Gmelin, 1789)		E			
African Green Pigeon *Treron calvus virescens* Amadon, 1953	S				
FAMILY CUCULIDAE					
Great Spotted Cuckoo *Clamator glandarius* (Linnaeus, 1758)	v^{s}		V^{S}		Pv^{S}: Monteiro *et al*. (2016).

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Taxa	**P**	**S**	**A**	**O**	**Reference**
Pied Cuckoo *Clamator jacobinus* (Boddaert, 1783)	u	V^S			PU: M. Dallimer & M. Melo *in Bull. Afr. Bird Cl.* 15: 274.
Klaas's Cuckoo *Chrysococcyx klaas* (Stephens, 1815)		u			Su: no proof of presence.
African Emerald Cuckoo *Chrysococcyx cupreus insularum* Moreau & Chapin, 1951	S	S	R		It is unclear if the Annobón population belongs to this subspecies; additionally, the species may be monotypic (Payne 2020).
Common Cuckoo *Cuculus canorus* Linnaeus, 1758 / African Cuckoo *C. gularis* Stephens, 1815		U			
FAMILY CAPRIMULGIDAE					
Caprimulgus sp.			u		Au: Sloan (2017).
FAMILY APODIDAE					
São Tomé Spinetail *Zoonavena thomensis* (E. Hartert, 1900)	E	E			
Alpine Swift *Apus melba* (Linnaeus, 1758)			u		Au: no proof of presence.
Common Swift *Apus apus* (Linnaeus, 1758)	v^P	U	v^T		Pv^P: ebird.org/checklist/S65190331. SU: N. Borrow *in Bull. Afr. Bird Cl.* 6: 78, ebird.org/checklist/S22513117, Tavares & Leitão (2012). Av^T: Åkesson *et al.* (2012).
Pallid Swift *Apus pallidus* Shelley, 1870		U			SU: ebird.org/checklist/S14846119.
African Swift *Apus barbatus sladeniae* (Ogilvie-Grant, 1904)	U	U			PU: N. Borrow & R. Demey *in Bull. Afr. Bird Cl.* 5: 74, Boix (2010).
Little Swift *Apus affinis bannermani* E. Hartert, 1928	S	S			
Bates's Swift *Apus batesi* (Sharpe, 1904)	u				Pu: P. Verbelen took a photo in July 2016 that matched this species, but identification could not be confirmed.
African Palm Swift *Cypsiurus parvus brachypterus* (Reichenow, 1903)	i	i			
FAMILY RALLIDAE					
African Rail *Rallus caerulescens* J. F. Gmelin, 1789		V^S			
African Crake *Crex egregia* (W. Peters, 1854)	V^S	V^S			SV^S: Monteiro *et al.* (2016).
Lesser Moorhen *Paragallinula angulata* (Sundevall, 1851)	?	?			P?: Monteiro *et al.* (2016), ebird.org/checklist/S63554107. S?: safring.birdmap.africa/ring_info.php?ring=5A17962, ebird.org/checklist/S52109208. It is unclear if the species is resident or migrant, and if it breeds on either or both islands.
Common Moorhen *Gallinula chloropus meridionalis* (C. L. Brehm, 1831)	R	R	r		Ar: Sloan (2017). The species persists on Annobón.
Allen's Gallinule *Porphyrio alleni* Thomson, 1842	V^{SP}	v^{SP}	V^S		PV^P: ebird.org/checklist/S30800298. PV^S & Sv^S: Monteiro *et al.* (2016). Sv^P: ebird.org/checklist/S51835860. The few records refer mostly to juveniles, but we assume that it does not breed on the islands.
FAMILY BURHINIDAE					
Eurasian Thick-knee *Burhinus oedicnemus* (Linnaeus, 1758)	v^P				Pv^P: ebird.org/checklist/S53730549.

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Taxa	P	S	A	O	Reference
FAMILY CHARADRIIDAE					
Black-bellied Plover *Pluvialis squatarola* (Linnaeus, 1758)	v^P	V^S			Pv^P: Correia *et al.* (2021). SV^S: Monteiro *et al.* (2016).
European Golden Plover *Pluvialis apricaria* (Linnaeus, 1758)		U			
American Golden Plover *Pluvialis dominica* (Statius Müller, 1776)	v^P	V^S			Pv^P: Correia *et al.* (2021). SV^S: Monteiro *et al.* (2016).
Spur-winged Lapwing *Vanellus spinosus* (Linnaeus, 1758)	v^P				Pv^P: Valle & Patacho (2014).
Senegal Lapwing *Vanellus lugubris* (Lesson, 1826)	v^P				Pv^P: Correia *et al.* (2021).
Common Ringed Plover *Charadrius hiaticula* Linnaeus, 1758	v^P	U			Pv^P: Correia *et al.* (2021), ebird.org/checklist/S49597625, ebird.org/checklist/S83661197.
Little Ringed Plover *Charadrius dubius* Scopoli, 1786		U			
White-fronted Plover *Charadrius marginatus* Vieillot, 1818	v^P	V^S			Pv^P: ebird.org/checklist/S83661197. SV^S: Monteiro *et al.* (2016).
FAMILY SCOLOPACIDAE					
Whimbrel *Numenius phaeopus* (Linnaeus, 1758)	M	M	M		
Eurasian Curlew *Numenius arquata* (Linnaeus, 1758)	u	V^S			
Bar-tailed Godwit *Limosa lapponica* (Linnaeus, 1758)	U	U	U		SU: ebird.org/checklist/S33613204.
Ruddy Turnstone *Arenaria interpres* (Linnaeus, 1758)	v^P	V^{SP}			Pv^P: Hall *et al.* (2010). SV^P: B. Piot *in Bull. Afr. Bird Cl.* 23: 241.
Red Knot *Calidris canutus* (Linnaeus, 1758)		v^P			Sv^P: ebird.org/checklist/S41339760.
Ruff *Calidris pugnax* (Linnaeus, 1758)		u			Su: ebird.org/checklist/S32889474, ebird.org/checklist/S33613204.
Curlew Sandpiper *Calidris ferruginea* (Pontoppidan, 1763)	V^{SP}	u			Pv^P: Correia *et al.* (2021). Su: C. Hjort *in Bull. Afr. Bird Cl.* 12: 187, ebird.org/checklist/S60715447.
Sanderling *Calidris alba* (Pallas, 1764)	v^P	v^P	v^S		Pv^P: H. Uhlig *in Bull. Afr. Bird Cl.* 10: 61, Valle (2018), Correia *et al.* (2021). Sv^P: H. Uhlig *in Bull. Afr. Bird Cl.* 10: 61, ebird.org/checklist/S49555086.
Pectoral Sandpiper *Calidris melanotos* Vieillot, 1818	V^S				PV^S: Monteiro *et al.* (2016).
Little Stint *Calidris minuta* (Leisler, 1812)	U	U			
Great Snipe *Gallinago media* (Latham, 1787)	v^P				Pv^P: Correia *et al.* (2021).
Common Sandpiper *Actitis hypoleucos* (Linnaeus, 1758)	M	M			
Green Sandpiper *Tringa ochropus* Linnaeus, 1758		U			
Common Greenshank *Tringa nebularia* (Gunnerus, 1767)	M	M			
Wood Sandpiper *Tringa glareola* (Linnaeus, 1758)		v^{SP}			Sv^{SP}: reclassified as vagrant as not recorded in most years (ebird.org/species/woosan/ST-S).
FAMILY GLAREOLIDAE					
Black-winged Pratincole *Glareola nordmanni* J. G. Fischer, 1842	V^S		V^S		PV^S: Monteiro *et al.* (2016).
Grey Pratincole *Glareola cinerea* Fraser, 1843	v^P				Pv^P: Correia *et al.* (2021).

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Taxa	P	S	A	O	Reference
FAMILY STERCORARIIDAE					
Pomarine Jaeger *Stercorarius pomarinus* Temminck, 1815		u			Su: V. Schollaert & G. Willem *in Bull. Afr. Bird Cl.* 7: 76.
Parasitic Jaeger *Stercorarius parasiticus* (Linnaeus, 1758)		v^{P}		U	Sv^{P}: ebird.org/checklist/S14846065.
Long-tailed Jaeger *Stercorarius longicaudus* Vieillot, 1819				U	
FAMILY LARIDAE					
Sabine's Gull *Xema sabini* (Sabine, 1819)	U	U	U	U	Pu: ebird.org/checklist/S68133545.
Lesser Black-backed Gull *Larus fuscus* Linnaeus, 1758	U	U			Su: A. Gascoigne *in Bull. Afr. Bird Cl.* 11: 177.
Brown Noddy *Anous stolidus stolidus* (Linnaeus, 1758)	B	B	B		
Black Noddy *Anous minutus atlanticus* (Mathews, 1912)	B	?	B		S?: breeding possible but not confirmed. An aberrant yellow-legged individual of the local breeding population was photographed on Tinhosas (Demey & da Rocha in press).
Sooty Tern *Onychoprion fuscatus fuscatus* (Linnaeus, 1766)	B	?	?		S? & A?: breeding possible but not confirmed.
Bridled Tern *Onychoprion anaethetus melanopterus* (Swainson, 1837)	?	?	B		P? & S?: breeding possible but not confirmed.
Black Tern *Chlidonias niger* (Linnaeus, 1758)		U		U	Su: ebird.org/checklist/S32779735.
White-winged Tern *Chlidonias leucopterus* (Temminck, 1815)			u		Au: single record in Fry (1961) but no supporting evidence.
Common Tern *Sterna hirundo* Linnaeus, 1758	U	U			Pu: ebird.org/checklist/S10327997. Su: C. Hjort *in Bull. Afr. Bird Cl.* 12: 187, ebird.org/checklist/S10328000.
Arctic Tern *Sterna paradisaea* Pontoppidan, 1763	U	U			Su: A. Gascoigne *in Bull. Afr. Bird Cl.* 11: 177.
Royal Tern *Thalasseus maximus* (Boddaert, 1783)		u		U	Su: ebird.org/checklist/S60715447.
Sandwich Tern *Thalasseus sandvicensis* (Latham, 1787)	u	v^{S}			Pu: ebird.org/checklist/S68133545. Sv^{S}: reclassified as vagrant since most years it is not recorded (ebird.org/species/santer1/ST-S).
FAMILY PHAETHONTIDAE					
White-tailed Tropicbird *Phaethon lepturus ascensionis* (Mathews, 1915)	B	B	B		
Red-billed Tropicbird *Phaethon aethereus* Linnaeus, 1758	?	v^{P}			P?: S. J. Rumsey *in Bull. Afr. Bird Cl.* 8: 46, ebird.org/checklist/S6591443, P. Catry saw one on Tinhosas in 2020, and in 2021 N. Rocha saw the species on a nest, suggesting that it might breed sporadically. Sv^{P}: L. Sineux *in Bull. Afr. Bird Cl.* 27: 114.
FAMILY OCEANITIDAE					
Wilson's Storm Petrel *Oceanites oceanicus* Kuhl, 1820				U	
Black-bellied Storm Petrel *Fregetta tropica* (Gould, 1844)	u	u		U	Pu: V. Schollaert & G. Willem *in Bull. Afr. Bird Cl.* 7: 76. Su: ebird.org/checklist/S57214304.
FAMILY HYDROBATIDAE					
European Storm Petrel *Hydrobates pelagicus* (Linnaeus, 1758)				U	Ou: N. Borrow *in Bull. Afr. Bird Cl.* 8: 65.

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Taxa	P	S	A	O	Reference
Leach's Storm Petrel *Oceanodroma leucorhoa* (Vieillot, 1818)				U	
Band-rumped Storm Petrel *Oceanodroma castro* (Harcourt, 1851)		?	U	M	S?: V. Schollaert & G. Willem *in Bull. Afr. Bird Cl.* 7: 76, ebird.org/checklist/S57025283, ebird.org/checklist/S57214304. Om: N. Borrow *in Bull. Afr. Bird Cl.* 8: 65 and 9: 70. Breeding on São Tomé is likely but not confirmed (Flood *et al.* 2019). Possibly *O. jabejabe* or an undescribed form.
FAMILY PROCELLARIIDAE					
Bulwer's Petrel *Bulweria bulwerii* Jardine & Selby, 1828				U	
Cory's Shearwater *Calonectris diomedea* (Scopoli, 1769)	u			U	Pu: ebird.org/checklist/S20636314. The possibility of a Cape Verde Shearwater *C. edwardsii* could not be discarded.
Great Shearwater *Ardenna gravis* (O'Reilly, 1818)				U	
Sooty Shearwater *Ardenna grisea* (J. F. Gmelin, 1789)				V^{S}	Pu: ebird.org/checklist/S10327997.
Little Shearwater *Puffinus assimilis* Gould, 1838				U	
FAMILY CICONIIDAE					
White Stork *Ciconia ciconia* (Linnaeus, 1758)		V^{SP}			SV^{P}: A. Gascoigne *in Bull. Afr. Bird Cl.* 15: 135.
Yellow-billed Stork *Mycteria ibis* (Linnaeus, 1766)		u			
FAMILY FREGATIDAE					
Ascension Frigatebird *Fregata aquila* (Linnaeus, 1758)	U			U	
Magnificent Frigatebird *Fregata magnificens* Mathews, 1914	v^{P}				Pv^{P}: Matilde & de Lima (2016), Correia *et al.* (2021).
FAMILY SULIDAE					
Masked Booby *Sula dactylatra* Lesson, 1831	v^{SP}		U	u	Pv^{S}: Monteiro *et al.* (2016), Pv^{P}: ebird.org/checklist/S6591443.
Brown Booby *Sula leucogaster leucogaster* (Boddaert, 1783)	B	B	?		A?: breeding possible but not confirmed.
Red-footed Booby *Sula sula* (Linnaeus, 1766)	u	v^{P}			Pu: ebird.org/checklist/S39180120. Sv^{P}: ebird.org/checklist/S80241954
Cape Gannet *Morus capensis* (M. H. C. Lichtenstein, 1823)	U	U			
FAMILY PHALACROCORACIDAE					
Long-tailed Cormorant *Microcarbo africanus africanus* (J. F. Gmelin, 1789)	v^{P}	R			Pv^{P}: ebird.org/checklist/S63580421.
Great Cormorant *Phalacrocorax carbo* (Linnaeus, 1758)	U	U			
FAMILY ARDEIDAE					
Little Bittern *Ixobrychus minutus* (Linnaeus, 1766)	?				P?: breeding confirmed on Príncipe but no subsequent records.
Grey Heron *Ardea cinerea* Linnaeus, 1758	u	V^{SP}			Pu: V. Schollaert & G. Willem *in Bull. Afr. Bird Cl.* 7: 76, N. Borrow *in Bull. Afr. Bird Cl.* 10: 137. SV^{S}: Monteiro *et al.* (2016). SV^{P}: ebird.org/checklist/S63841541.
Black-headed Heron *Ardea melanocephala* (Children & Vigors, 1826)	v^{P}	v^{P}			Pv^{P}: Cheke & Pereira (2020). Sv^{P}: B. Piot *in Bull. Afr. Bird Cl.* 23: 241.

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Taxa	P	S	A	O	Reference
Purple Heron *Ardea purpurea* (Linnaeus, 1766)		V^{S}			SV^{S}: Monteiro *et al.* (2016).
Great Egret *Ardea alba* Linnaeus, 1758		U			SU: ebird.org/checklist/S51768645.
Intermediate Egret *Ardea intermedia* A. E. Brehm, 1854	u	v^{P}			Pu: M. Melo *in Bull. Afr. Bird Cl.* 11: 77, Sv^{P}: Hall *et al.* (2010).
Little Egret *Egretta garzetta* (Linnaeus, 1766)	v^{P}	U			Pv^{P}: Hall *et al.* (2010). SU: ebird.org/species/litegr/ST-S.
Western Reef Heron *Egretta gularis gularis* (Bosc, 1792)	R	R	R		AR: Sloan (2017).
Black Heron *Egretta ardesiaca* (Wagler, 1827)	u	V^{P}			Pu: Y. Santos described a black heron using its wings to form a canopy for feeding.
Cattle Egret *Bubulcus ibis ibis* (Linnaeus, 1758)	r	r	u		Pr & Sr: present year-round (ebird.org/species/categr/ST-P, ebird.org/species/categr/ST-S). Au: no proof of presence.
Squacco Heron *Ardeola ralloides* (Scopoli, 1769)	v^{P}	v^{P}	v^{P}		Pv^{P}: Valle (2017), Correia *et al.* (2021), ebird.org/checklist/S63580421. Sv^{P}: ebird.org/checklist/S26063168, ebird.org/checklist/S80242124. Av^{P}: Sloan (2017).
Striated Heron *Butorides striata atricapilla* (Afzelius, 1804)	R	R	V^{S}		
Black-crowned Night Heron *Nycticorax nycticorax* (Linnaeus, 1758)		U			
FAMILY THRESKIORNITHIDAE					
Olive Ibis *Bostrychia olivacea rothschildi* (Bannerman, 1919)	x				Px: last confirmed sighting in 1901 by Leonardo Fea (Salvadori 1903). We consider two reports from the 1990s (Jones & Tye 2006) unsubstantiated. This subspecies is probably extinct, especially as island-wide surveys since the early 2000s have failed to find it.
São Tomé Ibis *Bostrychia bocagei* (Chapin, 1923)		E			
FAMILY PANDIONIDAE					
Osprey *Pandion haliaetus* (Linnaeus, 1758)	v^{P}				Pv^{P}: ebird.org/checklist/S63580421.
FAMILY ACCIPITRIDAE					
Bat Hawk *Macheiramphus alcinus* Bonaparte, 1850		u			Su: H. Uhlig *in Bull. Afr. Bird Cl.* 10: 61.
Black Kite *Milvus migrans parasitus* (Daudin, 1800)	R	R	V^{S}		
FAMILY TYTONIDAE					
Barn Owl *Tyto alba thomensis* (Hartlaub, 1852)		S			SS: might be best treated as an endemic species (Uva *et al.* 2018, Alves 2019).
FAMILY STRIGIDAE					
São Tomé Scops Owl *Otus hartlaubi* (Giebel, 1849)		E			
African Scops Owl *Otus senegalensis feae* (Salvadori, 1903)			S		AS: Sloan (2017). Ongoing debate on taxonomic status (e.g., Freitas 2019 and Billerman *et al.* 2020 vs. Collar & Boesman 2020 and Gill *et al.* 2021).
Otus sp. nov.	e				Pe: Freitas 2019.
FAMILY UPUPIDAE					
Eurasian Hoopoe *Upupa epops* Linnaeus, 1758		v^{P}			Sv^{P}: A. Gascoigne *in Bull. Afr. Bird Cl.* 11: 77.

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Taxa	P	S	A	O	Reference
FAMILY ALCEDINIDAE					
Malachite Kingfisher *Corythornis cristatus* (Pallas, 1764)					Both subspecies sometimes treated as separate endemic species.
C. c. thomensis (Salvadori, 1902)		S			
C. c. nais (Kaup, 1848)	S				PS: Melo & Fuchs (2008). Previously *C. leucogaster nais*.
Blue-breasted Kingfisher *Halcyon malimbica dryas* Hartlaub, 1854	S				
Kingfisher *Halcyon* sp.		u			Su: Hansson & Thomasson (2014).
Pied Kingfisher *Ceryle rudis* (Linnaeus, 1758)	?	U			P?: R. Rocha *in Bull. Afr. Bird Cl.* 16: 107, A. Castelo *et al. in Bull. Afr. Bird Cl.* 21: 105–106, Correia *et al.* (2021), ebird.org/species/piekin1/ST-P. It is unclear if the species is resident or migrant, or if it breeds occasionally on Príncipe. SU: ebird.org/species/piekin1/ST-S.
FAMILY MEROPIDAE					
Merops sp.			U		
FAMILY CORACIIDAE					
European Roller *Coracias garrulus* Linnaeus, 1758	V^{S}	V^{S}			
Broad-billed Roller *Eurystomus glaucurus* (Statius Müller, 1776)	v^{P}				Pv^{P}: ebird.org/checklist/S46018843.
FAMILY FALCONIDAE					
Common Kestrel *Falco tinnunculus* Linnaeus, 1758	U				
Red-footed Falcon *Falco vespertinus* Linnaeus, 1766	v^{P}	V^{SP}			Pv^{P}: ebird.org/checklist/S61016398. SV^{S}: Monteiro *et al.* (2016). SV^{P}: A. Gascoigne *in Bull. Afr. Bird Cl.* 11: 77.
Lanner Falcon *Falco biarmicus* Temminck, 1825		u			Su: ebird.org/checklist/S63841918, ebird.org/checklist/S63940605.
Peregrine Falcon *Falco peregrinus* Tunstall, 1771		U			
FAMILY PSITTACULIDAE					
Red-headed Lovebird *Agapornis pullarius pullarius* (Linnaeus, 1758)	X	i			
FAMILY PSITTACIDAE					
Grey Parrot *Psittacus erithacus* Linnaeus, 1758	R	i			Si: ebird.org/species/grepar/ST-S. Continuous presence, especially in the north-east, where possibly established from released caged birds. Unclear which taxon occurs on the islands (Melo & O'Ryan 2007).
FAMILY ORIOLIDAE					
Eurasian Golden Oriole *Oriolus oriolus* (Linnaeus, 1758)	V^{S}	v^{P}			PV^{S}: Monteiro *et al.* (2016). Sv^{P}: van Boekel (2016).
São Tomé Oriole *Oriolus crassirostris* Hartlaub, 1857		E			
FAMILY DICRURIDAE					
Velvet-mantled Drongo *Dicrurus modestus modestus* Hartlaub, 1849	s				Ps: formerly recognised as a species endemic to Príncipe.

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Taxa	P	S	A	O	Reference
FAMILY MONARCHIDAE					
São Tomé Paradise Flycatcher *Terpsiphone atrochalybeia* (Thomson, 1842)		E			
Black-headed Paradise Flycatcher *Terpsiphone rufiventer smithii* (Fraser, 1843)			s		Previously treated as an endemic species, *T. smithii*.
Family LANIIDAE					
Red-backed Shrike *Lanius collurio* Linnaeus, 1758		u	V^{R}		
Lesser Grey Shrike *Lanius minor* J. F. Gmelin, 1788	V^{S}		u		PV^{S}: Monteiro *et al*. (2016).
Newton's Fiscal *Lanius newtoni* Bocage, 1891		E			
FAMILY CISTICOLIDAE					
Chattering Cisticola *Cisticola anonymus* (J. W. von Müller, 1855)		-			
São Tomé Prinia *Prinia molleri* Bocage, 1887		E			
FAMILY ACROCEPHALIDAE					
Western Olivaceous Warbler *Iduna* cf. *opaca* (Cabanis, 1850)	v^{P}				Pv^{P}: Correia *et al*. (2021).
Sedge Warbler *Acrocephalus schoenobaenus* (Linnaeus, 1758)		v^{R}			Sv^{R}: S. Andersson *in Bull. Afr. Bird Cl*. 11: 77, safring.birdmap.africa/ring_info.php?ring=GA70214, safring.birdmap.africa/ring_info.php?ring=GA70215.
Great Reed Warbler *A. arundinaceus* (Linnaeus, 1758)		v^{A}			Sv^{A}: B. Piot *in Bull. Afr. Bird Cl*. 23: 241.
FAMILY HIRUNDINIDAE					
Banded Martin *Riparia cincta* (Boddaert, 1783)	V^{S}				
Sand Martin *Riparia riparia* (Linnaeus, 1758)	u				Pu: Mills *et al*. (2007).
Barn Swallow *Hirundo rustica* (Linnaeus, 1758)	V^{SR}	v^{SP}			PV^{S}: Monteiro *et al*. (2016). Sv^{P}: ebird.org/checklist/S14845048. Considered vagrant also on São Tomé, as not recorded most years (ebird.org/species/barswa/ST-S).
Lesser Striped Swallow *Cecropis abyssinica* (Guérin-Méneville, 1843)	u				Pu: H. Uhlig *in Bull. Afr. Bird Cl*. 10: 61.
Common House Martin *Delichon urbicum* (Linnaeus, 1758)	V^{S}	v^{P}			Sv^{P}: ebird.org/checklist/S49555067.
Grey-rumped Swallow *Pseudhirundo griseopyga* (Sundevall, 1850)	U	u			Su: P. Christy *in Bull. Afr. Bird Cl*. 18: 102, ebird.org/checklist/S24605216.
FAMILY PHYLLOSCOPIDAE					
Willow Warbler *Phylloscopus trochilus* (Linnaeus, 1758)	v^{P}	u		U	Pv^{P}: ebird.org/checklist/S32876010. Su: ebird.org/checklist/S18824617, ebird.org/checklist/S63701919.
FAMILY SYLVIIDAE					
Dohrn's Thrush-Babbler *Sylvia dohrni* (Hartlaub, 1866)	E				Formerly included in the endemic monospecific genus *Horizorhinus*.
Garden Warbler *Sylvia borin* (Boddaert, 1783)	v^{P}	u	V^{S}		Pv^{P}: ebird.org/checklist/S42176347. Su: C. Hjort *in Bull. Afr. Bird Cl*. 12: 187, ebird.org/checklist/S16448286, ebird.org/checklist/S54165131.

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Taxa	P	S	A	O	Reference
Common Whitethroat *Sylvia communis* Latham, 1787	v^{R}				Pv^{R}: safring.birdmap.africa/ring_info.php?ring=GA59510, safring.birdmap.africa/ring_info.php?ring=GA59517.
FAMILY ZOSTEROPIDAE					
Príncipe White-eye *Zosterops ficedulinus* Hartlaub, 1866	E				Previously treated as an endemic subspecies of *Z. ficedulinus*.
Annobón White-eye *Zosterops griseovirescens* Bocage, 1893			E		
São Tomé White-eye *Zosterops feae* Salvadori, 1901		E			Previously treated as an endemic subspecies of *Z. ficedulinus*.
Black-capped Speirops *Zosterops lugubris* (Hartlaub, 1848)		E			Formerly included in the genus *Speirops*, endemic to the Cameroon line of volcanoes, which is no longer considered valid.
Príncipe Speirops *Zosterops leucophaeus* (Hartlaub, 1857)	E				Formerly included in the genus *Speirops*, endemic to the Cameroon line of volcanoes, which is no longer considered valid.
FAMILY STURNIDAE					
Chestnut-winged Starling *Onychognathus fulgidus fulgidus* (Hartlaub, 1849)		S			
Splendid Starling *Lamprotornis splendidus* (Vieillot, 1822)	r				Pr: ebird.org/species/spgsta1/ST. Frequent throughout the year.
Príncipe Starling *Lamprotornis ornatus* (Daudin, 1800)	E				
FAMILY TURDIDAE					
Príncipe Thrush *Turdus xanthorhynchus* Salvadori, 1901	e				Previously treated as an endemic subspecies of *T. olivaceofuscus*.
São Tomé Thrush *Turdus olivaceofuscus* Hartlaub, 1852		E			
FAMILY MUSCICAPIDAE					
Spotted Flycatcher *Muscicapa striata* (Pallas, 1764)	V^{SP}	u	V^{S}	u	PV^{S}: Monteiro *et al*. (2016). PV^{P}: Correia *et al*. (2021). SU: ebird.org/checklist/S14846119, ebird.org/checklist/S35796350.
Common Nightingale *Luscinia megarhynchos* (C. L. Brehm, 1831)		v^{A}			Sv^{A}: ebird.org/checklist/S54165131.
Whinchat *Saxicola rubetra* (Linnaeus, 1758)	V^{S}	u			PV^{S}: Hall *et al*. (2010), Correia *et al*. (2021). Su: ebird.org/checklist/S18824617.
Northern Wheatear *Oenanthe oenanthe* (Linnaeus, 1758)	v^{P}				Pv^{P}: Correia *et al*. (2021).
Isabelline Wheatear *Oenanthe isabellina* (Temminck, 1829)		u			Su: C. Hjort *in Bull. Afr. Bird Cl*. 12: 187.
FAMILY NECTARINIIDAE					
Príncipe Sunbird *Anabathmis hartlaubii* (Hartlaub, 1857)	E				
Newton's Sunbird *Anabathmis newtonii* (Bocage, 1887)		E			
São Tomé Sunbird *Dreptes thomensis* (Bocage, 1889)		E			
Olive Sunbird *Cyanomitra olivacea cephaelis* (Bates, 1930)	R				

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Taxa	P	S	A	O	Reference
FAMILY PLOCEIDAE					
Príncipe Golden Weaver *Ploceus princeps* (Bonaparte, 1851)	E				
Southern Masked Weaver *Ploceus velatus* Vieillot, 1819		i			Endemic *P. v. peixotoi* (Frade & Naurois, 1964) no longer considered valid.
Vitelline Masked Weaver *Ploceus vitellinus* (M. H. C. Lichtenstein, 1823)		-			In the past considered conspecific with *P. velatus* and, as such, was sometimes listed for São Tomé under this name.
Village Weaver *Ploceus cucullatus* (Statius Müller, 1766)		i			
Giant Weaver *Ploceus grandis* (G. R. Gray, 1844)		E			
São Tomé Weaver *Ploceus sanctithomae* (Hartlaub, 1848)		E			
Red-headed Quelea *Quelea erythrops* (Hartlaub, 1848)	X	?			S?: Monteiro *et al.* (2016), ebird.org/species/rehque1/ST. No records March–June, so it might be either resident or a breeding migrant.
Red-billed Quelea *Quelea quelea* (Linnaeus, 1758)		U			
Black-winged Bishop *Euplectes hordeaceus* (Linnaeus, 1758)		i			
Golden-backed Bishop *Euplectes aureus* (J. F. Gmelin, 1789)		i			Endemic to Angola with a resident population on São Tomé.
White-winged Widowbird *Euplectes albonotatus asymmetrurus* (Reichenow, 1892)		i			
FAMILY ESTRILDIDAE					
Chestnut-breasted Nigrita *Nigrita bicolor brunnescens* Reichenow, 1902	R				
Cinderella Waxbill *Estrilda thomensis* (de Sousa, 1888)		?			S?: single record from 1887 considered vagrant or escapee.
Common Waxbill *Estrilda astrild jagoensis* Alexander, 1898	i	i			Pi & Si: Billerman *et al.* (2020).
Southern Cordon-bleu *Uraeginthus angolensis angolensis* (Linnaeus, 1758)		i			
Red-billed Firefinch *Lagonosticta senegala* (Linnaeus, 1766)	?				P?: Monteiro *et al.* (2016). Single record from 1970, which might refer to a vagrant or escapee.
Bronze Mannikin *Spermestes cucullata cucullata* (Swainson, 1837)	i	i	i		Pi & Si: Leventis & Olmos (2009).
FAMILY VIDUIDAE					
Pin-tailed Whydah *Vidua macroura* (Pallas, 1764)	U	i			PU: ebird.org/checklist/S45937385. Si: Leventis & Olmos (2009).
Eastern Paradise Whydah *Vidua paradisaea* (Linnaeus, 1758)		?			S?: two records, the most recent from 1909, either vagrant, introduced or escaped birds.
FAMILY MOTACILLIDAE					
São Tomé Short-tail *Motacilla bocagii* (Sharpe, 1892)		E			Formerly included in the endemic monospecific genus *Amaurocichla*.
Western Yellow Wagtail *M. flava* Linnaeus, 1758	v^{P}	u			Pv^{P}: Hall *et al.* (2010). Su: ebird.org/checklist/S18824617. *M. f. thunbergi* is unconfirmed on Príncipe (ebird.org/checklist/S17866672).
White Wagtail *M. alba* Linnaeus, 1758	v^{P}				Pv^{P}: ebird.org/checklist/S75550610.
Motacilla sp.	U				Probably *M. alba*.

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Taxa	P	S	A	O	Reference
Plain-backed Pipit *Anthus leucophrys* Vieillot, 1818	u				Pu: Hall *et al*. (2010).
Tree Pipit *Anthus trivialis* (Linnaeus, 1758)		U			
FAMILY FRINGILLIDAE					
Yellow-fronted Canary *Crithagra mozambica* (Statius Müller, 1776)		i	?		A?: single record, probably of a vagrant or escapee.
Príncipe Seedeater *Crithagra rufobrunnea* (G. R. Gray, 1862)	E	E			
C. r. rufobrunnea (G. R. Gray, 1862)	S				Subspecies endemic to Príncipe.
C. r. thomensis (Bocage, 1888)		S			Subspecies endemic to São Tomé.
C. r. fradei (Naurois, 1975)	S				Subspecies endemic to Boné de Jóquei Islet (off Príncipe).
São Tomé Grosbeak *Crithagra concolor* (Bocage, 1888)		E			Formerly included in the endemic monospecific genus *Neospiza*.

Following these criteria, we confirmed the occurrence of 146 species (Tables 1–2), an increase of 28 versus the previous checklist (Jones & Tye 2006). These include 66 resident landbird species, of which 29 are endemic, including three that occur on more than one island (São Tomé Pigeon *Columba malherbii*, São Tomé Spinetail *Zoonavena thomensis* and Príncipe Seedeater *Crithagra rufobrunnea*). Recent changes in the list of resident species include the recognition of the extinction of the Príncipe subspecies of Olive Ibis *Bostrychia olivacea rothschildi*, the discovery of a scops owl *Otus* sp. nov. on Príncipe, the recognition of Splendid Starling *Lamprotornis splendidus* as a resident species, the elevation to species level of Príncipe Thrush *Turdus xanthorhynchus* and São Tomé White-eye *Zosterops feae*, the downgrading to subspecies of Príncipe Drongo (now Velvet-mantled Drongo, *Dicrurus modestus modestus*) and Annobón Paradise Flycatcher (now Black-headed Paradise Flycatcher *Terpsiphone rufiventer smithii*), and reassignment of the *Corythornis* kingfisher on Príncipe to Malachite Kingfisher as *C. cristatus nais* (previously considered a subspecies of White-bellied Kingfisher *C. leucogaster*). Among resident species we highlight 17 as possibly non-native. The list of breeding seabirds has not changed. There are now just four regular non-breeding migrant birds, with Sanderling *Calidris alba*, Wood Sandpiper *Tringa glareola* and Sandwich Tern *Thalasseus sandvicensis* considered vagrants due to the paucity of records. Eight species are of uncertain status, one fewer than the previous checklist, with the addition of Red-billed Tropicbird *Phaethon aethereus* and Red-billed Firefinch *Lagonosticta senegala*, but the formerly 'uncertain' Klaas's Cuckoo *Chrysococcyx klaas* and Alpine Swift *Apus melba* are now unconfirmed, and Splendid Starling is now resident. There are 62 vagrants, with documentation of eight species that were previously unconfirmed, 20 newly recorded, and the downgrading of three that were previously considered regular non-breeding migrants (see above), whilst three species formerly considered vagrants are now treated as unconfirmed. The 31 newly confirmed species were documented by photographs (*n* = 27), ringing (*n* = 2) and geolocator records (*n* = 1), specimens (*n* = 4) and sound-recordings (*n* = 1). The number of unconfirmed species increased from 45 to 51, a net gain of six, although 11 were confirmed (one uncertain, one endemic and nine vagrants), whereas 17 were added to the unconfirmed list (two previously uncertain, three previously considered vagrant and 12 new records). The number of endemic subspecies decreased from 21 to 17 due to the confirmed extinction of the Príncipe subspecies of Olive Ibis and taxonomic rearrangements (the Annobón subspecies of Lemon Dove *C. l. hypoleuca* is no

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longer recognised, and there were four upgrades to, and two downgrades from, endemic species).

We list 90 confirmed species for Príncipe, an increase of 25 on the previous checklist, including 32 resident landbirds, of which 11 are endemic and five possibly non-native. New single-island endemics include the recently split Principe Thrush and Príncipe White-eye *Zosterops ficedulinus*, and the as yet undescribed *Otus* on Príncipe. On the other hand, Príncipe Drongo was downgraded to an endemic subspecies. Other recent changes among resident landbirds include treating as extinct the subspecies of Olive Ibis but the addition of Splendid Starling, whilst Red-billed Tropicbird was moved to the list of species of uncertain status. There are now 44 vagrant and 30 unconfirmed species, representing increases of 24 and seven, respectively. There are nine endemic subspecies, a decrease of two on the previous checklist, resulting from one extinction, two upgrades to species, and one downgrade to subspecies.

We list 96 confirmed species for São Tomé, an increase of four on the last checklist, including 50 resident landbirds, of which 20 endemic and 17 possibly non-native. São Tomé Thrush and São Tomé White-eye are recognised as single-island endemic species, Grey Parrot *Psittacus erithacus* as resident, and Klaas's Cuckoo is moved from uncertain status to unconfirmed. There are 32 vagrants and 45 unconfirmed species, representing increases of nine and 12, respectively.

Thirty species were confirmed for Annobón, the same number as the previous checklist, including 11 resident landbirds, of which two are endemic and three possibly non-native. Recent changes included the downgrading of Annobón Paradise Flycatcher to subspecies, confirmation that Common Moorhen is not extirpated, and removal of Cattle Egret *Bubulcus ibis* from uncertain status to unconfirmed. There are 11 vagrant and ten unconfirmed species, representing increases of two and six, respectively.

The resident avifauna includes 13 globally threatened species (IUCN 2020), including four that are Critically Endangered (São Tomé Ibis *Bostrychia bocagei*, São Tomé Fiscal *Lanius newtoni*, Príncipe Thrush and São Tomé Grosbeak *Crithagra concolor*), four Endangered (Maroon Pigeon *Columba thomensis*, São Tomé Green Pigeon, Grey Parrot and Príncipe White-eye) and five Vulnerable (São Tomé Scops Owl *Otus hartlaubi*, São Tomé Oriole *Oriolus crassirostris*, Annobón White-eye *Zosterops griseovirescens*, Giant Sunbird *Dreptes thomensis* and São Tomé Short-tail *Motacilla bocagii*). All but Grey Parrot are endemic, meaning that 41% of the endemic species are threatened. Additionally, the Annobón subspecies of African Scops Owl *Otus senegalensis feae*, considered by some authorities as a valid species (Collar & Boesman 2020, Gill *et al*. 2021), has been assessed as Critically Endangered. Likewise, the as yet undescribed *Otus* on Príncipe is also likely to meet one or more of the criteria for the latter category (Freitas 2019). Three species are Near Threatened (São Tomé Pigeon, São Tomé White-eye and Giant Weaver *Ploceus grandis*).

Concluding remarks

We report 146 confirmed bird species for the oceanic islands of the Gulf of Guinea, including 66 resident landbirds, of which 29 are endemic species, 17 are endemic subspecies, and 17 are possibly non-native. Additionally, there are six breeding seabirds, four regular non-breeding migrant birds, eight species of uncertain status, 62 vagrants, and 51 unconfirmed species. Confirmed species have increased by 28 since the previous checklist (Jones & Tye 2006), or an increase of 19% in just 15 years. Most of these are doubtless attributable to the larger number of ornithologists and birders visiting the islands in recent years, whilst the platforms to report sightings have become more diverse and easily accessible. However, a few changes have resulted from our review of historical

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records, and changes in taxonomy, most of the latter resulting from the application of molecular techniques. A striking number of changes refer to the avifauna of Príncipe.

We expect that more species will be reported in the next few decades. Most are likely to involve the confirmation of vagrants that are currently unconfirmed, but further molecular work is also likely to modify the taxonomic status of a few resident species. Although some of the unconfirmed species probably do occur in the region, others are less likely and might reflect misidentifications of similar species, e.g., Long-tailed Skua *Stercorarius longicaudus* and Isabelline Wheatear *Oenanthe isabellina*. Therefore, the number of unconfirmed species must be interpreted carefully. The avifauna of Annobón is the most poorly known, although any additions will probably be vagrants. We also expect that the number of species of uncertain status will decline. Regrettably, it is also expected that the number of non-native species will increase (Reino *et al*. 2017). Promoting birdwatching and the use of existing reporting tools locally has huge potential to clarify statuses that remain unclear, with the side benefit of also raising environmental awareness.

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Elevation of two subspecies of Dunnock *Prunella modularis* to species rank

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Summary.—The Western Palearctic endemic Dunnock *Prunella modularis* was recently revealed to comprise three distinct genetic lineages, each distributed in different Pleistocene refugia. Specifically, one is isolated in the Iberian refugium, another is confined to the Caucasus refugium, and the third is distributed in both the Italian and Balkan refugia, as well as across broader Europe. There is a probable absence of gene flow between the refugia. Analysis of plumage and song characteristics reveals robust differences between the Iberian subspecies *P. m. mabbotti*, Caucasian *P. m. obscura* and nominate *P. m. modularis*. Our assessments, in conjunction with genetic isolation, support species recognition under the Phylogenetic, Biological and Comprehensive Biological Species Concepts, via qualitative and quantitative criteria, and diagnosability. We thus propose the elevation of Iberian Dunnock *P. mabbotti* and Caucasian Dunnock *P. obscura* to species level.

Dunnock *Prunella modularis* is a common songbird species that is endemic to the Western Palearctic. Some north European populations migrate short distances to winter in southern Europe, whereas populations breeding in the latter region are largely sedentary (del Hoyo & Collar 2016). No fewer than 15 subspecies have been described, with several having ranges largely circumscribed by peninsular (e.g., Iberia), insular (British Isles) or montane regions (e.g., Caucasus). Subspecific descriptions have been based on plumage differences, and in a few cases qualitative assessments of mensural characters; assessments of vocalisations have been restricted to *P. m. occidentalis* from England (e.g., Cramp 1988). Since their formal description, many Dunnock taxa have been subsumed into other races (Table 1), and recent treatments vary in recognising as many as eight (Cramp 1988, del Hoyo & Collar 2016, Gill *et al*. 2020) to just three subspecies (Dickinson & Christidis 2014, Shirihai & Svensson 2018). None of these decisions was based on genetic data.

In our recent phylogeographic study of the Dunnock (Drovetski *et al*. 2018a), sampling included individuals from the distributions of *P. m. modularis* (most of central and northern Europe), *P. m. obscura* Hablizl, 1783 (north-east Turkey, Caucasus, north Iran), *P. m. occidentalis* E. Hartert, 1910 (Britain and west France), *P. m. mabbotti* Harper, 1919 (French Pyrenees, Iberia, and possibly the Italian Apennines and Greece; recent treatments are in conflict) and *P. m. meinertzhageni* Harrison & Pateff, 1937 (former Yugoslavia and Bulgaria).

The results of the Drovetski *et al*. (2018a) study placed Dunnocks into one of three highly supported clades, each distributed in different Pleistocene refugia: a Caucasus clade, an Iberian clade, and a clade comprising all other individuals, including from the Balkans. Gene-flow analysis indicated that the Caucasus and Iberian clades were isolated from each other, as well as from the remaining clade, in which extensive gene flow was evident between Italy, the Balkans (Montenegro, Serbia and Greece) and broader Europe. Based on this genetic isolation, we suggested that Dunnock comprises three species (Drovetski

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TABLE 1
The eight subspecies of *Prunella modularis* currently recognised by Gill *et al*. (2020) and their type localities, and their treatment under other modern classifications.

Taxon and authority	**Type locality**	**Cramp (1988)**	**Dickinson & Christidis (2014)**	**del Hoyo & Collar (2016)**	**Shirihai & Svenson (2018)**	**Clements *et al*. (2019)**
P. m. hebridium R. Meinertzhagen, 1934	South Uist, Outer Hebrides, Scotland	*P. m. hebridium*	*P. m. occidentalis*	*P. m. hebridium*	*P. m. occidentalis*	*P. m. hebridium*
P. m. occidentalis E. Hartert, 1910	Tring, Hertfordshire, England	*P. m. occidentalis*	*P. m. occidentalis*	*P. m. occidentalis*	*P. m. occidentalis*	*P. m. occidentalis*
P. m. modularis (Linnaeus, 1758)	Sweden	*P. m. modularis*	*P. m. modularis*	*P. m. modularis*	*P. m. modularis*	*P. m. modularis*
P. m. mabbotti Harper, 1919	3 km south of Saillagouse, Pyrénées-Orientales, France	*P. m. mabbotti*	*P. m. modularis*	*P. m. mabbotti*	*P. m. modularis*	*P. m. mabbotti*
P. m. meinertzhageni Harrison & Pateff, 1937	Beglik and Rila, Bulgaria	*P. m. meinertzhageni*	*P. m. modularis*	*P. m. meinertzhageni*	*P. m. modularis*	*P. m. meinertzhageni*
P. m. fuscata Mauersberger, 1971	Ai-Petri, Crimea, Ukraine	*P. m. fuscata*	*P. m. obscura*	*P. m. fuscata*	*P. m. obscura*	*P. m. fuscata*
P. m. euxina Watson, 1961	Uludağ, Bursa, north-west Turkey	*P. m. euxina*	*P. m. modularis*	*P. m. euxina*	*P. m. modularis*	*P. m. euxina*
P. m. obscura (Hablizl, 1783)	Gilan, Iran	*P. m. obscura*	*P. m. obscura*	*P. m. obscura*	*P. m. obscura*	*P. m. obscura*

et al. 2018a), which was supported by molecular species delimitation. Here we summarise in more detail the morphological and vocalisation data supporting the elevation of two Dunnock subspecies, corresponding to the Iberian and Caucasus clades described by Drovetski *et al*. (2018), to species status. In addition, we suggest that *P. m. meinertzhageni* of the former Yugoslavia and Bulgaria be synonymised with the nominate subspecies.

Material and Methods

Based on our genetic results (Drovetski *et al*. 2018), we compared specimens collected during the breeding season from the distributions of the three Dunnock lineages to their original descriptions (as subspecies) in order to verify the accuracy and validity of the proposed distinguishing characters. We analysed specimens held in the American Museum of Natural History, New York (AMNH), National Museum of Natural History, Smithsonian Institution, Washington DC (USNM), Biodiversity Research and Teaching Collection Texas A&M University, College Station, TX (TCWC), and Museo Civico di Storia Naturale di Carmagnola, Italy (MCCI). Specifically, we sought to assess if the plumage characters used in the original descriptions were in fact diagnostic. We analysed 50 specimens of *P. m. modularis*, 17 of *P. m. mabbotti* and 14 of *P. m. obscura* (Appendix 1). To visualise plumage variation among these taxa, we present photographs of the ventral, lateral and dorsal aspects of specimens of these lineages, including the holotype of *P. m. mabbotti* at USNM (Fig. 1). All photographed specimens were collected between late April and early June, and

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Figure 1. Specimens of the three Dunnock taxa considered in this work in dorsal, ventral and lateral views. A. *Prunella* [*modularis*] *modularis*, USNM 640862 (female; left) and USNM 640847 (male; right), Greece. B. *P.* [*m.*] *mabbotti*, first pair USNM 256648 (female; left) and USNM 256755 (type specimen, male; right), French Pyrenees; second pair USNM 317499 (female; left), and USNM 317500 (male; right), Spain. C. *P.* [*m.*] *obscura*, USNM 640349 (female; left) and USNM 640358 (male; right), Greater Caucasus (S. V. Drovetski)

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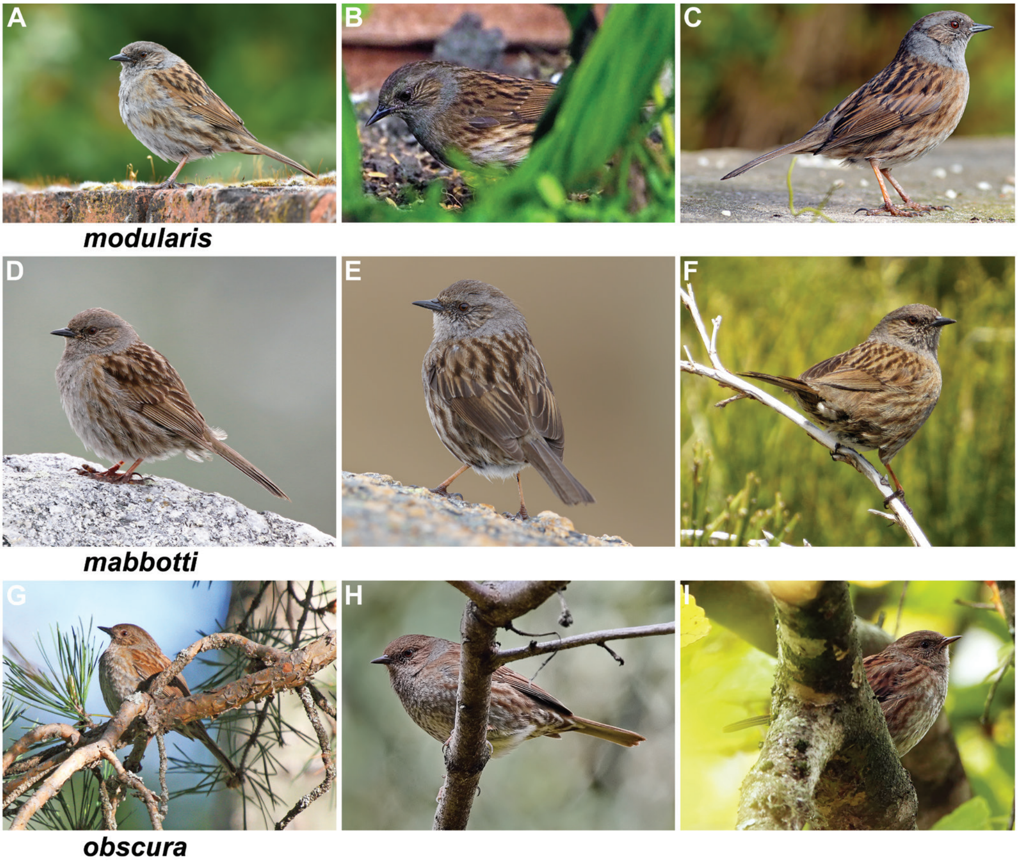

Figure 2. Individuals of the three Dunnock taxa considered herein. A. *Prunella* [*modularis*] *modularis*, UK (© L. Pulawski). B. *P.* [*m.*] *modularis*, Ireland (© B. Carruthers). C. *P.* [*m.*] *modularis*, UK (© K. Johnson). D. *P.* [*m.*] *mabbotti*, Spain (© D. Jauvin). E. *P.* [*m.*] *mabbotti*, Spain (© D. Petterson). F. *P.* [*m.*] *mabbotti*, Spain (© P. Alves). G. *P.* [*m.*] *obscura*, Armenia (© P. Adriaens). H. *P.* [*m.*] *obscura*, Georgia (© O. Nabrovenko). I. *P.* [*m.*] *obscura*, Iran (© C. Mroczko)

are therefore in breeding plumage. We also provide pictures of live individuals of the same taxa, photographed in the breeding season (Fig. 2).

We also compared songs of the three lineages, by using the Xeno-canto database (www.xenocanto.org) to select good-quality recordings made during the breeding season in the distributions of the three taxa. We analysed 125 phrases of *P. m. modularis*, 31 of *P. m. mabbotti* and 11 of *P. m. obscura* (Appendix 2). The sonograms (Figs. 3–4) and the analyses were prepared using the software Praat (Boersma & Weenink 2020). For each analysed phrase, we calculated the total length (in seconds) and the frequency range, including min. and max. (in kHz). We also evaluated whether rattles were present (Constantine & The Sound Approach 2006: 38–39) and, if so, assessed their length and frequency range. To assess if differences between taxa were significant, we calculated *p*-value and Cohen's *d* value (Table 2).

Results

Plumage characteristics.—Dunnock *P. modularis sensu lato* has a grey to brownish head with streaky ear-coverts, plain to mottled crown, a heavily streaked mantle, and grey to brown breast grading to dusky white on the central belly, with the body-sides streaked

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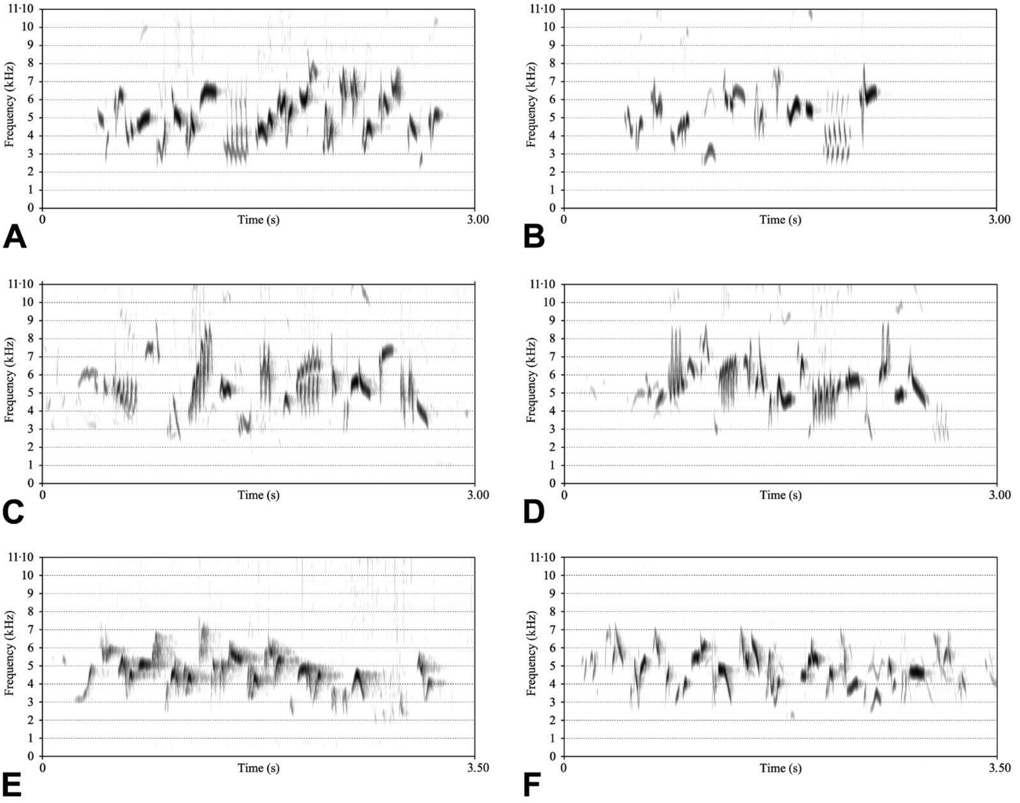

Figure 3. Sonograms of songs of Dunnock taxa considered in this work. A. *Prunella* [*modularis*] *modularis*, XC 392787 (J. Matusiak; www.xeno-canto.org/392787), Slovakia. B. *P.* [*m.*] *modularis*, XC 132703 (J. Matusiak; www.xeno-canto.org/132703), Poland. C. *P.* [*m.*] *mabbotti*, XC 342428 (A. Tomás; www.xeno-canto.org/342428), Portugal. D. *P.* [*m.*] *mabbotti*, XC 471699 (J. Calvet; www.xeno-canto.org/471699), Spain. E. *P.* [*m.*] *obscura*, XC 480650 (A. Lastukhin; www.xeno-canto.org/480650), Azerbaijan. F. *P.* [*m.*] *obscura*, XC 139532 (F. Deroussen; www.xeno-canto.org/139532), Georgia. Sonograms generated using Praat (Boersma & Weenink 2020).

buff-brown. The three subspecies assessed here (central European *P. m. modularis*, Iberian *P. m. mabbotti* and Caucasian *P. m. obscura*) show clear plumage differences relative to each other (Figs. 1–2). In particular, *P. m. mabbotti* (Figs. 1B, 2D–F) can be distinguished from other taxa of *P. modularis* by plumage differences listed in the original description (Harper 1919). Specifically, it differs from *P. m. modularis* (Figs. 1A, 2A–C) by its greyer, less rufescent back, mantle and wings, with their feather edgings buffy brown and smoke grey instead of cinnamon-brown as in *P. m. modularis* (Harper 1919), and their centres are brown instead of black as in *P. m. modularis*. Ventrally, *P. m. mabbotti* is less grey than *P. m. modularis* but closer in appearance to the latter than either is to *P. m. obscura* (Fig. 1C). Furthermore, the head of *P. m. mabbotti* is not as grey as, and lacks the brown streaking on crown and cheeks of, *P. m. modularis* and the former's ear-coverts are not as brown as those of the latter, conveying the impression of a plain face in *P. m. mabbotti*.

P. m. obscura is distinguished from the other taxa of *P. modularis* primarily by the plumage characters reported in the original description (Hablizl 1783; see also del Hoyo & Collar 2016). These differences are particularly evident on the head: buff-tinged chin, brownish nape (not grey), light brown plain supercilium (vs. pure grey in *P. m. modularis*), and light brown and finely streaked crown. Further differences include back feathers with

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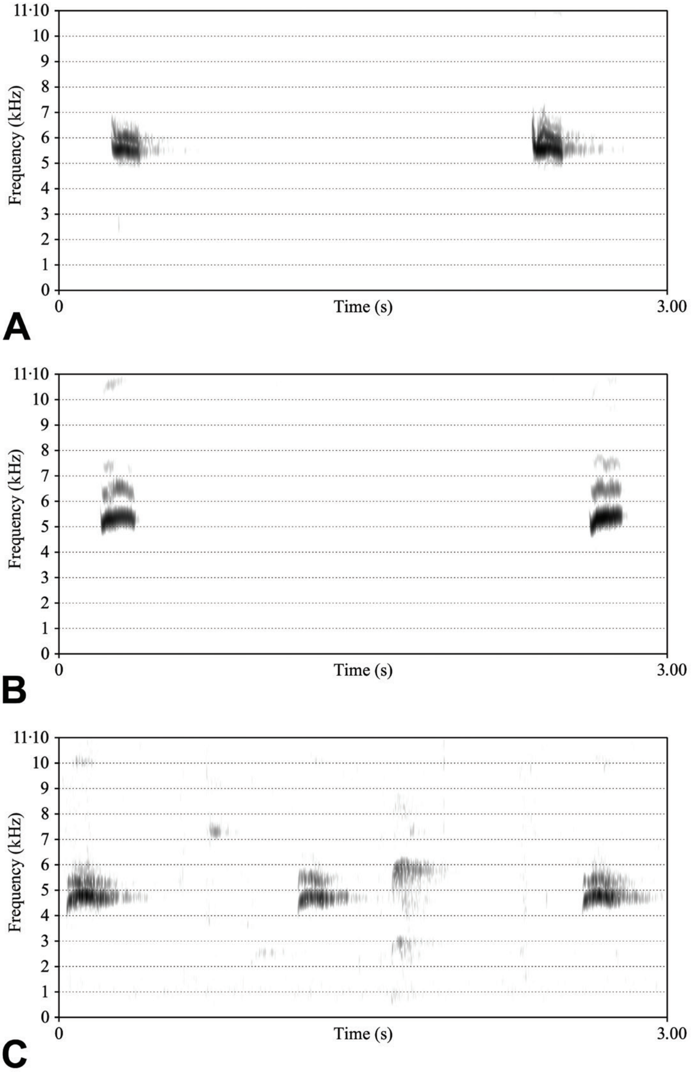

Figure 4. Sonograms of calls of Dunnock taxa considered in this work. A. *Prunella* [*modularis*] *modularis*, XC107150 (P. Åberg; www.xeno-canto.org/107150), Sweden. B. *P.* [*m.*] *mabbotti*, XC335177 (C. Mroczko; www.xeno-canto.org/335177), Spain. C. *P.* [*m.*] *obscura*, XC512728 (C. Mroczko; www.xeno-canto.org/512728), Iran. Sonograms generated using the software Praat (Boersma & Weenink 2020).

ill-defined chestnut streaks, and distinctly darker breast, compared to the other lineages, and throat to breast extensively marked with off-white or pale buff feather tips, forming a scaly pattern. Overall, *P. m. obscura* is much darker ventrally and more rufous-brown overall than the other two lineages, with less contrast between the grey and brown tones, a pattern approaching that of Japanese Accentor *P. rubida*.

Mensural data reported in the literature show great overlap between the various subspecies, with none available for breeding birds from Iberia and southern France (*P. m. mabbotti*) (Cramp 1988, Shirihai & Svensson 2018), thus we did not consider these parameters in our analysis.

Vocalisations.—The song of *P. modularis sensu lato* is a rather loud warble, usually 2.0–3.5 seconds long, and quite formless in that the notes lack a distinct structure (Fig. 3). The song of *P. modularis sensu lato* shows more prolonged units in the frequency range 4–6 kHz, and brief and sharply modulated units at 3–7 kHz with peaks up to 8 kHz. All units typically comprise different notes, apart from repetitions of a trill or rattle, usually once each phrase. Each male has repertoire of up to six (perhaps more) different songs, with each

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TABLE 2

Measurements of sound parameters in *Prunella* [*modularis*] *modularis*, *P.* [*m.*] *mabbotti* and *P.* [*m.*] *obscura*. Means and standard deviations are given. s = seconds; Cohen's *d* = effect size in terms of magnitude.

TAXON		**Total phrase length (s)**	**Max. frequency (kHz)**	**Min. frequency (kHz)**	**Frequency range (kHz)**	**1st rattle length (s)**	**1st rattle max. frequency (kHz)**	**1st rattle min. frequency (kHz)**	**1st rattle frequency range (kHz)**	**2nd rattle length (s)**	**2nd rattle max. frequency (kHz)**	**2nd rattle min. frequency (kHz)**	**2nd rattle frequency range (kHz)**
P. m. modularis	Mean	2.393	8.2694	2.2029	6.0665	0.174	6.1673	2.6125	3.5548				
	SD	0.550	0.4242	0.2931	0.5423	0.039	1.1325	0.4729	1.2084				
	N	125	125	125	125	80	80	80	80				
P. m. mabbotti	Mean	2.429	8.9648	2.5530	6.4118	0.163	7.8582	3.2321	4.6261	0.169	7.5744	3.6722	3.9022
	SD	0.360	0.3666	0.3344	0.5870	0.027	1.0104	0.3904	1.0281	0.024	0.90515	0.5863	0.6914
	N	31	31	31	31	31	31	31	31	25	25	25	25
P. m. obscura	Mean	2.992	7.5911	1.9797	5.6113								
	SD	0.285	0.3358	0.3420	0.6111								
	N	11	11	11	11								
modularis / mabbotti	t-test	0.3453	8.3822	5.7861	3.1213	1.4093	7.2644	6.4842	4.3593				
	P	0.73033	0.00000	0.00000	0.00215	0.16160	0.00000	0.00000	0.00003				
	Cohen's *d*	0.0773	1.7735	1.1136	0.611	0.3217	1.5756	1.4290	0.9549				
modularis / obscura	t-test	3.5653	5.1584	2.3884	2.6424								
	P	0.00050	0.00000	0.01832	0.00921								
	Cohen's *d*	1.3692	1.8072	0.7006	0.7879								
mabbotti / obscura	t-test	4.6860	10.8999	4.8574	3.8455								
	P	0.00003	0.00000	0.00002	0.00042								
	Cohen's *d*	1.7367	3.9081	1.6951	1.3360								

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song usually different in all units from the others; modification to an individual's song does occur between years and during counter-singing (Cramp 1988). These factors combine to render comparisons across lineages difficult, and furthermore the availability of recordings of *P. m. mabbotti* and *P. m. obscura* song during the breeding season is reduced compared to those of *P. m. modularis*.

Despite these difficulties, our comparison of songs did reveal some variation that seems to permit discrimination between *P. m. modularis*, *P. m. mabbotti* and *P. m. obscura*. Analysis demonstrates that the songs of *P. m. mabbotti* are higher pitched (with peaks up to 9 kHz) with the rattle repeated more frequently within the phrase (Fig. 3C–D). Specifically, *P. m. mabbotti* had two rattles in 81% of examined phrases and occasionally a third at the start of the phrase (Table 2), whereas in *P. m. modularis* 64% of examined songs possessed just a single rattle. On the other hand, the song of *P. m. obscura* (Fig. 3E–F) is longer and lower pitched (barely exceeding 7 kHz) than both *P. m. modularis* and *P. m. mabbotti*, and lacks the typical rattles of the other two (with one exception where a faint rattle was present). Most differences we identified are statistically significant, but effect size is relatively low based on Cohen's *d* values (Table 2).

Dunnock also produces a wide variety of calls (Cramp 1988), which makes their comparison rather complicated. Similar types of calls across the three taxa show very slight differences, with *P. m. obscura* being of lower frequency (kHz) and repeated more frequently than the other two (Fig. 4). As such, calls seem to have little bearing for distinguishing taxa.

Species concept criteria.—Diagnosability is an obvious threshold for recognising species, and diagnosable characters vary across species. In a recent study that used both morphological and genetic data to assess avian diversity, Barrowclough *et al*. (2016) postulated that recognised biological species each harbour on average 1.97 phylogenetic species based on a criterion of morphological diagnosability. Their genetic estimates found an average of 2.4 phylogenetic species per biological species. In other words, each biological species appears to include on average two phylogenetic species.

Our previous genetic results (Drovetski *et al*. 2018a), which included a species delimitation method, and Bayesian and gene-flow analyses, clearly indicated that the three lineages are reproductively isolated with no gene flow. It is highly unlikely that adding more genes (we used 11) or samples (we included 13 for Iberia, 36 for the Caucasus and 66 for the remaining clade) would alter our interpretation of reproductive isolation (see, e.g., Felsenstein 2006). Based on reproductive isolation and independent evolutionary trajectories (Drovetski *et al*. 2018a), the obvious plumage differences identified by previous works (summarised above), and song differences documented here, we suggest that *P. modularis* comprises three species under the Phylogenetic Species Concept (Cracraft 1983). Considering that an independent evolutionary history is what ultimately identifies a species (see Zachos *et al*. 2013), we consider our genetic data sufficient to also recognise the three lineages as species in accord with both the Biological Species Concept (for which reproductive isolation is the paramount issue; Mayr 1963) and the Comprehensive Biological Species Concept (Johnson *et al*. 1999). Our proposal to recognise three species is also consistent with the criteria proposed by Helbig *et al*. (2002), as all are diagnosable by plumage, mitochondrial and nuclear DNA, with differences in song.

Offering further support is that two Dunnock lineages (*P. m. modularis* and *P. m. mabbotti*) are probably parapatric (we can find no records to indicate sympatry) in south-west France, and that *P. m. obscura* is isolated from *P. m. modularis* (and other described subspecies) in the Caucasus and adjacent regions. Finally, we suggest that the length of time since lineages are estimated to have diverged should not be a factor in recognising species; to suggest otherwise seems notional rather than evidence-based. For example,

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Motacilla species diverged more recently than *Prunella* species, but the former are often accepted as separate species (Drovetski *et al*. 2018b). Among the *Prunella* radiation, of the 14 recognised species, ten (including *P. modularis*) are estimated to have diverged from their closest relative within the last two million years, and the most recent divergence was just 0.13 million years ago (between Brown Accentor *P. fulvescens* and Kozlov's Accentor *P. koslowi*; Drovetski *et al*. 2013).

Taxonomic assessment

Considering the various aspects detailed above, we propose the following taxonomic arrangement for European Dunnock taxa.

***Prunella modularis* (Linnaeus, 1758) Common Dunnock**
Remarks.—*P. modularis* is distributed in Europe from Scandinavia and the British Isles to France and northern Italy, and east to the eastern slope of the Ural Mountains (Cramp 1988, Shirihai & Svensson 2018). Based on our molecular work (Drovetski *et al*. 2018a), which included samples from the former Yugoslavia and Greece that were embedded within those from elsewhere in the range of the nominate subspecies, we propose that *P. m. meinertzhageni* be synonymised with *P. m. modularis*, as already suggested by Ripley (1964) and Shirihai & Svensson (2018). Placing this taxon in synonymy means that the range of *P. m. modularis* is expanded to include the Balkans and Greece. This species is polytypic and includes the following subspecies: *P. m. hebridium*, *P. m. occidentalis*, *P. m. modularis*, *P. m. fuscata*, and *P. m. euxina*.

***Prunella mabbotti* Harper, 1919, Iberian Dunnock, new rank**
Remarks.—Although this taxon has been considered a synonym of *P. modularis* by some authors (e.g., Dickinson & Christidis 2014, Shirihai & Svensson 2018), our results confirm its validity. *P. mabbotti* is distributed in the Iberian Peninsula and French Pyrenees (the type locality), where it is apparently resident (Cramp 1988). Vaurie (1955: 24) noted that two birds from the Pyrenees, two from central Spain and three from Portugal were similar to each other, and distinguishable from *P. m. modularis*. However, Vaurie (1955) erroneously attributed these birds to *P. m. lusitanica* Stresemann, 1928, a substitute name introduced for *P. m. obscura* Tratz, 1914, a junior homonym of *P. obscura* (Hablizl, 1783). Vaurie (1955) synonymised *P. m. mabbotti* with *P. m. lusitanica* but following Art. 60 of the *International code of zoological nomenclature* (replacement of junior homonyms) (ICZN 1999), the species-group name *mabbotti* Harper, 1919, has priority over its synonym *lusitanica*. We elaborate on this to eliminate future confusion, because while the nomenclatural priority is widely recognised, it has not been explicitly detailed in some recent works (e.g., Ripley 1964, Cramp 1988, Hatchwell 2005).

Based on our genetic results (Drovetski *et al*. 2018a), *P. mabbotti* does not occur in either Greece or the Italian Alps. The possible presence of *P. mabbotti* in the Apennines (northern to southern Italy) requires confirmation. While some treatments suggest this distribution as possible (e.g., Cramp 1988, Hatchwell 2005), the supporting rationale is unclear and the morphology of individuals we examined (specimens and photos of live birds) from the region are attributable to *P. modularis*. In addition, a preliminary genetic analysis of a recently fledged bird sampled in Abruzzo (central Italy) revealed a relationship with *P. modularis*, not *P. mabbotti* (L. Ilahiane pers. comm. 2021). Elsewhere, *P. mabbotti* is occasionally listed for south-central France (e.g., Hatchwell 2005) which implies a distribution on the north-east slopes of the Pyrenees, which is where the type locality is situated. As such, the northern limits of *P. mabbotti* relative to south-west France populations

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of *P. modularis* are not well defined, but these two forms are probably parapatric in this area, as corroborated by photographs of live birds during the breeding season. It appears that the eastern Pyrenees are occupied by Iberian Dunnocks (see, e.g., https://www.inaturalist.org/observations/39468304, https://www.inaturalist.org/observations/67241118), whereas in the western Pyrenees, where the mountains are lower, and in extreme northern Spain Common Dunnock occurs in an extension from its French distribution (see, e.g., https://www.inaturalist.org/observations/67829328, https://macaulaylibrary.org/asset/245589781). We consider *P. mabbotti* to be monotypic.

Prunella obscura **(Hablizl, 1783), Caucasian Dunnock, new rank**

Remarks.—The distribution of *P. obscura* is the Caucasus region, Transcaucasia, north-east Turkey and northern Iran (type locality), where it is resident (Cramp 1988). Given this distribution, *P. obscura* is unlikely to intergrade with either *P. m. euxina* or *P. m. fuscata*, which appear to be restricted to north-west Turkey and Crimea, respectively. We consider *P. obscura* to be monotypic.

To conclude, further studies based on sampling and morphological characterisation of breeding Dunnocks in different parts of Spain, Portugal and the French Pyrenees could clarify the distribution and conservation status of *P. mabbotti* and potential contact zones with *P. modularis* in France and Iberia. Additional sampling is also needed to assess whether *P. mabbotti* is present in central Italy. Further study is necessary to confirm the relationships of *P. m. occidentalis* and other subspecies of *P. modularis* not included by Drovetski *et al.* (2018a), viz. *P. m. hebridium* Meinertzhagen, 1934 (western Scotland, Hebrides and Ireland), *P. m. euxina* Watson, 1961 (north-west Turkey) and *P. m. fuscata* Mauersberger, 1971 (Crimea), to the taxa considered herein.

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Appendix 1

List of analysed specimens for each taxon. Abbreviations: AMNH: American Museum of Natural History, New York; USNM: National Museum of Natural History, Smithsonian Institution, Washington DC; TCWC: Biodiversity Research and Teaching Collection Texas A&M University, College Station; MCCI: Museo Civico di Storia Naturale di Carmagnola.

Prunella mabbotti: AMNH 584749, July, Portugal; AMNH 584750, July, Portugal; AMNH 584752, May, France. USNM 256648, April, France; USNM 256755, April, France (type specimen); USNM 317497, May, Spain; USNM 317498, May, Spain; USNM 317499, May, Spain; USNM 317500, May, Spain; USNM 317501, May, Spain; USNM 317502, May, Spain; USNM 317503, May, Spain; USNM 317504, May, Spain; USNM 317505, May, Spain; USNM 317506, May, Spain; USNM 317508, April, Spain; USNM 317509, April, Spain.

Prunella modularis: AMNH 25035, May, England; AMNH 54484, May, England; AMNH 261763, May, Sweden; AMNH 261764, May, Sweden; AMNH 348170, April, Scotland; AMNH 348175, April, Scotland; AMNH 450916, April, England; AMNH 454255, June, England; AMNH 455661, April, Austria; AMNH 455662, April, Austria; AMNH 455665, July, Germany; AMNH 455666, July, Germany; AMNH 455667, July, Germany; AMNH 455670, July, Germany; AMNH 455671, July, Germany; AMNH 455674, April, Austria; AMNH 584699, April, England; AMNH 584702, July, England; AMNH 584713, April, England; AMNH 584723, April, England; AMNH 584768, April, Switzerland; AMNH 584769, April, Switzerland; AMNH 584773, April, Germany; AMNH 584776, April, Germany; AMNH 748654, May, Denmark; AMNH 787814,

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April, Germany; AMNH 787818, April, Germany. MCCI 3684, June, Italy; MCCI 3686, July, Italy; MCCI 4301, July, Italy; MCCI 4380, June, Italy; MCCI 4386, May, Italy; MCCI 4623, June, Italy. TCWC 22939, July, Italy; TCWC 22940, July, Italy; TCWC 22941, July, Italy; TCWC 22942, July, Italy; TCWC 22943, July, Italy. USNM 111121, June, Norway; USNM 113817, April, England; USNM 113818, April, England; USNM 191639, July, Switzerland; USNM 191642, July, Switzerland; USNM 234673, April, England; USNM 256647, April, France; USNM 424650, April, Denmark; USNM 637507, May, Greece; USNM 640157, May, Greece; USNM 640847, May, Greece; USNM 640862, May, Greece.

Prunella obscura: AMNH 464668, April, Iran; AMNH 584738, March, Russia; AMNH 584741, March, Russia; AMNH 584742, March, Russia. MCCI 4095, June, Armenia; MCCI 4096, June, Armenia. TCWC 21769, June, Armenia. USNM 639814, June, Russia; USNM 639823, June, Russia; USNM 639833, June, Russia; USNM 640349, June, Russia; USNM 640358, June, Russia; USNM 640381, June, Russia; USNM 640452, June, Russia.

Appendix 2

List of analysed sound recordings for each taxon. All sounds were retrieved from Xeno-canto (www.xeno-canto.org).

Prunella mabbotti: XC 34430, Spain, Juan Malo de Molina; XC 342428, Portugal, Agostinho Tomás; XC 410813, Portugal, João Tomás; XC 421712; Portugal, Jorge Leitão; XC 443925, Portugal, Jorge Leitão; XC 468269, Spain, Marcel Gil Velasco; XC 471699, Spain, Jordi Calvet; XC 472305, Spain, Jordi Calvet; XC 477802, Portugal, Jorge Leitão; XC 502693, Portugal, Jorge Leitão; XC 560619, Portugal, Jorge Leitão.

Prunella modularis: XC 46515, France, Jacques Prevost; XC62835, Norway, Holger Schielzeth; XC 70132, England, Paul Driver; XC 77229, France, Jacques Prevost; XC 77399, Denmark, Luis A. Hansen; XC 100666, Switzerland, Bram Piot; XC 101995, Denmark, Niels Krabbe; XC 102924, Switzerland, Pascal Christe; XC 111910, Denmark, Elias A. Ryberg; XC 132703, Poland, Jarek Matusiak; XC 132705, Poland, Jarek Matusiak; XC 132707, Poland, Jarek Matusiak; XC 133850, Scotland, Mike Nelson; XC 181582, Italy, Francesco Sottile; XC 183444, England, Marc Anderson; XC 192411, Norway, Stein Ø. Nilsen; XC 193374, Norway, Stijn De Win; XC 196790, England, 'David M'; XC 243941, Switzerland, Jerome Fischer; XC 247270, Sweden, Mikael Litsgård; XC 270206, France, Peter Boesman; XC 281379, Belgium, Peter Boesman; XC 281380, Belgium, Peter Boesman; XC 325335, Lithuania, Jarek Matusiak; XC 331874, France, Cedric Mroczko; XC 335679, England, 'David M'; XC 367329, Denmark, Luis A. Hansen; XC 371122, England, David Bissett; XC 374616, France, Manuel Grosselet; XC 374617, France, Manuel Grosselet; XC 384332, Denmark, Luis A. Hansen; XC 384369, Denmark, Luis A. Hansen; XC 389110, Germany, Antonio Xeira; XC 392787, Slovakia, Jarek Matusiak; XC 415511, Norway, Stein Ø. Nilsen; XC 420704, France, Jérémy Simar; XC 420855, Italy, Giuseppe Speranza; XC 443875, Norway, Karl-Birger Strann; XC 478151, Belgium, Peter Boesman; XC 483786, France, Jérémy Simar; XC 488737, Germany, Stephan Risch; XC 602656, Finland, Alain Malengreau.

Prunella obscura: XC 138593, Georgia, Maercin Solowiej; XC 139532, Georgia, Fernand Deroussen; XC 480650, Azerbaijan, Albert Lastukhin; XC 480651, Azerbaijan, Albert Lastukhin; XC 561010, Turkey, Lider Sinav.

The correct scientific name of the Black Crake (Rallidae)

by Matthew R. Halley

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http://zoobank.org/urn:lsid:zoobank.org:pub:EDE9AA39-2999-4ACC-8BA2-F90AFDA3C53F

Summary.—The original scientific name of the Black Crake *Rallus niger* J. F. Gmelin, 1788, a diurnal species of African rail, was supplanted in the mid-19th century by William Swainson, who claimed the original description was unidentifiable. Swainson published two replacement names: *Rallus carinatus* Swainson, 1836, and *Gallinula flavirostra* Swainson, 1837, the latter of which is in prevailing usage. Here, I use historical and modern study skins to show that Swainson was confused by post-mortem colour changes and that the original description of *R. niger* J. F. Gmelin is not ambiguous as claimed. Therefore, according to the principle of priority, the oldest available name for the species is *Amaurornis niger* (J. F. Gmelin). To resolve this issue, a petition will be filed with the International Commission of Zoological Nomenclature, to request that the senior synonym be suppressed in the interest of nomenclatural stability.

During Cook's second voyage (1772–75), the expedition naturalist Johann Reinhold Forster (1729–98) collected the first specimens of an African rail that was then unknown to European naturalists. In November 1772, a few days after arriving at the Cape of Good Hope, Forster wrote in his journal: 'we daily brought home ample collections of vegetables and animals, and were much surprised to find a great number, especially among the latter, entirely unknown to natural historians, though gathered in fields adjacent to a town, from whence the cabinets and repositories of all Europe have been repeatedly supplied with numerous and valuable acquisitions to the science' (Forster 1777).

Cook's expedition returned to the Cape of Good Hope in 1775, en route to England, but Forster made no mention in his journal of collecting specimens during that period (Forster 1777). Within a month of his arrival in England, Forster prepared a manuscript in which he gave the name '*Rallus Aethiops*' to the new species from 'Prom. b. spei' (Promontorium Bonae Spei = Cape of Good Hope, South Africa). However, due to unforeseen circumstances, Forster's manuscript ('Descriptiones animalium') was not published until nearly a half century after his death (Forster 1844).

John Latham (1740–1837) studied Forster's specimens in the British Museum while preparing *A general synopsis of birds* (1781–85), but he was evidently unaware of Forster's unpublished manuscript. None of the specimens described by Latham (1785) has survived, with most believed to have perished by the early 19th century due to inferior taxidermy methods (Sharpe 1906). Latham (1785: 236) based his 'Black [Rail]' on multiple specimens in the British Museum that were collected at the Cape of Good Hope: 'size of the Spotted Gallinule: length nine inches. Bill yellow at the base; the tip brown: general colour of the plumage dusky black, deepest on the head: legs brown; in some birds red.' This description was likely based on Forster's material from 1772, because no specimens in the genus *Rallus* were collected at the Cape of Good Hope during Cook's third voyage (Stresemann 1950). Thus, Forster's specimens were *c.*12–13 years old when Latham studied them.

J. F. Gmelin (1788: 717) based the new name *Rallus niger* solely on Latham's (1785) account, after which Latham (1790: 759) adopted Gmelin's (1788) nomenclature. A half-

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century later, William Swainson (1789–1855) challenged this by claiming that Latham's (1785) account, and therefore the name *Rallus niger*, was ambiguous and unidentifiable (Swainson 1837). This created a nomenclatural vacancy that Swainson (1837) filled with his own name: *Gallinula flavirostra*. In his description of *G. flavirostra*, Swainson (1837) wrote: 'To this species, which is probably one of those which pass under the general name of Black Rail, we have not affixed the specific name of *Niger*, because Dr. Latham's account is too vague to be applied without doubt. He mentions, for instance, that the legs are either brown or red, that the end of the bill is brown, that the plumage in general is dusky-black, but deepest on the head, and that the claws are 'hooked'. As these discrepancies with our Senegal specimens lead to the suspicion that there may be more black species than one, we have distinguished this by a separate name.'

Specimen comparisons

To evaluate the identity of Latham's (1785) original description of the 'Black [Rail]', I studied a series of specimens from the Cape of Good Hope that were in the private collection of François Victor Masséna, second Duke of Rivoli, which was purchased by Thomas Bellerby Wilson in 1846, for the Academy of Natural Sciences of Philadelphia (ANSP). Like Forster's types in the British Museum during the 1780s, specimens in the Rivoli collection were originally mounted and displayed in glass cases until the mid-19th century, after which they were stored in dark cabinets and eventually dismounted. Forster's types were more than a decade old by the time Latham's (1785) description was published, long enough for plumage to fade and soft parts to change colour. For comparison, I also examined a modern specimen (ANSP 190276), collected in Equatorial Guinea in 2002 and prepared as a study skin by N. H. Rice. This specimen has been stored in darkness for 19 years, ever since it was prepared in the field (Fig. 1).

I compared study skins to colour patches in Smithe (1975) and hereafter use capitalised colour names and numbers from that work. The dorsal plumage of ANSP 190276 is Blackish Neutral Gray (82) and the crown is Jet Black (89). In the Rivoli specimens, the dorsal surface is Sepia (119) and the crown is a darker shade of sepia (no Smithe equivalent), approaching the intensity of Jet Black (89). The contrast between the crown and dorsal surface is more pronounced in the Rivoli specimens than ANSP 190276, but present in both. This may be a side effect of light exposure, if crown feathers fade more slowly because they are smaller and more tightly spaced than dorsal feathers. Irrespective of the cause of fading, Latham's (1785) comment that 'the plumage in general is dusky-black, but deepest on the head' is consistent with study skins of Black Crake, especially faded material that was previously mounted for display.

The orbital skin and feet of the Black Crake are bright red in life, but these parts rapidly change colour in study skins. Latham's (1785) comment that the claws were 'hooked' is sufficiently vague to match any degree of curvature and is therefore irrelevant. His comment 'that the legs are either brown or red' is consistent with differential post-mortem colour change. ANSP 190276 had 'reddish pink' tarsometatarsi when it was prepared in 2002, but now they are somewhere between Cinnamon (123A) and Yellow Ochre (123C), more like historical specimens (Fig. 1). The bill also undergoes post-mortem changes and some 'brownish' colour may be variably distributed on its surface, including the tip (Fig. 1). Therefore, Latham's (1785) comment about bill colour ('the tip [is] brown') is also consistent with specimens of the Black Crake and not ambiguous. Swainson's (1837) confusion was evidently caused by his ignorance of post-mortem colour changes, more than a lack of knowledge of geographic variation, as he supposed. Without fresh material from across its geographic range, I am currently unable to evaluate geographic variation in the species'

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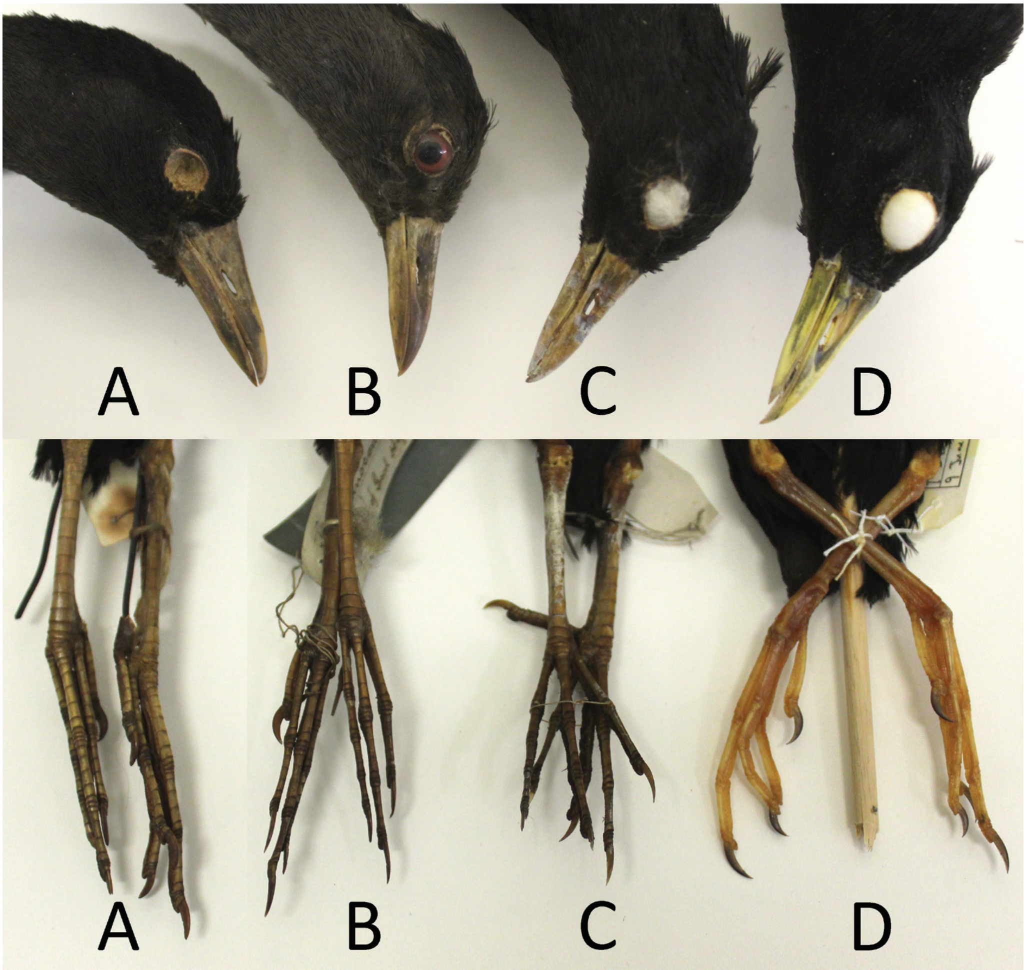

Figure 1. Digital photographs of the bills and feet of Black Crake *Amaurornis niger* specimens. The first three specimens (A–C) form part of the historic Rivoli collection, acquired by the Academy of Natural Sciences of Philadelphia in 1846: (A) ANSP 6278, collected at the 'Cape of Good Hope, South Africa'; (B) ANSP 6279, collected at the 'Cape of Good Hope, South Africa'; and (C) ANSP 6273, collected in 'South Africa'. The fourth specimen (D) is ANSP 190276, collected and prepared by N. H. Rice in Centro Sur, Equatorial Guinea, on 9 June 2002. The two digital images were taken on 17 January 2021 under the same light source, but a portion of the image lower left (A) was shifted to the right to make the figure compact (Matthew R. Halley)

plumage. Notwithstanding, Latham's (1785) description was based on faded specimens that were more than a decade old, whereas Swainson (1837) based his description on fresh material, evidently without older material for reference.

Another layer of synonymy

The name *Gallinula flavirostris* Swainson, 1837, is also a junior synonym of *Rallus carinatus* Swainson, 1836. Swainson (1836: 158, fig. 86) illustrated the head and toe of a specimen of 'a most singular rail from Senegal' and noted that it 'is our *Rallus carinatus* of the Appendix, and of the 'Birds of Western Africa'.' Although these works never materialised, Swainson (1836) already published 'a new species-group name in association with an illustration of the taxon being named', thereby meeting the criteria of availability in the Code (ICZN 1999, Art. 12.2.7). For aesthetic reasons, Swainson (1838) later changed his mind about the name

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R. carinatus, because he had 'reason to think the elevation of the bill, in the specimen figured as above quoted, [was] accidental, for another, since examined, had not this peculiarity.' He concluded: 'As the name of *carinatus* ['keeled, ridged'] would, therefore, lead to error, I now substitute that of *flavirostra*' (Swainson 1838).

Benson (1999: 39) claimed that 'there [was] no indication that [Swainson] had more than this one specimen', referring to a putative type of *G. flavirostra* Swainson, 1837, now in the University of Cambridge (UK) collection (15/Ral/27/a/3). However, Swainson (1837: 245) explicitly referred to 'two specimens now before us' in his description of *R. flavirostra* and two adult specimens ('a., b.') of *G. flavirostra* Swainson, 1837, collected by Mr. Rendall in Senegal, were listed in Gray's (1844: viii, 118) inventory of the British Museum collection. It appears likely that one of those specimens was Swainson's (1836) 'most singular rail from Senegal' (i.e., the holotype of *R. carinatus* Swainson, 1836) and the other was the second specimen, 'since examined', which alerted him to the aberrant bill structure in the first specimen (Swainson 1838). Type status of the specimen mentioned by Benson (1999), which was presumably in Swainson's private collection before it was acquired by the University of Cambridge, is therefore questionable.

Summary and taxonomic implications

There is no ambiguity in Latham's (1785) original description of the 'Black [Rail]' from the Cape of Good Hope, which served as the sole basis for the Linnaean binomial *Rallus niger* J. F. Gmelin, 1788. Therefore, the oldest available name of the Black Crake is *Amaurornis niger* (J. F. Gmelin), rendering *A. carinatus* (Swainson) and *A. flavirostra* (Swainson) junior synonyms. The name in prevailing usage (*A. flavirostra*, see del Hoyo *et al*. 1996) is not the oldest, or even second-oldest, available name. It was not a printing error or other inadvertent mistake that led to this confusion, but a deficit of knowledge that required specimen-based research to resolve. The correct synonymy (i.e., *niger* > *carinatus* > *flavirostra*) was used by at least one of Swainson's contemporaries (see Gray 1844: 118), only to be subsequently misinterpreted by many later authors, especially during the 20th century.

Under the Code (ICZN 1999, Art. 23.9.1), prevailing usage must be maintained, even when historically incorrect, if both of the two following conditions are met: (1) the senior synonym has not been used as a valid name after 1899, and (2) the junior synonym has been used 'in at least 25 works, published by at least 10 authors in the immediately preceding 50 years and encompassing a span of not less than 10 years.' In this case, the first condition is not met because the senior synonym was used as a valid name until the 1930s, including by Stone (1905: 757), Stark & Sclater (1906: 260), Grote (1912: 509), Sassi (1912: 354), Haagner & Ivy (1914: 253), van Someren (1916: 22), Miller (1924: 308), Moreau (1935: 29) and Coatney (1936: 96).

According to the Code (ICZN 1999, Art. 23.9.3), in cases where the above requirements are not met, an author may refer the case to the International Commission of Zoological Nomenclature, which may use its plenary power to suppress the senior synonym in the interest of nomenclatural stability. To resolve this issue, a petition will soon be submitted to the *Bulletin of Zoological Nomenclature*.

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Avifauna of the Aiope River basin, Kunua District, north-west Bougainville Island

by Iain A. Woxvold & Junior Novera

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Summary.—We present the results of a bird survey undertaken in the Aiope (Sarime) River basin in the Kunua District of north-west Bougainville, Papua New Guinea, during October–November 2019. Birds were surveyed across an elevational gradient of nearly 1,800 m, from the coast at the mouth of the Aiope River to the catchment headwaters in the north-west Emperor Range. Seventy-nine bird species were recorded, including three-quarters of Bougainville's resident land and freshwater avifauna (76/102 species) and a high proportion of its island-endemic and Solomons-endemic taxa (genera, species and subspecies). Resident avifauna include three species listed as threatened on the IUCN Red List—Sanford's Sea Eagle *Haliaeetus sanfordi*, Fearful Owl *Nesasio solomonensis* and (provisionally) Yellow-legged Pigeon *Columba pallidiceps*—nine Near Threatened species and two species that are protected under Papua New Guinean law. Forest supports 84% of the recorded resident bird species, most of which are forest-dependent, including all island-endemic taxa and all species of conservation concern apart from the Near Threatened Woodford's Rail *Nesoclopeus woodfordi*. Forest extent and condition improved with increasing elevation along the surveyed route; upper hill zone forest provides a narrow band of suitable habitat for a suite of lowland and hill forest species that were locally formerly more common across a broader altitudinal range. Elevational range extensions are reported for six species, and the vocalisations of Solomons Frogmouth *Rigidipenna inexpectata* are described from Bougainville for the first time.

Bougainville Island lies *c.*600 km east of New Guinea at the northern end of the Solomon archipelago, in the Northern Melanesian region of the south-west Pacific Ocean (Mayr & Diamond 2001). The largest island in the Solomon group, it is 210 km long and covers approximately 8,800 km^2 (excluding Buka). Its central chain of mountains is dominated by a series of Pleistocene and recent volcanoes (Speight & Scott 1967) and is divided into the Emperor Range in the north-west and the Crown Prince Range in the south-east.

Bougainville's avifauna includes 102 resident land and freshwater species plus 31 migrants that regularly visit the island (excluding vagrants, seabirds and resident species confined to offshore islets; distributional data from Hadden 2004). Avian community structure is strongly affiliated with that of other large islands in the Solomon archipelago, particularly Choiseul and Santa Isabel, with which Bougainville was periodically connected during Pleistocene glacial periods (Mayr & Diamond 2001).

The Solomons avifauna includes exceptionally high rates of endemism—the 'Solomon group Endemic Bird Area' (EBA) has the largest number of restricted-range bird species of any of the world's 218 EBAs (Stattersfield *et al.* 1998). Of 79 extant bird species that are endemic to the Solomons, nearly half occur on Bougainville (36 species), including one genus (*Stresemannia*), four species and ten subspecies that are confined to the island. A

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further two species and six subspecies occur only on Bougainville and smaller satellite islands (Buka, Fauro and the Shortland Islands).

Biodiversity across the Solomons is under sustained threat from forest clearance, habitat degradation and the establishment and spread of invasive species (Filardi *et al*. 2007, Aalbersberg *et al*. 2012, Katovai *et al*. 2015). As a result, 18% of Bougainville's resident avifauna (18/102) is currently classified as threatened or Near Threatened with extinction (IUCN 2020), 83% of which (15/18) is endemic to the Solomons.

Despite the high conservation value of Bougainville's avifauna, relatively little ornithological work has been conducted on the island. Recent data are especially scarce owing to the decade-long secessionist conflict that commenced in the late 1980s, and several of the island's rarer species have not been seen for more than 80 years. Historically, most effort has focused on the east and south, and north-west Bougainville is particularly poorly covered.

At the invitation of the Rapoisi community, and on behalf of the Critical Ecosystems Partnership Fund (CEPF), in October–November 2019 a bird survey was undertaken in the Aiope River basin, in the Kunua District of north-west Bougainville. The Aiope basin lies immediately north of the Kunua Plains and Mount Balbi Key Biodiversity Area (KBA) (Fig. 1). Surveys were conducted at multiple sites along an elevational gradient from sea level to *c*.1,800 m on the western slopes of the Emperor Range.

Previous data

Surveys of western Bougainville began in 1928 with the Whitney South Sea Expedition. From Cape Moltke, *c*.32 km south of the then-established Kunua coconut plantation, H. Hamlin led a group into the southern Emperor Range and was the first outsider to reach the Mt. Balbi crater (Hamlin 1929). Birds were collected en route, as well as at coastal localities near Amun ('Hamon') *c*.15 km south of Kunua. The specimens are held at the American

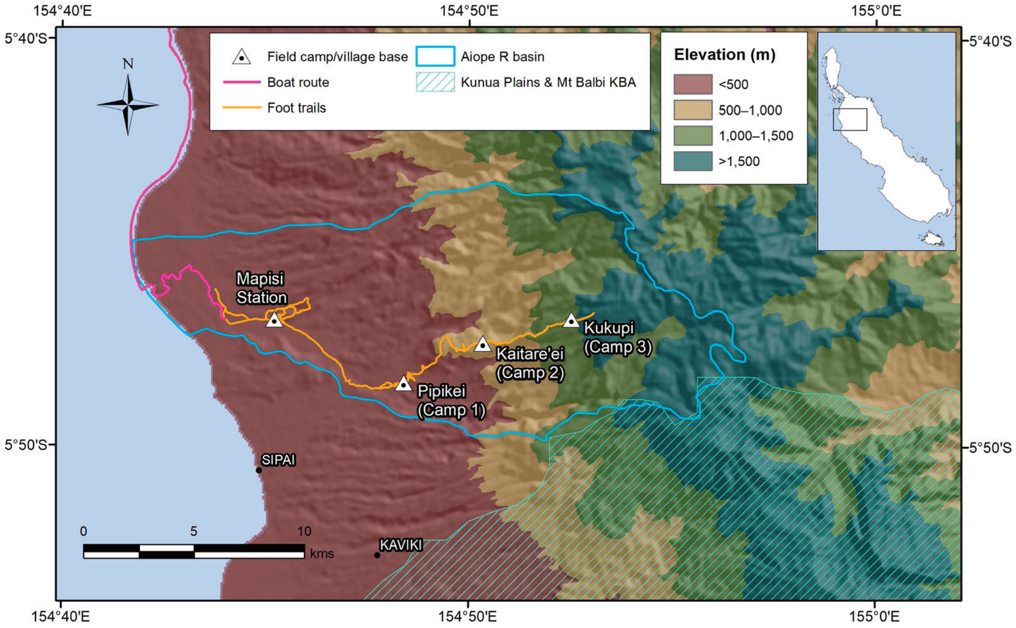

Figure 1. Study area and survey route.

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Museum of Natural History, New York (AMNH). These are the only data collected from the western drainage of the Kunua Plains and Mount Balbi KBA.

Subsequent data from western Bougainville largely comprise historical records from the coastal lowlands near Torokina and Empress Augusta Bay (Beecher 1945, Virtue 1947, Baker 1948, Filewood 1969). More recently, T. Mark observed birds from the coast near Atsinima inland to the upper hill zone (below 1,000 m) in the southern Emperor Range (sound recordings at www.xeno-canto.org). These sites lie *c*.40–90 km south-east of Kunua.

Other ornithologists have approached Mt. Balbi from the east, following roads from the coastal towns of Wakunai and Asitavi Mission. J. Diamond surveyed birds up to 1,950 m in 1972 (Diamond 1975; J. M. Diamond *in litt*. 2020), D. Hadden to at least 2,000 m in 2002 (Hadden 2004), and T. Mark to 2,200 m in 2014 (sound recordings at www.xeno-canto.org).

This is the sum of publicly available ornithological data from the Emperor Range and the hills and lowlands of north-west Bougainville. We are aware of no prior data from Kunua district or from those parts of the Emperor Range north of Mt. Balbi and Rotokas territory.

Study area and Methods

Aiope River basin.—Birds were surveyed in the Aiope (Sarime) River basin, a *c*.197 km^2 catchment reaching more than 2,050 m elevation in the north-west Emperor Range (Fig. 1). Steep terrain characterises the volcanic landform above *c*.250 m, below which low-to-moderate relief foothills flank broad alluvial plains lining the major watercourses (Scott *et al*. 1967). Permanent swamps lie within 2.5 km of the coast, which is lined with a narrow band of beach ridges. The climate is wet tropical, with annual rainfall averaging more than 2,600 mm near the coast (McAlpine 1967, Bryan & Shearman 2008). Rainfall increases with elevation and is mildly seasonal, with slightly lower monthly totals during the south-east 'trade winds' season (April–October: McAlpine 1967).

The study area is located in the Teua Constituency of Kunua District on traditional lands of the Rapoisi (Kunua) people. Kunua is also the name of the district administrative centre, comprising multiple villages located along *c*.10 km of the lower Aiope River valley. The area is sparsely populated outside the Kunua centre (Bourke *et al*. 2002).

Survey sites and timing.—Surveys were conducted from 11 October to 4 November 2019. Coverage spanned an elevational gradient of nearly 1,800 m, from the coast at the mouth of the Aiope River to the Porua River headwaters *c*.19 km north-west of Mt. Balbi (Fig. 1). The main survey programme was based on sampling over multiple days (range: 4−11 days) at each of four sites provided with resident household or field-based accommodation. Transfer between sites was made on foot with the assistance of Rapoisi residents. Travel between Buka Island and the Kunua survey base was by boat.

Table 1 lists the location, timing and elevations covered at each survey site. A brief description of each site and the habitats surveyed for birds is given below. Vegetation descriptions follow the PNG Forest Inventory Mapping System (FIMS) (Hammermaster & Saunders 1995). Place names are those used by local Rapoisi residents.

Mapisi Station.—Located in the Kunua centre along the lower Aiope River. Village and agricultural land covers much of the high-lying alluvial plain and flanking foothills for more than 10 km along the valley. Birds were surveyed on foot within 4 km of Mapisi Station in village and garden environments, agroforestry areas (including cocoa and coconut plantations), along the Aiope River, in flood-prone riverine grasslands, and in remnant and secondary forest environments (riverine seral and hill forest). No trapping or automated recording was undertaken at this site.

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TABLE 1
Accommodation/camp base locations, elevations covered and sampling effort.

	Mapisi	Pipikei	Kaitare'ei	Kukupi	Lower Aiope R.
Camp/base coordinates	05°46.9′S, 154°45.2′E	05°48.5′S, 154°48.4′E	05°47.5′S, 154°50.4′E	05°46.9′S, 154°52.5′E	
Camp/base elevation (m)	35	240	730	1,480	
Elevations covered (m)	15–160	160–360	590–900	(1,000–)1,400–1,765	
Dates present	11–16 Oct; 2–4 Nov	16–21 Oct	21–29 Oct; 1–2 Nov	29 Oct–1 Nov	11 Oct; 4 Nov
Search hours*	21.5	18.5	30.75	15.5	2
MacKinnon lists	24	20	30	10	
No. of mist-nets		9	7	7	
Mist-net hours		57	35	50	
No. camera traps		7	7		
Camera trap hours		483.5	517		
No. BAR positions		1	3	3	
BAR hours		51.5	114.5	133	

* Excluding opportunistic survey periods such as time around camp, deploying camera traps and mist-nets.

Pipikei (Camp 1).—This hamlet is in the foothills at the base of the former volcano slope (Scott *et al*. 1967), above the Porua River *c*.900 m east of its confluence with the Aiope River. The terrain east of camp is steep with ridges high above deeply incised valleys. Below and west of Pipikei, gentler terrain occurs as shallowly dissected volcano alluvial fans and alluvial plains. Natural vegetation is mapped as hill forest with riverine seral forest on alluvial plains; however, forest across much of the surveyed area had been cleared or is otherwise heavily disturbed. Surveys were conducted within 2 km of camp in a mosaic of secondary forest, bamboo, gardens and agroforestry with remnant patches of natural forest and isolated trees.

Kaitare'ei (Camp 2).—Located in the upper hill zone *c*.4 km east-northeast of Pipikei. Terrain is steep and of very high relief, with the hamlet perched *c*.250 m above the Porua Valley floor. Most former village sites at this elevation were abandoned some decades prior (residents relocating to the foothills) and the Kaitere'ei hamlet itself is not permanently occupied. Natural forest predominates, with areas of bamboo and secondary forest, including old-growth agroforestry species, present around the hamlet and at former village sites. Surveys were conducted within 2 km of camp, predominantly along the main ridge.

Kukupi (Camp 3).—This camp was established in the lower montane zone (above 1,000 m) on a ridge near the headwaters of the Porua River valley. The slope is steeper here than at lower sites, although the stream valleys are more shallowly incised. There are no permanent structures or prior settlements at this site. The lower montane forest is largely undisturbed with Myrtaceae, palms (*Hydriostele*) and multi-crowned pandans (*Pandanus*) among the canopy dominants. Understorey is dense with moss-covered woody surfaces and heavy epiphyte loads. Below camp, at *c*.850–1,350 m the route between Kaitare'ei and Kukupi passes through extensive areas of bamboo/tree fern (*Bambusa*/*Cyathea*) scrub. This zone covers the transition from hill to lower montane forest. Most survey effort was conducted over two mornings due to a delay in departure from Kaitare'ei and the onset of persistent heavy rain each afternoon. Surveys were conducted along the main ridge within

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2 km of camp. Additional records collected from above 1,000 m en route from Kaitare'ei are included in the Kukupi list.

Lower Aiope River.—In addition to the main survey programme, opportunistic boat-based records were made along the lower 7 km of the Aiope River during transit between Mapisi Station and the coast. Riverine successional growth (grassland–scrub–forest) occurs on aggrading banks throughout the course. Behind this, and along erosional banks, permanent swamps near the coast (*c*.4.5 km of river) support mixed swamp forest, while most forest upstream on the high-lying alluvial plain has been converted to agriculture. A narrow band of sand ridges supports littoral *Casuarina* forest along the coast, and tidal beaches and mudflats flank the river mouth.

Field techniques and survey effort.—A variety of sampling methods was employed to maximise completeness of the bird species inventory in the time available. Trapping and automated recording methods were limited to non-populous areas at Pipikei, Kaitare'ei and Kukupi. Table 1 lists the effort summaries at each site.

Active searches.—These were conducted on foot along pre-existing walking trails, through forest and along watercourses, and by boat along the lower Aiope River. Effort was weighted to peak periods of bird activity in the early morning and late afternoon, and included time before dawn and after dusk. Records at each of the four main survey sites were collated into a series of ten-species 'MacKinnon lists' (MacKinnon & Phillipps 1999, MacLeod *et al*. 2011); during each search period, sequential lists of ten species were generated with allowance for the same species to occur on multiple lists. To avoid double-counting, lists were not generated during the return journey along linear (non-loop) survey trails.

Mist-nets.—Up to nine mist-nets (9/12 m, 31/38 mm mesh) were deployed at Pipikei, Kaitare'ei and Kukupi in areas of primary forest, secondary forest and bamboo scrub. Trapped birds were measured (bill, head, tarsus, wing), photographed, blood sampled (70% ethanol; deposited at Museums Victoria, Melbourne) and released with the terminal end of three outer rectrices clipped to permit subsequent identification.

Camera traps.—Seven white-flash digital camera traps (Reconyx HC550/PC850) were deployed in forest near Pipikei and Kaitare'ei, close to the ground along animal trails and at apparent feeding stations. Survey time at Kukupi was insufficient to deploy cameras during the present field work. Additional data were collected from 30 camera traps (Reconyx HF) deployed by JN prior to the survey across an altitudinal gradient of 370–1,850 m. These cameras operated variably for 3–6 months, with most positioned to record mammals at the entrance of burrows and rock shelters, or in trees.

Sound-recording and playback.—Automated bioacoustic recorders (BARs, Frontier Labs) were deployed in forest at Pipikei, Kaitare'ei and Kukupi. During active searches, bird calls were opportunistically recorded on a Sony PCM-D50 Linear PCM Recorder. Selected sounds were played aloud using a portable speaker. A selection of bird sounds recorded during the survey (131 files, 50 species) has been uploaded to the Xeno-canto website (www.xeno-canto.org). Website catalogue numbers accompany specific recordings mentioned in the text (e.g. 'XC 543612').

Information from local residents.—Direct observations were supplemented with data gathered during conversations with Rapoisi residents. Discussions focused on the distribution and status of recognisable species of conservation significance and on the local language ('*tok ples*'—*Rapoisi*) names of distinctive and commonly encountered bird species. Rapoisi is one of the easternmost Papuan non-Austronesian languages (J. M. Diamond *in litt*. 2021). Identifications were considered most reliable when based on two or more of the following reference points: (1) images shown in a field guide (Dutson 2011); (2) sounds

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played aloud from an audio library; (3) birds photographed, seen or heard together in the field for which the local informant could provide an accurate description; (4) distinct local language names consistently provided by multiple informants.

Conventions.—Taxonomy and nomenclature (English and scientific names) follow the IOC world bird list (version 11.1) (Gill *et al*. 2021). Species in square brackets were only provisionally identified to species level; though not definitively identified, they likely represent taxa not confusable with previously recorded species and are included in site totals. Species of conservation concern include those listed in the IUCN Red List of threatened species (IUCN 2020) as globally threatened, Near Threatened or Data Deficient, and those listed as Protected under the PNG Fauna (Protection & Control) Act 1966.

To distinguish between potentially confusing political and geographical terms: (1) the term 'Solomon Islands' refers to the sovereign state of the Solomon Islands; (2) the Solomon island group, including parts of the sovereign states of Papua New Guinea (PNG) and the Solomon Islands, is referred to as the 'Solomon archipelago' and abbreviated as the 'Solomons'.

Endemism is a useful measure of habitat conservation value (Stattersfield *et al*. 1998, Waltert *et al*. 2011), especially in the Melanesian island context (Mayr & Diamond 2001, Davies *et al*. 2015). Three degrees of endemism are distinguished herein: (1) taxa confined to Bougainville ('island endemic'); (2) taxa found only on Bougainville and smaller satellite islands (Buka, Fauro and the Shortland Islands); and (3) taxa confined to the Solomons ('Solomons endemic').

Two hierarchical categories of forest use are distinguished: (1) 'forest species' include all birds regularly found in natural forest environments, many of which also utilise open and converted habitats; (2) 'forest-dependent' species comprise the subset of forest species reliant on forest environments, including birds that permanently reside in forest (including mature secondary forest) and those that may also be found in anthropogenic environments but are either rarely encountered in such habitats or rely on mature forest elements for some part of their life cycle (e.g. large trees with suitable nest hollows). Data on habitat use in Bougainville were taken from Coates (1985, 1990) and Hadden (2004).

Results

Appendix 1 lists the species recorded at each site, their conservation status, encounter rate, degree of endemism, major habitat associations, and Rapoisi names where known. A total of 77 bird species was recorded directly during the surveys. Two additional species are included based on information provided by local residents—Woodford's Rail *Nesoclopeus woodfordi* and, provisionally, Yellow-legged Pigeon *Columba pallidiceps*. Forty-four birds of 17 species were mist-netted (26 individuals, eight species) or photographed by camera trap (18 birds, 11 species) (Appendix 1). The diversity recorded at each of the main survey sites ranged from 34 to 49 species, with the highest tallies recorded at Kaitare'ei (49 species) and Mapisi Station (42 species). The avifauna includes 76 (96.2%) resident breeders. Three migratory species breed in the Northern Hemisphere and visit the region during the austral summer: Eurasian Whimbrel *Numenius phaeopus*, Common Sandpiper *Actitis hypoleucos* and Common Tern *Sterna hirundo*.

Fig. 2 shows the number of endemic taxa recorded at each of the four main survey sites. Rates of endemism increased with elevation. Taxa confined to Bougainville were recorded only in lower montane forest at Kukupi; they include three island-endemic species—Bougainville Honeyeater *Stresemannia bougainvillea*, Bougainville Whistler *Pachycephala richardsi* (Fig. 4D) and Bougainville Bush Warbler *Horornis haddeni*—and six subspecies (Appendix 1).

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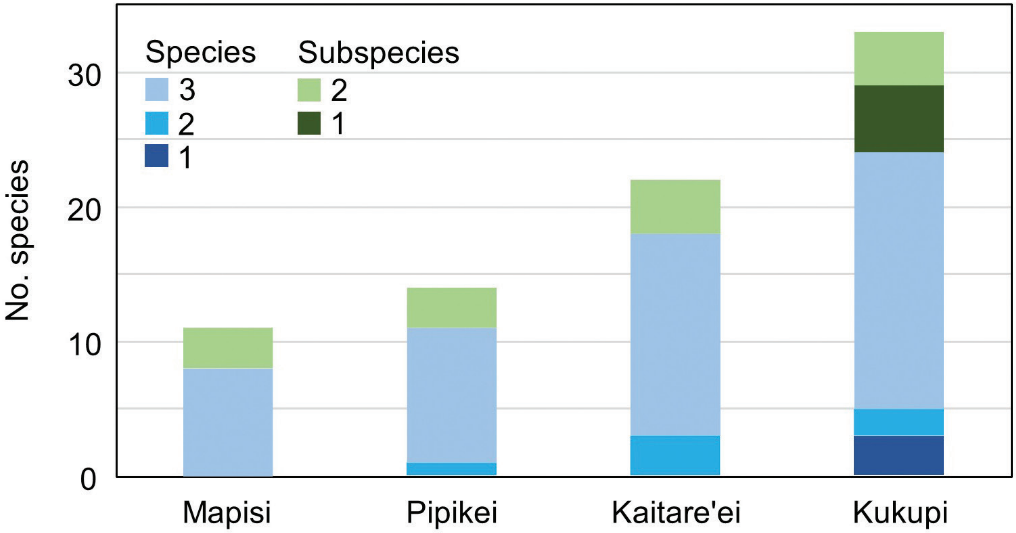

Figure 2. The number of regional and island-endemic species and subspecies recorded at each survey site. Endemism codes: 1—endemic to Bougainville; 2—endemic to Bougainville and small offshore islands (Buka, Shortland and Fauro); 3—endemic to the Solomons (displayed only at the species level).

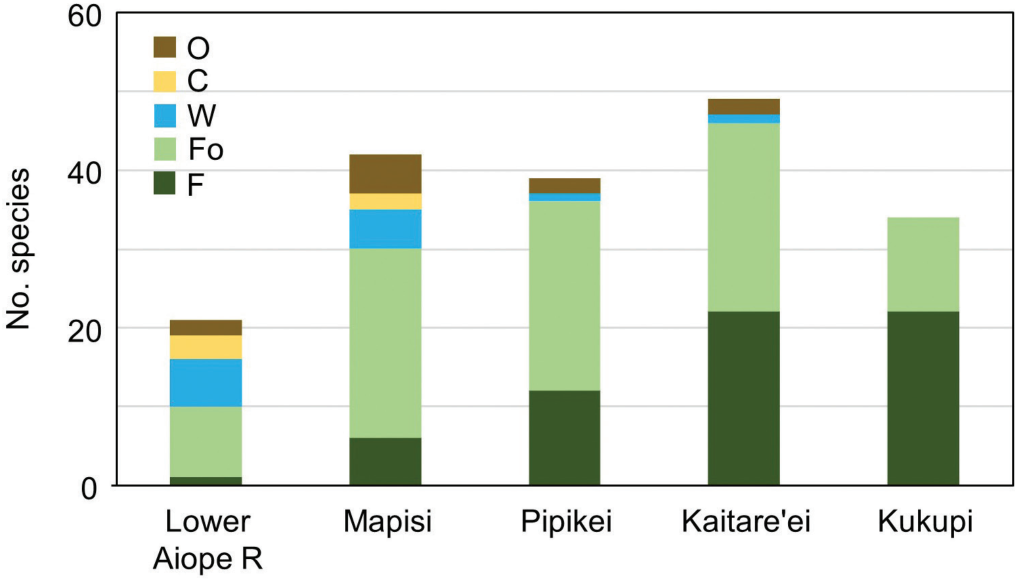

Figure 3. The number of species at each site and their major habitat associations. Habitat association codes: F—forest-dependent; Fo—forest, edge and converted land; W—rivers and wetlands; C—coastal; O—anthropogenic converted land. Data from Coates (1985, 1990) and Hadden (2004).

Fig. 3 shows the number of species recorded at each site and their major habitat associations. Both the proportion of forest species and number of forest-dependent species at each site increased with elevation. Most wetland species, and all predominantly coastal species, were recorded along the lower Aiope River and at Mapisi Station. Species requiring open and disturbed habitats were most diverse in the densely settled areas near Mapisi Station.

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Figure 4 (a) Red-knobbed Imperial Pigeon *Ducula rubricera* (Iain Woxvold); (b) Fearful Owl *Nesasio solomonensis* (Junior Novera); (c) male Red-capped Myzomela *Myzomela lafargei* (Iain Woxvold); (d) male Bougainville Whistler *Pachycephala richardsi* (Iain Woxvold); (e) female Steel-blue Flycatcher *Myiagra ferrocyanea* (Iain Woxvold); (f) Grey-throated White-eye *Zosterops rendovae* (Iain Woxvold)

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TABLE 2

Species of conservation concern recorded at each survey site. Conservation status is shown in brackets for species listed by the IUCN as Vulnerable (VU) or Near Threatened (NT) and species protected (P) under PNG law. Record codes: X—recorded directly by the authors; L—presence inferred from landowner testimony. Provisional records appear in square brackets.

Species (conservation status)	Mapisi	Pipikei	Kaitare'ei	Kukupi
Solomons Frogmouth *Rigidipenna inexpectata* (NT)		X		
Yellow-legged Pigeon *Columba pallidiceps* (VU)			[L]	
Crested Cuckoo-Dove *Reinwardtoena crassirostris* (NT)				X
Red-knobbed Imperial Pigeon *Ducula rubricera* (NT, P)		X	X	
Woodford's Rail *Nesoclopeus woodfordi* (NT)	L			
Sanford's Sea Eagle *Haliaeetus sanfordi* (VU)			X	
Fearful Owl *Nesasio solomonensis* (VU)				X
Blyth's Hornbill *Rhyticeros plicatus* (P)	X	X	X	X
Meek's Lorikeet *Charmosyna meeki* (NT)			X	X
Duchess Lorikeet *Charmosyna margarethae* (NT)			X	X
Solomons Cuckooshrike *Edolisoma holopolium* (NT)	X	X	X	
Solomons Monarch *Symposiachrus barbatus* (NT)			X	
Bougainville Bush Warbler *Horornis haddeni* (NT)				X

Thirteen species of conservation concern were recorded, including 12 listed by the IUCN as Vulnerable (Sanford's Sea Eagle *Haliaeetus sanfordi*, *Columba pallidiceps*, Fearful Owl *Nesasio solomonensis*) or Near Threatened, and two species protected under PNG law (Table 2). The highest numbers of species of conservation concern were recorded in relatively undisturbed forest environments at higher elevation sites—in the upper hill zone at Kaitare'ei (eight species) and in lower montane forest at Kukupi (six species).

Species accounts

Species accounts follow (in taxonomic order) for taxa of conservation concern, rarely recorded birds, and wherever records extend a species' known geographical or elevational range. Local Rapoisi names are shown where known. Dates without a year refer to the 2019 survey.

SOLOMONS FROGMOUTH *Rigidipenna inexpectata* (NT); 'kororori'

Endemic to the northern Solomons (Bougainville, Buka, Choiseul, Santa Isabel and San Jorge) where it is uncommon in forest and second growth from the lowlands to at least 700 m (BirdLife International 2020). It was familiar to local residents who stated that it occurs locally in forested hills.

Vocalisations from Bougainville are undescribed (Hadden 2004) and elsewhere are poorly known (Dutson 2011). Examples from Santa Isabel (at www.xeno-canto.org) include single high-pitched whistles repeated at long intervals, and a lower pitched, descending series of 3–5 whistles given 1–2 seconds apart (Fig. 6 *in* Cleere *et al*. 2007; G. Dutson *in litt*. 2020). Variants of both vocalisations were recorded on a BAR unit at Pipikei (XC 543626–629), on a ridge with secondary forest and tall bamboo at 250 m. The commonest sound was the descending series (19 detected over two nights, all at 0.8–2.0 kHz). This may be the species' 'song'. The full sequence consists of 3–4 (occasionally 1–2) upslurred whistles followed by 2–6 (normally three) trills. The sequence descends in pitch, and each note

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becomes progressively shorter, quieter and lower in amplitude (difference between max. and minimum pitch). Truncated sequences were sometimes given, consisting only of terminal trills or, less commonly, initial whistles. The higher pitched whistle call (1.8–2.7 kHz) was given singly as short (0.7–1.0-second), upslurred, mono- or disyllabic calls. These vocalisations are drastically different from those given by other *Podargus* species in Australia and New Guinea.

YELLOW-LEGGED PIGEON *Columba pallidiceps* (VU); 'rerebe'e'

This large pigeon is rare across most of its range in the Solomon and Bismarck archipelagos. At least partially terrestrial, it feeds and nests on the ground making the species susceptible to hunting and predation by cats and dogs (Mittermeier *et al*. 2018, BirdLife International 2020). Although most records are from hill forest, it has also been found in the lowlands, including in coconut plantation regrowth (Read 2013), and in lower montane forest at *c*.1,065–1,675 m on Bougainville (Hamlin 1928) and 1,300 m on Guadalcanal (Buckingham *et al*. 1990). There have been no records from Bougainville since 1928, when Hamlin collected one near Kupei in the Crown Prince Range (Hamlin 1928).

On 22 October, while listening to the calls of an imperial pigeon (*Ducula* sp.) at *c*.700 m near Kaitare'ei camp, a Rapoisi field assistant stated that the sounds belonged to a bird called 'rerebe'e'. The name is different to that applied to other locally occurring columbids, including Red-knobbed Imperial Pigeon *Ducula rubricera* ('beta'u basi') and Island Imperial Pigeon *D. pistrinaria* ('bo uru'uru') (Appendix 1). When questioned about the bird's appearance, he described it as a 'green *balus* [= pigeon] with white head and yellow legs' and iridescent plumage 'shiny like a mirror', features collectively unique to *C. pallidiceps*. Local *Ducula* species have a variety of calls; the deep, smooth-toned *wooOOo* sounds heard are somewhat similar to the call of *C. pallidiceps* (example from Makira Island available at www.xeno-canto.org). Later the same day, another man considered to be an experienced hunter by his Rapoisi colleagues confidently identified 'rerebe'e' as *C. pallidiceps* from among the columbids in the Dutson (2011) field guide, stating that he had last caught one in the area *c*.2013. Based on these statements, it seems likely that *C. pallidiceps* occurs in hill forest near Kaitare'ei. The record is here treated as provisional; if confirmed, it would be the first record from northern Bougainville and the first from anywhere on the island in more than 90 years.

CRESTED CUCKOO-DOVE *Reinwardtoena crassirostris* (NT)

This Solomons endemic is generally uncommon on Bougainville where it is most frequently encountered in primary forest in the upper hills and mountains (Hamlin 1928, Hadden 2004; *cf*. Schodde 1977). Recorded previously from the Emperor Range during the Whitney South Sea Expedition (Mt. Balbi: Hamlin 1928) and by T. Mark (at 1,100 m near Sisivi). In 2019, its distinctive song was recorded on the mornings of 31 October and 1 November on a steep forested slope below Kukupi camp at 1,200 m (XC 543612). Local residents stated that it does not occur in the populous lowlands.

RED-KNOBBED IMPERIAL PIGEON *Ducula rubricera* (NT, P); 'beta'u basi'

Endemic to the Solomon and Bismarck archipelagos where it occupies forest, less commonly degraded habitats, from the lowlands to upper hills and mountains, to at least 800 m on Bougainville (Hadden 2004) and 1,200 m on Guadalcanal (BirdLife International 2020). At Kaitare'ei this species was encountered daily in forest, including tall secondary forest, up to *c*.850 m (Fig. 4A). It was recorded there with certainty on more than one-third of MacKinnon lists. Probable additional encounters (up to 60% of lists: Appendix 1) are

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conservatively considered provisional due to the difficulty in distinguishing some call types from those of *Ducula pistrinaria* (Hadden 2004; pers. obs.). Although predominantly a bird of the lowlands, a *D. pistrinaria* seen at Kaitare'ei (at 730 m) matches the highest elevation reported for that species (Hadden 2004). At Pipikei, one *D. rubricera* observed after rain atop a remnant tall tree on 19 October was the only other record.

WOODFORD'S RAIL *Nesoclopeus woodfordi* (NT); 'siki'i'
A large, flightless rail endemic to the Solomons. The endemic Bougainvillean subspecies *N. w. tertius* is recognised by the IUCN as a separate species (Bougainville Rail *Hypotaenidia tertia*; del Hoyo & Collar 2014). Formerly considered extinct on Bougainville (Diamond 1987), the population appears to have increased greatly with the expansion of suitable regrowth habitat during the 1990s secessionist conflict (Hadden 2002). Although not recorded directly during the survey, *N. woodfordi* was familiar to local residents (as 'siki'i') who readily distinguished it from the sympatric Australasian Swamphen *Porphyrio melanotus* ('kosa') and Pale-vented Bush-hen *Amaurornis moluccana* ('keobau'). It was said to be fairly common in areas with tall grass and scrub in the populous region along the lower Aiope River, including in flood-prone riparian sites and along roadsides. They are sometimes hunted with dogs, particularly when flooding drives the birds out of cover.

SANFORD'S SEA EAGLE *Haliaeetus sanfordi* (VU); 'kerakera'
Endemic to the Solomons where it is the region's largest native terrestrial predator. It is widespread but sparsely distributed from the coast to the mountains. *H. sanfordi* is an important totem in many Bougainvillean cultures (Oliver 1968, Nash & Ogan 1990, Hage 2004). Rapoisi society is divided into matrilineal moieties represented by the sea eagle ('kerakera') and Blyth's Hornbill *Rhyticeros plicatus* ('bohuhu'), within which multiple subclans are identified by other bird totems. Bird-clan membership governs patterns of marriage, sexual relations, customary land ownership and local leadership structures (ensuring balanced representation in ward and village assemblies), and it is forbidden for people to hunt or eat their own totem. Local residents are consequently very familiar with these species, and indicated that it is not uncommon to see one or two 'kerakera' soaring overhead anywhere in the district. On 21 October, during transfer from Pipikei to Kaitare'ei, JN and several Rapoisi assistants observed a single *H. sanfordi* circling low over forest at *c.*600 m.

FEARFUL OWL *Nesasio solomonensis* (VU); 'itu'uko'
This large owl is endemic to the northern Solomons (Bougainville, Choiseul and Santa Isabel) where it is widespread but sparsely distributed in forest from the lowlands to at least 2,000 m. Local residents are familiar with this species and readily distinguished it from Solomons Boobook *Ninox jacquinoti* ('kuro'i') by its appearance, call and habit of hunting Northern Common Cuscus *Phalanger orientalis*. The Rapoisi name given during the survey ('itu'uko') is different to that reported by Hadden (2004) ('tuubaa'). Prior to the main survey, on the morning of 18 April (11.14 h) one *N. solomonensis* was camera-trapped above Kukupi camp at 1,600 m (Fig. 4B). During the main survey, calls of this species were recorded on 31 October (23.04 h) on a BAR unit deployed along a ridge in lower montane forest near Kukupi camp at 1,440 m (XC 543582). The species' voice is poorly known (Olsen & Marks 2020). Three calls were given over a period of 56 seconds, each consisting of a single, disyllabic note (*HOoWOoo*) lasting *c.*1.3 seconds and falling slightly in pitch.

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BLYTH'S HORNBILL *Rhyticeros plicatus* (P); 'bohuhu'
An important totem in Rapoisi society (see *Haliaeetus sanfordi*). Encountered daily at each of the four main survey sites and in a variety of habitats wherever tall trees were present, including forest, plantations, open areas and village gardens. Encounter rates were highest at Kaitare'ei where it was recorded on nearly 50% of MacKinnon lists (Appendix 1). As a mobile and easily detected species, multiple records at the same site may involve repeat encounters with the same individuals.

MELANESIAN KINGFISHER *Todiramphus tristrami*
Common in open and disturbed habitats across the Bismarck and most of the Solomon archipelagos. A duo calling below Kukupi camp at 1,420 m is the highest reported elevation on Bougainville (previously up to 700 m; reported to 1,500 m on New Britain: Dutson 2011).

MEEK'S LORIKEET *Charmosyna meeki* (NT)
A blossom nomad endemic to the Solomons. On most islands, it is normally found above 900–1,000 m (Collar & Boesman 2020). Previously on Bougainville, Hamlin (1928) encountered it above 900 m in flocks of up to more than 100 birds; Diamond (1975) observed *C. meeki* on Mt. Balbi where it was 'confined to the mountains' (Diamond 1975: 15); and Schodde (1977) reported the species at 300–1,500 m, usually in flocks of 10–15. In 2019, at Kaitare'ei a group of at least 12 *C. meeki* was seen together with Duchess Lorikeet *C. margarethae* in a flowering *Syzygium* at 650 m. At Kukupi, flocks of 3–8+ were encountered daily above 1,450 m.

DUCHESS LORIKEET *Charmosyna margarethae* (NT); 're'rai'
Endemic to the Solomons where the species is reportedly scarce and local across most of its range (BirdLife International 2020) though 'common' on Bougainville (Hadden 2004). On Bougainville it has been recorded in primary forest, tall secondary forest, plantations and gardens, predominantly in the hills (100–750 m) and more widely from the coastal lowlands to 1,350 m (Diamond 1975, Schodde 1977, Hadden 2004). In 2019, at least eight were seen at Kaitare'ei in company with *C. meeki* in a flowering *Syzygium* at 650 m. At Kukupi campsite (1,480 m), singles and small groups of 2–4 were observed daily feeding on epiphytic *Schefflera* fruits. This is the highest reported elevation for the species.

WHITE-BELLIED CUCKOOSHRIKE *Coracina papuensis*; 'kusiau'
Occurs widely in open and disturbed habitats across the Australo-Papuan region, predominantly in the lowlands and hills, occasionally at lower montane elevations up to 1,650 m on New Guinea and 1,400 m on New Britain (Coates 1990). On Bougainville, the endemic north Solomons subspecies *C. p. perpallida* has been reported as high as 1,100 m (Diamond 1975). At Kukupi the species was recorded twice in forest on a narrow ridge at 1,440 m and 1,460 m.

SOLOMONS CUCKOOSHRIKE *Edolisoma holopolium* (NT)
This Solomons endemic is scarce on some islands (Choiseul, Santa Isabel) but at least fairly common on Bougainville where it occupies forest including second growth from the lowlands to at least 800 m (Hadden 2004, Dutson 2011, Taylor *et al*. 2020). Singles and duos were encountered daily at Kaitare'ei in forest up to 800 m, less frequently in remnant forest at Pipikei, and once (a duo) in scattered trees along the Aiope River near Mapisi Station.

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GREY-CAPPED CICADABIRD *Edolisoma remotum*

Fairly common in forest, second growth and gardens, to 1,400 m on New Ireland and to at least 1,000 m on Bougainville (Coates 1990, Hadden 2004). Records from lower montane forest around Kukupi at 1,200 m, 1,360 m and 1,440 m are the highest reported elevations for the species on Bougainville.

COCKERELL'S FANTAIL *Rhipidura cockerelli*

Endemic to the Solomons where it inhabits the interior of closed forest, including primary and tall secondary forest, in the lowlands and hills (Schodde 1977, Hadden 2004). It has been recorded to *c.*1,000 m on Bougainville, and elsewhere to 1,150 m (Hadden 2004, Dutson 2011). A recording of the species' distinctive song (XC 543617), made on a steep forested slope below Kukupi camp at 1,200 m, is from the highest reported elevation.

SOLOMONS MONARCH *Symposiachrus barbatus* (NT)

Endemic to the Solomons where largely confined to the interior of primary and tall secondary hill forest (Schodde 1977, Coates 1990, Hadden 2004, Dutson 2011). It was unobtrusive but fairly common at Kaitare'ei with singles or duos encountered on most days, usually in the forest interior but occasionally in hamlet gardens near the forest edge where it was accompanied by Bougainville Monarch *Monarcha erythrostictus*. In hill forest the species was observed in a feeding flock with *M. erythrostictus*, *Rhipidura cockerelli*, Steel-blue Flycatcher *Myiagra ferrocyanea* (Fig. 4E) and Finsch's Pygmy Parrot *Micropsitta finschii*. It was not found in more heavily disturbed foothill forests at Pipikei where *M. erythrostictus* persisted.

BOUGAINVILLE MONARCH *Monarcha erythrostictus*; 'sose'e'

Endemic to Bougainville and surrounding smaller islands (Buka, Shortland and Fauro). It is treated by the IUCN as a subspecies of the Solomons endemic Chestnut-bellied Monarch *M. castaneiventris erythrostictus* (del Hoyo & Collar 2016). Sightings at 1,525 m at Kukupi are the highest reported elevation for the species (previously up to 1,200 m: Hadden 2004).

BOUGAINVILLE BUSH WARBLER *Horornis haddeni* (NT); 'kopaki'

This island endemic occupies steep forested slopes at 700–1,500 m (Hadden 2004). It was recorded only at Kukupi where its distinctive song was heard or recorded daily at 1,200–1,450 m (e.g. XC 543567). Prior to our bird survey, one was camera-trapped near Kukupi camp at 1,500 m on 2 August.

BLUE-FACED PARROTFINCH *Erythrura trichroa*

Rarely reported on Bougainville (Hadden 2004), on 29 October this species' distinctive call was heard twice at *c.*1,050 m during transfer to Kukupi, near a forested stream amid extensive grass and bamboo.

Discussion

The 2019 survey results include the first avifaunal data to be collected in Kunua district and one of the few recent datasets from north-west Bougainville. Our records include three-quarters of Bougainville's resident land and freshwater bird species (76/102), three of Bougainville's four island-endemic species, 60% (6/10) of its endemic subspecies and 80% (29/36) of Solomons endemic species that occur on Bougainville.

Appendix 2 lists the 26 Bougainvillean resident (at least historically) land and freshwater bird species that were not recorded during the survey, along with their conservation status,

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degree of endemism and major habitat associations. An additional 27 migratory species (not tabulated) may also visit the study area (excluding vagrants and those with fewer than five records: Hadden 2004), most of which (23 species) occupy rivers, wetlands and coastal sites. Avian community composition, conservation value and the potential for additional species of conservation significance to occur in each of the study area's major natural environments are discussed below.

Forest environments.—Of the 76 resident species recorded, 64 (84%) occur in forest, most of which are forest-dependent (Appendix 1). All island-endemic taxa (genera, species and subspecies), most Solomons endemic species (21/29) and almost all species of conservation concern (except *Nesoclopeus woodfordi*) recorded in the study area are dependent on forest environments (Appendix 1).

The extent and condition of forest environments improved with increasing elevation along the surveyed route—from remnant fragments at Mapisi Station, through secondary and disturbed forest prevalent at Pipikei, to predominantly intact forest at Kaitare'ei and Kukupi. Consequently, the proportion of forest species, the number of forest-dependent species, and the number of Solomons and island-endemic taxa at each site increased with forest availability along an altitudinal gradient (Figs. 2–3), and the most intact forest bird communities were recorded at the higher elevation sites at Kaitare'ei and Kukupi.

Lowland plains and hill forest.—Bird species richness was highest in the upper hill zone at Kaitare'ei. Almost all of the species recorded there (46/49) occupy forest environments, nearly half of which are forest-dependent (22/46) (Appendix 1). Eight species of conservation concern were recorded at Kaitare'ei, the most at any survey site (Table 2), including three species not found at other sites—*Haliaeetus sanfordi*, *Symposiachrus barbatus* and the rare *Columba pallidiceps*; although the latter species is listed as provisional, the testimonies of two informants strongly suggest that it is still present around Kaitare'ei, albeit probably in small numbers.

The majority of species recorded at Kaitare'ei also occupy lowland plains and foothill forest (*cf*. Red-breasted Pygmy Parrot *Micropsitta bruijnii*, *Charmosyna meeki* and Oriole Whistler *Pachycephala orioloides*). However, many of these were not recorded in more degraded habitats at suitable elevations around Mapisi or Pipikei, e.g., Superb Fruit Dove *Ptilinopus superbus*, *Micropsitta finschii*, *Charmosyna margarethae*, Red-capped Myzomela *Myzomela lafargei* (Fig. 4C), *Rhipidura cockerelli*, Rufous Fantail *R. rufifrons* and *Symposiachrus barbatus*. Among those forest species recorded in the foothills at Pipikei, many were encountered more frequently at Kaitare'ei—Claret-breasted Fruit Dove *Ptilinopus viridis*, *Ducula rubricera*, *Edolisoma holopolium*, *E. remotum* and *Myiagra ferrocyanea*. By contrast, species encountered more often at Pipikei than at Kaitare'ei were typically birds of forest edge or of open and disturbed habitats, e.g., *Ducula pistrinaria*, Brush Cuckoo *Cacomantis variolosus*, Cardinal Lory *Pseudeos cardinalis*, *Coracina papuensis* and Olive-backed Sunbird *Cinnyris jugularis*.

For the most part, changes in forest condition thus explain changes in bird community composition. In a notable exception, Bougainville Crow *Corvus meeki* was present at Kaitare'ei and Kukupi but absent from Mapisi Station and Pipikei. This easily detected species is reportedly common in forest, edge and open habitats, including village gardens and coconut plantations, from the lowlands to 1,600 m (Coates 1990, Hadden 2004). Multiple Rapoisi residents stated that it was once common in settled areas near Mapisi Station, but that it had not been observed there for some time. The reason for its recent decline at lower elevations is unknown.

The forest at Kaitare'ei provides a narrow band of suitable habitat for a suite of forest species that, at least along the survey route, were formerly more common across a broader

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elevational range. On mountainous Melanesian islands, many forest species are more or less confined to distinct altitudinal zones (Diamond 1975, Coates 1985). Diversity is generally highest in the lowlands and hills (Diamond & Mayr 1976), and on Bougainville many hill forest species naturally drop out between *c*.750 and 1,200 m (Hadden 2004). In the Aiope basin, extensive areas of bamboo/tree-fern scrub at *c*.800–1,300 m limit the availability of forest at the upper bound of this range (FIMS data; pers. obs.). Below Kaitare'ei, as demonstrated, the fragmented and degraded forests below *c*.500–600 m support a depauperate forest bird community.

Better-quality foothill forest may occur elsewhere in the Aiope basin. The present survey route followed a frequently used track into the mountains that provided access to multiple settlement sites, both current and former, around which anthropogenic disturbance is concentrated. Elsewhere, both the FIMS mapping anthropogenic disturbance codes (based on 1970s aerial imagery) and Landsat imagery from 2014 (Google Earth Pro V 7.3.2.5776) suggest that well-structured foothill forest still occurs patchily in a well-integrated network between *c*.50 and 500 m elevation across much of the northern catchment. Surveys of this area may reveal more intact lowland forest bird communities.

Lower montane forest.—The primary forest prevalent at Kukupi supports an intact lower montane bird community. Despite the low survey effort—limited to the rain-free hours of three days—almost all species known to occur above 1,250 m and previously reported from northern Bougainville were found; *Haliaeetus sanfordi* and Uniform Swiftlet *Aerodramus vanikorensis* being the exceptions, both of which probably also utilise the Kukupi forest. In addition to regular montane residents, five species were reported at record high elevations at Kukupi—*Todiramphus tristrami*, *Coracina papuensis*, *Edolisoma remotum*, *Rhipidura cockerelli* and *Monarcha erythrostictus*. *Charmosyna margarethae* and *Pseudeos cardinalis* normally occur at lower elevations but occasionally visit montane sites in response to seasonal food availability (Hadden 2004); both were seen feeding on epiphytic *Schefflera* fruits at Kukupi camp.

Narrow-range endemism among Melanesia's avifauna is highest in montane habitats (Mayr & Diamond 2001, Danielsen *et al*. 2010). Despite having the lowest species tally of the main survey sites (due to naturally lower diversity at montane elevations), Kukupi's avian community includes the largest number of Solomons endemic taxa and the only island-endemic species and subspecies recorded during the survey (Appendix 1; Fig. 2). Of Bougainville's four island-endemic bird species, three were confirmed at Kukupi—*Stresemannia bougainvillea*, *Pachycephala richardsi* and *Horornis haddeni*. Bougainville Thicketbird *Cincloramphus llaneae*, yet to be recorded on the Emperor Range, was the only island endemic not found at Kukupi.

Potential additional forest species.—Appendix 2 includes 14 resident Bougainvillean forest bird species not recorded during the survey. Most are cryptic, rare or uncommon, and four are yet to be recorded in northern Bougainville. Nevertheless, most are expected to occur in the Aiope basin and may be found with additional survey effort in suitable habitat. Among the rarer species, North Melanesian Cuckooshrike *Coracina welchmani* and White-eyed Starling *Aplonis brunneicapillus* (Vulnerable) were recently recorded in north Bougainville by T. Mark (Xeno-canto records).

A targeted effort was made to locate two of Bougainville's rarest and most enigmatic birds: Moustached Kingfisher *Actenoides bougainvillei* (Endangered) and Black-faced Pitta *Pitta anerythra* (Vulnerable).

The island-endemic subspecies of Moustached Kingfisher *A. b. bougainvillei* (treated as a separate species by the IUCN; del Hoyo & Collar 2014) is known only from southern Bougainville, although this may reflect the greater survey effort expended there. There are

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a handful of recent records (within the last 40 years) from upper hill / lower montane forest in the northern Crown Prince Range and a potential aural record from lowland swamp forest near Arawa (Bishop 1987, Hadden 2004, BirdLife International 2020). One or two local residents claimed to recognise the species from the field guide, stating that it occurs locally in upper hill and lower montane forest. When viewing illustrations there is much potential for confusion with other kingfishers. Although the reported elevations are encouraging, no informants were clearly familiar with the song (Guadalcanal data), and there was no response to playback in potentially suitable habitat. It may persist locally in small numbers, but further work is required to confirm or deny its presence.

The island-endemic subspecies of Black-faced Pitta *P. a. pallida* has not been seen since 1938 (Hadden 2004, BirdLife International 2020). It was not recognised by local residents and its preferred plains and foothill habitat (to at least 700 m: Hamlin 1928) has been heavily fragmented and degraded, and supports a suite of invasive species including rats (Black Rat *Rattus rattus*, Pacific Rat *R. exulans*), feral pigs (*Sus scrofa*), cats (*Felis catus*), dogs (*Canis familiaris*) and Cane Toad (*Rhinella marina*), which potentially threaten adults and nests or compete for invertebrate food resources. Its presence in the study area is considered doubtful.

Among montane birds, three unrecorded species are known only from the Crown Prince Range—the rare Metallic Pigeon *Columba vitiensis* (not seen on Bougainville for more than 50 years; Hadden 2004), *Cincloramphus llaneae* and Black-backed Thrush *Zoothera talaseae*. The Emperor Range is less well surveyed than its southern counterpart, and the presence of these (or closely reated) taxa in northern Bougainville is not unexpected; in all cases, the same or closely related species occur on nearby mountainous islands, notably New Britain, which is closer to the Emperor Range than it is to the Crown Prince Range. The hills linking the Emperor and Crown Prince Ranges lie below 750 m at their lowest point. If *Cincloramphus* or *Zoothera* do occur on the Emperor Range, given that there are no confirmed records of *C. llaneae* or *Z. talaseae* fom below 1,500 m, it will be interesting to determine if the same taxa are present in both areas. *C. llaneae* and *Z. talaseae* are predominantly terrestrial, and *Columba vitiensis* occasionally feeds on the ground (Baptista *et al*. 2020). Camera traps are an effective tool for detecting elusive birds (O'Brien & Kinnaird 2008, Murphy *et al*. 2017, Woxvold & Legra 2017, 2019) and their use in future searches is recommended.

Freshwater and coastal environments.—Watercourses, other waterbodies and coastal sites provide habitat for a variety of freshwater wetland and coastal specialist birds. Resident wetland species, such as Pacific Black Duck *Anas superciliosa*, *Porphyrio melanotus*, Nankeen Night Heron *Nycticorax caledonicus*, Striated Heron *Butorides striata* and the colonial nesting Little Pied Cormorant *Microcarbo melanoleucos*, may breed locally in backwater swamps and well-vegetated former river channels within *c*.2 km of the coast. At least some of these wetlands are considered sacred sites and are visited only by local landowners.

The Aiope River basin is unlikely to provide important habitat for any freshwater or coastal marine bird species of conservation significance. Regional residents include two rare coastal species, neither of which is likely to occur locally—Solomons Nightjar *Eurostopodus nigripennis* (Vulnerable) has not been recorded on Bougainville for almost 100 years and Beach Stone-curlew *Esacus magnirostris* (Near Threatened) is largely restricted to undisturbed beaches and offshore islets (Hadden 2004, BirdLife International 2020). In terms of migrants, most Palearctic shorebirds visit Bougainville in small numbers (Hadden 2004) and local shores do not include the extensive tidal mudflats required to support large wader aggregations.

Introduced species.—No non-native bird species were recorded. Among the most likely introductions: (1) we did not observe Common Myna *Acridotheres tristis*, which was at least

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formerly present at Arawa on Bougainville's east coast (Hadden 2004), and; (2) as yet, there are no pubished reports of Eurasian Tree Sparrow *Passer montanus* from the island, although it is well established and rapidly expanding in similar environments on mainland PNG (Beehler & Pratt 2016).

Final remarks.—Forest loss and degradation present the greatest threat to Melanesian bird communities (Filardi *et al*. 2007). Solomon Islands' forests have been excessively and unsustainably logged over the last 25 years (Katovai *et al*. 2015, Minter *et al*. 2018). Locally, more than 40% of Bougainville's lowland forest has been lost or degraded over the last half century (Allison & Tallowin 2015), and while no forest was commercially logged during 2002–14 (Bryan *et al*. 2015), this situation is expected to change as the island re-opens to development after an extended period of secessionist conflict.

Invasive alien species further threaten the Solomons avifauna, particularly those species that forage or nest on the ground (Filardi *et al*. 2007, Mittermeier *et al*. 2018). In this study, feral pigs were camera-trapped in forest at Kaitare'ei, feral cats were camera-trapped in forest on at least six cameras spanning elevations of 560–1,820 m, dogs (usually accompanied by men) were camera-trapped on multiple occasions in forest at Pipikei and Kaitare'ei, and introduced rats were the most commonly camera-trapped rodent, with records from all sampled elevations (JN unpubl.). Cane Toads were common in the lowlands and foothills at Mapisi Station and Pipikei, but were not observed in more intact forest at Kaitare'ei and Kukupi. Hunting represents an additional threat to large-bodied terrestrial species, including the rare *Columba pallidiceps*, especially when dogs are used (e.g. Mittermeier *et al*. 2018). A variety of birds is consumed by local residents, including large pigeons and Melanesian Megapode *Megapodius eremita*.

Despite these issues, bird communities in the natural forest prevalent at higher elevations were largely intact. The lower montane avifauna at Kukupi appears essentially unaltered, whilst the upper hill zone community at Kaitare'ei included the majority of species missing or otherwise under-represented in more degraded foothill forest. Beyond the survey route, recent satellite imagery indicates that better examples of foothill forest persist at the north-west rim of the Aiope River basin.

Bougainville has the richest avifauna of any Pacific island east of New Guinea. Published data are few, however, and almost no detailed surveys have been conducted since the civil war started in the late 1980s. Much remains to be learned concerning the distribution, status and ecology of many of Bougainville's birds. There is a pressing need for further studies as the island re-opens to development.

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Appendix 1

Birds recorded in the Aiope River basin in 2019. Migratory species are indicated by an asterisk (*) after the scientific name. Conservation status is shown in parentheses after the scientific name for species listed by the IUCN as Vulnerable (VU) or Near Threatened (NT) and species protected (P) under Papua New Guinean law. Site-based record codes: numerics (e.g., 0.125) indicate the proportion of MacKinnon lists that each species was recorded on during active search periods (see Active searches); X—recorded outside active search periods (e.g., via trapping or automated recording methods); L—deduced present based on local resident information. Square brackets indicate provisional records. 'Captures' indicate the number of birds camera-trapped (c) and mist-netted (n). 'Endemism' codes (species/subspecies): 1—endemic to Bougainville; 2—endemic to Bougainville and small offshore islands (Buka, Shortland and Fauro); 3—endemic to the Solomons. The subspecific epithet is provided for subspecies with an endemism rank of 1 or 2. 'Habitat' association codes: F—forest-dependent; Fo—forest, edge and converted lands; W—rivers and wetlands; C—coastal; O—anthropogenic converted land; data from Coates (1985, 1990) and Hadden (2004). Most Rapoisi names are similar to those provided by Hadden (2004). Exceptions include species for which: †—no Rapoisi name was provided by Hadden; ‡—the Rapoisi name is markedly different to that provided by Hadden; ‡‡—the names given to different sexes are the reverse of those provided by Hadden.

Species (conservation status)	**Mapisi**	**Pipikei**	**Kaitare'ei**	**Kukupi**	**Lower Aiope R.**	**Captures**	**Endemism**	**Habitat**	**Rapoisi name**
Melanesian Megapode *Megapodius eremita*	0.125	X	0.033			c2		F	'pa'e'o'
Pacific Black Duck *Anas superciliosa*	0.042				X			W	
Solomons Frogmouth *Rigidipenna inexpectata* (NT)		X					3/–	F	'kororori'
Moustached Treeswift *Hemiprocne mystacea*	0.083	0.050	0.033				–/3	Fo	'boisikura'
Glossy Swiftlet *Collocalia esculenta lagonoleucos*		0.050	0.067	0.400		n4	–/2	Fo	'tegeri'
White-rumped Swiftlet *Aerodramus spodiopygius*	0.167	X	X	0.100	X	n2	–/3	Fo	'tegeri'
Aerodramus sp.		0.050	0.067						
Pacific Koel *Eudynamys orientalis*		0.050					–/3	Fo	†'suki suki', 'koa'
Brush Cuckoo *Cacomantis variolosus*	0.333	0.650	0.200	0.600			–/3	Fo	'boipirupiru'
Yellow-legged Pigeon *Columba pallidiceps* (VU)			[L]					F	†'rerebe'e'
MacKinlay's Cuckoo-Dove *Macropygia mackinlayi*	0.083	0.100	0.167	0.100				F	‡'to'upe'e'
Crested Cuckoo-Dove *Reinwardtoena crassirostris* (NT)				X			3/–	F	
Stephan's Emerald Dove *Chalcophaps stephani*		0.050	X			c1	–/3	F	†'ka'aburio'
Superb Fruit Dove *Ptilinopus superbus*			0.167			n2		F	†'bisio'u'
Yellow-bibbed Fruit Dove *Ptilinopus solomonensis bistictus*				0.700			–/2	F	
Claret-breasted Fruit Dove *Ptilinopus viridis*	0.042	0.250	0.667		[X]			F	†'bisio'u', 'na'uru'o'
Red-knobbed Imperial Pigeon *Ducula rubricera* (NT, P)		0.050	0.367 [0.600]				–/3	F	'beta'u basi'
Island Imperial Pigeon *Ducula pistrinaria*	0.667	0.200 [0.550]	0.033 [0.066]		X			Fo	'bo uru'uru'

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Species (conservation status)	**Mapisi**	**Pipikei**	**Kaitare'ei**	**Kukupi**	**Lower Aiope R.**	**Captures**	**Endemism**	**Habitat**	**Rapoisi name**
Pale Mountain Pigeon *Gymnophaps solomonensis*				0.500			3/–	F	
Woodford's Rail *Nesoclopeus woodfordi tertia* (NT)	L						3/2	O	'siki'i'
Pale-vented Bush-hen *Amaurornis moluccana*	X							O	†'keobau'
Australasian Swamphen *Porphyrio melanotus*	0.042				X			W	'kosa, ‡'akaure'
Eurasian Whimbrel *Numenius phaeopus**					X			C	
Common Sandpiper *Actitis hypoleucos**		X			X			W	
Common Tern *Sterna hirundo**	X				X			C	
Little Pied Cormorant *Microcarbo melanoleucos*	0.167				X			W	'morogoi tutu'
Nankeen Night Heron *Nycticorax caledonicus*	0.042		X		X	c1		W	‡'ku'ita'
Striated Heron *Butorides striata*					X			W	
Pacific Reef Heron *Egretta sacra*	X				X			C	
Pacific Baza *Aviceda subcristata*	0.208	0.100					–/3	Fo	'ki'itou'
Variable Goshawk *Accipiter hiogaster bougainvillei*	0.042		0.133				–/2	Fo	'ru'ete'
Pied Goshawk *Accipiter albogularis*	[0.042]		0.033				–/3	Fo	'ru'ete'
Brahminy Kite *Haliastur indus*	0.208	0.100	0.067		X		–/3	Fo	'bakawa'/'makawa'a'
Sanford's Sea Eagle *Haliaeetus sanfordi* (VU)			X				3/–	F	'kerakera'
Solomons Boobook *Ninox jacquinoti*		X	0.067	X			3/3	F	'kuro'i'
Fearful Owl *Nesasio solomonensis* (VU)				X		c1	3/–	F	‡'itu'uko'
Blyth's Hornbill *Rhyticeros plicatus* (P)	0.250	0.350	0.433	0.200				F	'bohuhu'
Oriental Dollarbird *Eurystomus orientalis*	0.042	X	0.067					Fo	†'bokikiora'o'
Ultramarine Kingfisher *Todiramphus leucopygius*	0.125	0.150	0.167				3/–	Fo	'toreikirakira'
Melanesian Kingfisher *Todiramphus tristrami*	0.375	0.550	0.367	0.300	X		–/3	Fo	†'tokorokoro'
Common Kingfisher *Alcedo atthis*	0.083						–/3	W	'si'iriko'
North Solomons Dwarf Kingfisher *Ceyx meeki pallidus*		[X]					3/2	F	
Solomons Cockatoo *Cacatua ducorpsii*	0.583	0.550	0.533	0.700	X		3/–	Fo	'kakare'e'
Finsch's Pygmy Parrot *Micropsitta finschii*			0.100				–/3	F	
Red-breasted Pygmy Parrot *Micropsitta bruijnii*			0.033	0.200		c2	–/3	F	†'sisipu'
Eclectus Parrot *Eclectus roratus*	0.417	0.600	0.167		X			Fo	‡‡'kiroko' (female), 'boka'a' (male)
Song Parrot *Geoffroyus heteroclitus*	0.083	0.100	0.033					Fo	'kira'iko'
Meek's Lorikeet *Charmosyna meeki* (NT)			0.033 [0.066]	0.500			3/–	F	
Duchess Lorikeet *Charmosyna margarethae* (NT)			0.100	0.300			3/–	F	†'re'rai'

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Species (conservation status)	**Mapisi**	**Pipikei**	**Kaitare'ei**	**Kukupi**	**Lower Aiope R.**	**Captures**	**Endemism**	**Habitat**	**Rapoisi name**
Cardinal Lory *Pseudeos cardinalis*	0.667	0.300	0.100	X	X			Fo	'bosirihe', 'bosiri'e'
Coconut Lorikeet *Trichoglossus haematodus*	0.292	0.350	0.333	[X]				Fo	'bokurusu'
Bougainville Honeyeater *Stresemannia bougainvillei*				0.100		c2	1/–	F	
Red-capped Myzomela *Myzomela lafargei*			0.067	0.100		n4	3/–	F	
Barred Cuckooshrike *Coracina lineata*	0.042	0.100	0.167				–/3	Fo	
White-bellied Cuckooshrike *Coracina papuensis*	0.458	0.500	0.167	0.100			–/3	Fo	'kusiau'
Solomons Cuckooshrike *Edolisoma holopolium* (NT)	0.083	0.100	0.267				3/3	F	
Grey-capped Cicadabird *Edolisoma remotum*	0.042	0.050	0.200	0.200			–/3	F	
Oriole Whistler *Pachycephala orioloides bougainvillei*			0.200				3/2	F	
Bougainville Whistler *Pachycephala richardsi*				0.600		n3,c4	1/–	F	
Willie Wagtail *Rhipidura leucophrys*	0.208				X			O	
Cockerell's Fantail *Rhipidura cockerelli septentrionalis*			0.133	X			3/2	F	
Brown Fantail *Rhipidura drownei drownei*				0.700		n1,c1	3/1	F	†'siroreipa'
Rufous Fantail *Rhipidura rufifrons*			0.267				–/3	F	†'sitoberi', 'sirubirubi'
Solomons Monarch *Symposiachrus barbatus* (NT)			0.200				3/3	F	
Bougainville Monarch *Monarcha erythrostictus*		0.300	0.367	0.400			2/–	F	‡'sose'e'
Steel-blue Flycatcher *Myiagra ferrocyanea cinerea*	0.458	0.200	0.633	0.200			3/2	Fo	
Bougainville Crow *Corvus meeki*			0.233	0.600			2/–	Fo	'ao'ao'
Solomons Robin *Petroica polymorpha septentrionalis*				0.400		c1	3/1	F	
Bougainville Bush Warbler *Horornis haddeni* (NT)				0.200		c1	1/–	F	†'kopaki
Island Leaf Warbler *Phylloscopus poliocephalus bougainvillei*				0.500			–/1	F	
Yellow-throated White-eye *Zosterops metcalfii*	0.583	0.850	0.833				3/3	f	'sioruka'
Grey-throated White-eye *Zosterops rendovae hamlini*				0.500		n1	3/1	F	
Metallic Starling *Aplonis metallica*	0.208	0.200						Fo	'sirio'o'
Singing Starling *Aplonis cantoroides*	0.208	0.300	0.033					O	
Brown-winged Starling *Aplonis grandis*	0.298	0.150	0.267				3/3	Fo	
Long-tailed Myna *Mino kreffti*	0.792	0.750	0.467		X			Fo	'sikiro'
Island Thrush *Turdus poliocephalus bougainvillei*				X		c2	–/1	F	
Midget Flowerpecker *Dicaeum aeneum*	0.833	0.700	0.567	0.800	X	n9	3/3	Fo	†'takapa'i'

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Species (conservation status)	Mapisi	Pipikei	Kaitare'ei	Kukupi	Lower Aiope R.	Captures	Endemism	Habitat	Rapoisi name
Olive-backed Sunbird *Cinnyris jugularis*	0.583	0.250	0.067		X			O	
Blue-faced Parrotfinch *Erythrura trichroa*				X			–/3	Fo	

Appendix 2

Resident Bougainvillean land and freshwater bird species not recorded in 2019. Conservation status is shown in parentheses after the scientific name for species listed by the IUCN as Endangered (EN), Vulnerable (VU) or Near Threatened (NT) and species protected (P) under Papua New Guinean law. 'Endemism' codes (species/subspecies): 1—endemic to Bougainville; 2—endemic to Bougainville and small offshore islands (Buka, Shortland and Fauro); 3—endemic to the Solomons. The subspecific epithet is provided for subspecies with an endemism rank of 1 or 2. 'Habitat' association codes: F—forest-dependent; Fo—forest, edge and converted land; W—rivers and wetlands; C—coastal; O—anthropogenic converted land; data from Coates (1985, 1990) and Hadden (2004).

Species (conservation status)	Endemism	Habitat	Distribution/status notes
Solomons Nightjar *Eurostopodus nigripennis* (VU)	3/–	C	Not recorded on Bougainville since the 1930s.
Uniform Swiftlet *Aerodramus vanikorensis*	–/3	Fo	Common, possibly overlooked or present among unidentified *Aerodramus* (Appendix 1).
Metallic Pigeon *Columba vitiensis*		F	Hills and mountains. Rare, last confirmed record 1964.
Nicobar Pigeon *Caloenas nicobarica*		C	
Bronze Ground Dove *Pampusana beccarii*	–/3	F	Hills and mountains to 1,250 m. Rare, few recent records.
White-browed Crake *Porzana cinerea*		W	
Tricoloured Grebe *Tachybaptus tricolor*		W	
Beach Stone-curlew *Esacus magnirostris* (NT)		C	Potentially restricted to offshore atolls.
Yellow Bittern *Ixobrychus sinensis*		W	
Black Bittern *Dupetor flavicollis*		W	
Eastern Osprey *Pandion cristatus* (P)		C	
Imitator Goshawk *Accipiter imitator* (VU)	3/–	F	Lowlands and hills to at least 750 m. Rare and cryptic, few records.
Eastern Barn Owl *Tyto javanica*		O	
Moustached Kingfisher *Actenoides bougainvillei bougainvillei* (EN)	3/1	F	Lowlands and hills (mountains on Guadalcanal). Rare; <5 records since the Whitney South Sea Expedition, no records from northern Bougainville.
Beach Kingfisher *Todiramphus saurophagus*		C	
Little Kingfisher *Ceyx pusillus*	–/3	F	Mangroves and lowland forest near streams. Not uncommon but cryptic.
Oriental Hobby *Falco severus*		Fo	
Peregrine Falcon *Falco peregrinus*		Fo	Rare; <5 records.
Red-flanked Lorikeet *Charmosyna placentis*		Fo	Lowlands. Possibly locally fairly common.

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Black-faced Pitta *Pitta anerythra pallida* (VU)	3/1	F	Lowlands and foothills. No Bougainville records since 1938; possibly extinct.
North Melanesian Cuckooshrike *Coracina welchmani bougainvillei*	3/1	F	Lowlands and hills. Rare.
Pacific Swallow *Hirundo tahitica*		O	
Australian Reed Warbler *Acrocephalus australis*		W	
Bougainville Thicketbird *Cincloramphus llaneae*	1/–	F	Only recorded from Crown Prince Range, above 1,200 m.
White-eyed Starling *Aplonis brunneicapillus* (VU)	3/–	Fo	Lowlands and hills to at least 900 m. Rare. Recently recorded in southern Emperor Range <4 km south of the Kunua Plains and Mount Balbi KBA.
Black-backed Thrush *Zoothera talaseae atrigena*	–/1	F	Only recorded from Crown Prince Range, *c.*1,500 m.

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The early death of Colonel Robert C. Tytler and the afterlife of his collection

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Summary.—A letter by Allan Octavian Hume and three by Bertram Bevan-Petman, all written between 1904 and 1911 to Ernst Hartert, bird curator of Rothschild's Tring Museum, are present in the Rothschild Tring archive, now held by the Natural History Museum. These shed light on both the probable cause of the early death in 1872 of Colonel Robert C. Tytler, British army officer and naturalist in colonial India, and on the somewhat convoluted fate of his collection subsequently.

By the mid 1880s, the famous Indian ornithologist Allan Octavian Hume (1829–1912) had both given up ornithology and presented his huge bird collection to the British Museum (Natural History), now the Natural History Museum (NHMUK) (Collar & Prŷs-Jones 2012). Given that this was some years before the founding in 1889 of the Tring Museum by Walter Rothschild (1868–1937), it is not surprising that only a single letter between Hume and Walter's bird curator, Ernst Hartert, exists in the Rothschild Tring Archive held at NHMUK. This letter (TR/1/1/25/230) is, however, of considerable interest for the light it sheds on both the early death of another Indian ornithologist, Robert C. Tytler (1818–72), and, in conjunction with three other letters (TR/1/1/25/355 and TR/1/1/32/376) from a Bertram Bevan-Petman, on the fate of Tytler's bird collection.

Colonel Robert Tytler spent his adult life serving in the army in British colonial India, but he was also a naturalist and photographer of some note, sharing the latter interest with his second wife Harriet (1828–1907), who is well known for her vivid first-hand account of the 1857–58 Indian Mutiny (Sattin 1986). As a natural historian, Tytler was probably best known as an ornithologist, notably of the Andaman Islands, where he was based from 1862 to 1864; Tytler's Warbler *Phylloscopus tytleri* Brooks, 1872, is perhaps the most familiar of several bird taxa named for him. Around 1861, Tytler had bought two houses in Simla (Sattin 1986) and, when not posted elsewhere, spent his later life in one of these, Bonnie Moon. This was situated a little higher up Jakko Hill than Rothney Castle, to which Hume moved with his bird collection in *c.*1871 (Moulton 1992). Based on his own collections, Tytler had by then already set up a museum, open to the public, in Bonnie Moon, the first in the Simla area. Besides a large collection of birds from all parts of the world, this included 'animals and shells from the Andamans, oriental manuscripts, and geological, mineralogical and mythological specimens' (Buck 1904: 129).

For at least the last eight years of his life, Tytler suffered a debilitating illness. In early 1864, after serving less than two years as Superintendent of the Andaman Islands and then only in his mid 40s, he had to ask to be relieved of his post 'and proceeded on sick leave, as his health was failing' (Sattin 1986: 179). By 1867, when his wife Harriet returned after some months in England, she was 'shocked with the awful change in him. His system was so drained of its strength that he was never the same man again' (Sattin 1986: 180). In autumn 1870 Lord Mayo, the Viceroy, requested Tytler's posting to the Home Department in Simla (Buck 1904), where 'the authorities thought he would be of most use devoting himself to the 'curious and valuable pieces on show' in his museum (Sattin 1986: 180). This closed

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after Tytler's death in September 1872, but Harriet 'preserved the ornithological specimens, and expressed her intention of giving them to Simla, in memory of her husband, should a museum ever be formed there' (Buck 1904: 129). Announcements of Tytler's passing stressed his long illness, e.g., 'The deceased officer had long been ailing, and of late the malady from which he was suffering assumed a form which left but little hope of recovery' (*Times of India*, 19 September 1872).

The gift of the collection to the Simla municipality did not materialise, and the specimens were wrapped in newspapers and packed away in boxes around 1873. In 1907 the collection passed to Harriet's daughter-in-law, a Mrs Livingstone-Thompson, who 'after some other efforts to dispose of it, sold it in 1909 to Mr. B. Bevan-Petman, the well-known barrister of Lahore. His intention was at first apparently to present it to the Tring Museum, but circumstances determined that he should give it to the Lahore Museum' (Whistler 1918: 738). Whistler spent ten days in 1918 examining it there, finding much of the collection very well documented but in a deplorable physical state. His key conclusions were that only about 2,500 skins remained, including material from many parts of the world, but notably Brazil and the Andamans. However, Tytler's catalogues were not with it, and an informant of Whistler's in Simla claimed that Hume had borrowed them without returning them—'rather a failing of his judging from old ornithological correspondence!' according to Whistler (1918: 739), who himself suspected that 'it is quite possible that the Catalogues are with his [Hume's] collections in the Natural History Museum at South Kensington'.

The first of the above-mentioned letters reveals that, on 26 May 1904, Bertram Bevan-Petman, by profession a barrister, wrote to Rothschild's bird curator, Ernst Hartert, from the Hotel Central in Simla, India, with information about Tytler's bird collection [NB: in the letters below, comments in parentheses are the author's, those in square brackets are our insertions]:

> '[Tytler's] collection numbering, I am told, some four thousand specimens is now in the possession of his widow, a client of mine, who is now willing to part with them. The birds are at present packed away in soldered tin cases. But the [*sic*] Mr. A.O. Hume, retired civilian, living near the Crystal Palace, who some while ago presented the whole of his collection to the South Kensington Museum, is well acquainted with every bird in the Tytler collection, and would give you any scientific particulars you might require as to its contents should you think of acquiring the same. I understand he offered Mrs. Tytler Rs. 3,000 for 100 birds (the pick, no doubt), but she refused to part with any, from a sentimental point of view. As the birds are of no use to her, I have persuaded her to sell if you wished to buy. In that case, you could get to hear from Mr. Hume what the probable worth of the collection is, and make your own estimate. Mrs. Tytler's idea is Rs. 10,000 for the lot, but I have no doubt I could persuade her to take less. I shall be happy to do anything I can in the matter for you, such as examining the specimens, reporting on their state of preservation, and the like. I shall be in Simla till November, after which my address will be Lower Mall, Lahore, Punjab.'

Hartert clearly acted on Bevan-Petman's suggestion to contact Hume, as the latter wrote from his Upper Norwood residence to Hartert on 1 October 1904. His letter is transcribed here in its entirety:

> 'I find your letter of the 5 July[?] still by me – I thought I had answered it, but there is no endorsement on it to that effect & in case I did not reply to it, as I intended, I will write now what little I have to say – if this prove [*sic*] to be a duplicate – please burn it.

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> I knew Col. Tytler's collection well, whilst he was alive – what it may be now after these years I cannot even guess – I should in this respect hope for the best, but expect the worst.
>
> But in its best days, I should think that the Collection would not have been of any value at Tring. What Tytler aimed at was a collection representative of the birds of the world. I should guess that fully half his birds were American & African; given to him by our mutual friend Jules Verreaux & most of these were very indifferent specimens. His Indian birds were mostly his own collection, but he was not a neat taxidermist. All his birds were carefully ticketed. Whoever has them can very easily make a list of them. I would not think of buying if I were in your place, unless they sent a list - & then even I would not buy unless they sent the birds that you might select out of the list, on inspection. Even before poor Tytler died, the birds had become very grimy & secondhand, as it were – He had a mode of shut[ting][?] all the doors & windows of the places he used as a museum & he used to fill this with a dense smoke to kill the insects – another point, the specimens, at any rate the majority of them were preserved mainly with powdered arsenic. In later years he used good arsenical soap – I gave him some pounds once (I used to make 2 stone (28 lbs) of my own speciality yearly) but apparently most of the French* (*Author's footnote*: *I mean the birds which had from time to time been given to him or sent by J. Verreaux.) and Andamanese birds were preserved by merely dusting in powdered arsenic, which used to dust out of them in my time, whenever they were pulled about much. This & this only killed poor Tytler – he died solely of arsenic poisoning, & the stupid Drs did not know – we none of us knew then how to treat him for this. This is another point to consider. I don't believe in the first place that you would find one tenth of the birds of any use to you – of that tenth, I suspect half would prove very bad specimens, & the rest likely to give trouble, owing to the manner in which they were preserved.'

This letter is classic Hume, with cogent opinion being presented as irrefutable fact and the statement 'please burn it' reminiscent of that in the preface to his first book, *My scrap book: or rough notes on Indian oology and ornithology* (Hume 1869–70), telling his readers to burn them if they did not find them of use (Collar & Prŷs-Jones 2012)! On receiving this less than enthusiastic recommendation from Hume, Hartert presumably replied cautiously to Bevan-Petman, who wrote again from Simla on 12 December 1904 as follows:

> 'Enclosed is a list of a few of the birds in the collection. Another list, more or less complete does exist in Col. Tytler's writing, but cannot at present be found, though I have asked that further search may be made. When found, it will be forwarded and may perhaps enable you to give some idea of what may fairly be asked for the collection. Of course, Mrs. Tytler has no real idea; and the only birds I know are game birds! Also, sending a few specimens for you to look at – labelled. Will endeavour to send you some vultures from Lahore this winter (where I shall be till March). Saw some splendid specimens of eagles last month when out shooting with Rana of Dhami (altitude 5000 ft.) – unluckily had only rifle with me. But hope to get them for you later on. Till March, address will be 'Lower Mall, Lahore' - after March, 'Walsingham, Simla'. Have been very busy all season – worked off legs – or would have written before. Excuse paper & scrawl, but am packed up, preparatory to migration down to the plains. There are some horribly repulsive vultures (several kinds) round Simla hills – are these any good to you? They smell like mad! – shooting is easy, but the work afterward nauseating…'.

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Hartert must have responded declining the offer of Tytler's birds, given Bevan-Petman's final letter sent from Walsingham, Simla, over six years later, on 10 January 1911:

> 'You may perhaps recollect the late Colonel Tytler's Collection of Bird Skins, concerning which we had some correspondence some while ago. Well, the old lady died, his widow, I mean; and the daughter begged me to take the birds off her hands. I did not want them, for the simple reason that my time is much too fully occupied with my work to allow me the relaxation of such pleasures. However, as she wanted the money badly, I bought them from her at her price, and the things have been stored here ever since, that is some two years ago, in one of my godowns. I got one of my babus to copy out the birds' names for the purpose of a catalogue, and though he appears to have made out some astounding names, I daresay that the expert will be able to guess in due course what the names stand for. I am sending you by this post under registered cover the said typed catalogue, in case you should require any of the birds. If so, will you please put a mark against the bird in question, with the price you are willing to pay, and I will arrange that the birds you select shall be sent to you. I do not of course know if you want any of the birds at all: I am quite ignorant of any of them, whether they are good bad or indifferent; but it struck me that by chance the Collection might contain one or two or perhaps more that Mr. Walter would like, and as the Collection was now mine, I should be very glad to let him have the pick of it, if only in recollection of some very pleasant days' shooting that he was good enough to give me some years ago.
>
> When you have done with the Catalogue, will you kindly send it to me at 14, Rockleaze, Sneyd Park, Bristol. I am sailing for Home this week, on account of the illness of my elder son, and I shall be home for some six weeks.'

Again, no reply from Hartert is available, but it seems almost certain that the Tring Museum did not acquire any specimens from Tytler's collection at either opportunity, as there is no sign of such in the American Museum of Natural History, New York, where the great bulk of Walter Rothschild's bird skins now reside (P. Sweet & T. Trombone *in. litt.* 19 February 2021). As to what survives of the collection Tytler still held when he died, an e-mail approach to Lahore Museum regarding its current state unfortunately remains unanswered. There is also no evidence that NHMUK ever received the main catalogue(s) of Tytler's collection via Hume, although it does possess an earlier short catalogue of specimens that Tytler passed to the East India Company Museum in London in early 1854 (MSS IND). A number of such catalogues of donations were received by NHMUK when it took on the bulk of the India Museum's zoological collections in the late 1870s. Tytler's is interesting in that it reveals he had donated not only bird and mammal specimens, but also fish, insects, cones (botanical), a dagger found on a battlefield and 'a pack of playing cards of native manufacture from an English design', highlighting his eclectic collecting.

Besides their role in filling in additional details concerning the fate of Tytler's collection prior to it reaching Lahore Museum, the most striking assertion in these letters is Hume's confident ascription of the cause of Tytler's death, namely poisoning from use of arsenic powder, a suggestion not seen in other accounts consulted. Given Hume's description of the state of Tytler's bird collection, the concept of chronic cumulative arsenic poisoning does however make considerable sense. Morris (2010) has assembled information relating to the apparent impact of arsenic on taxidermists and other collectors. Given the inevitable lack of any sort of data on individuals' actual accidental intake of the substance while using it, generalisations are difficult. However, it certainly appears that the use of arsenic powder

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tends to be more harmful than the use of the arsenical soap, mentioned by Hume, which gradually replaced it. Overall, perhaps the most interesting parallel is with the American ornithologist Elliott Coues (1842–99), who strongly recommended the use of arsenic powder and, who, like Tytler, died in his mid 50s. In his manual of field ornithology, Coues (1874: 54) wrote 'Use dry powdered arsenic, plenty of it, and nothing else. There is no substitute for arsenic worthy of the name, and no preparation of arsenic so good as the simple substance. Various kinds of 'arsenical soap' were and may still be in vogue; it is a nasty greasy substance, not fit to handle…'. Regarding his early demise, Allen (1909: 424) noted that despite '…all his apparent energy and ceaseless activities, his health gave way at last, and for some years before his death he was a sufferer from a complication of diseases.'

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