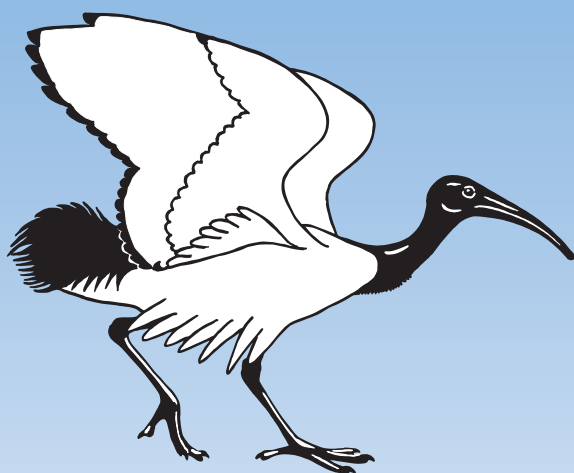


Bulletin of the British Ornithologists' Club



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December 2017

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FORTHCOMING MEETINGS

See also BOC website: <http://www.boc-online.org>

BOC MEETINGS are open to **all**, not just BOC members, **and are free**.

Evening meetings are in **an upstairs room at The Barley Mow, 104 Horseferry Road, Westminster, London SW1P 2EE**. The nearest Tube stations are Victoria and St James's Park; and the 507 bus, which runs from Victoria to Waterloo, stops nearby. For maps, see http://www.markettaverns.co.uk/the_barley_mow.html or ask the Chairman for directions.

The cash bar opens at **6.00 pm** and those who wish to eat after the meeting can place an order. **The talk will start at 6.30 pm** and, with questions, will last c.1 hour.

Please note that in 2018 evening meetings will again take place on a Monday, rather than Tuesday as hitherto.

It would be very helpful if those intending to come can notify the Chairman no later than the day before the meeting.

Monday 19 March 2018—6.30 pm—Justin Jansen—*The ornithology of the Baudin expedition (1800–04).*

Abstract.—Dwarf emus captured on King Island (King Island Emu *Dromaius novaehollandiae minor*) and Kangaroo Island (Kangaroo Island Emu *D. n. baudinianus*) were caged in wooden pens on the deck of the *Géographe* and force-fed wine and rice mash when they refused to eat on the voyage home. Two of these represent the sole specimens to reach Europe alive; after Baudin's visit these taxa became extinct. As well as live specimens of Black Swans *Cygnus ater* and cockatoos, Nicolas Baudin's expedition (1800–04) returned with more than 1,000 bird specimens, and 75 new bird taxa were described from this rich scientific haul. Baudin's was one of the most successful scientific expeditions of the 19th century. Justin Jansen will guide you through the stunning collection of birds yielded by this French expedition. He has followed the tale of Baudin's birds throughout Europe's rich collections, and this talk will showcase the fascinating findings that form the basis of Justin's Ph.D. thesis.

Biography.—Justin Jansen has been a regular visitor to Europe's major bird collections for many years, and is a correspondent attached to Naturalis Biodiversity Center at Leiden, Netherlands. He is both schooled and working in civil engineering, but has strong interests in historical bird collections, biographies of collectors, and challenging bird identification problems.

Monday 21 May—6.30 pm—Bard Stokke—*Host selection by the Common Cuckoo *Cuculus canorus**—full details to be confirmed shortly.

Thursday 14 and Friday 15 June—Joint two-day meeting in Liverpool with the Society for the History of Natural History on the subject *Bon voyage? 250 years exploring the natural world*. Full details to be announced later.

Monday 17 September—6.30 pm—details to be announced.

Monday 12 November—6.30 pm—details to be announced.

The Chairman: Chris Storey, 22 Richmond Park Road, London SW14 8JT UK. Tel. +44 (0)208 8764728. E-mail: c.storey1@btinternet.com

Bulletin of the BRITISH ORNITHOLOGISTS' CLUB

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CLUB ANNOUNCEMENTS

The 987th meeting of the Club was held on Monday 18 September 2017 in the upstairs room at the Barley Mow, 104 Horseferry Road, Westminster, London SW1P 2EE.

Sixteen friends and three visitors were recorded as present. Friends attending were Miss H. Baker, Cdr. M. B. Casement, RN, Mr S. Chapman, Dr N. J. Collar (*Speaker*), Mr M. Earp, Dr C. Fisher, Mr D. J. Fisher, Mr R. Langley, Mr D. J. Montier, Mr R. Pritchett, Mr D. Prŷs-Jones, Dr R. Prŷs-Jones, Dr D. C. D. Russell, Mr. S. A. H. Statham, Mr C. W. R. Storey (*Chairman*) and Mr P. Wilkinson.

Visitors attending were Mr G. de Silva, Ms J. Hatton and Mrs M. Montier.

Dr Nigel Collar gave a talk entitled *Preparing the Illustrated Checklist: value vs vanity*, and provided the following summary. World checklists are necessary but unforgiving confections. International conservation organisations and legal instruments require a list that is at once stable yet flexible, standardised yet sensitive. Using a set of criteria based on degree of phenotypical differentiation, the recent HBW and BirdLife checklist has sought to assess multifarious taxonomic suggestions emerging from the (mostly molecular) literature, but has also proposed a considerable number of novel changes. I called the talk 'value vs vanity' because, while there is obvious value in having a world list, it inevitably needs a degree of grandiose self-obsession to take on such a task and a degree of the opposite quality to keep reality in check. I thought of calling it 'Taxonomy and the Augean Stables', 'Taxonomy and the Minotaur's Labyrinth' or 'Taxonomy and the Punishment of Sisyphus', but these all project a mythical status on the work which is scarcely apposite.

Use of the Tobias criteria (*Ibis* 152: 724–746, 2010) helped the project to confront a significant number of issues which remained poorly researched and resolved. Criticisms of these criteria appearing in various papers as brief but sharply targeted asides can all be answered, including ones relating to the problem of paraphyly. One particular criticism, that the criteria ignore molecular evidence, is unfounded; it is just that there is no way to incorporate such evidence into the system of scoring that the criteria operate. Molecular scientists commonly propound that no genetic difference indicates conspecificity; but cases exist where genetic differences have not been found between taxa and yet the taxa in question are sympatric, so clearly species. Intriguingly, an Australian parrot has now been found to be able to discriminate subspecies by olfaction (*Anim. Behav.* 95: 155–164, 2014); is this perhaps a clue to the means by which Procellariiformes tell each other apart at colonies at night?

A recent call has been made for a single world list (*Nature* 546: 25–27, 2017) to be created through the International Union of Biological Sciences. As it happens, the four current world lists (IOC, 'Howard & Moore', Clements, and HBW-BirdLife) are in discussions to see if they can merge, which is generally recognised as desirable provided uniformity does not stifle independence of thought. That we are on safe ground in this last regard is indicated by the almost-as-recent call to revise the global avifauna according to the Phylogenetic Species Concept (*PLoS ONE* 11[11]: e0166307, 2016), which is likely to keep everyone on their taxonomic toes for many years yet.

CORRIGENDA

986th Meeting. The lists of those attending included: Dr A. Tye and Mrs B. Azuero-Benites. Apologies for these errors in transcription (C. W. R. Storey).

REVIEWS

Woods, R. W. 2017. *The birds of the Falkland Islands*. BOC Checklist 25. British Ornithologists' Club, Tring. 256 pp, 64 colour plates. ISBN 978-0-09522886-6-4. £29.99.

Following a hiatus of eight years, and the publication of the last jointly issued BOC and BOU checklist to the West Indian island of Barbados, the series emerges newly invigorated, under the fresh editorship of David Wells and the sole auspices of the BOC, with this extremely useful volume to the Falkland Islands. The author of this addition to an often invaluable but somewhat eclectic series, Robin Woods, has impeccable credentials, not only having produced two of the other most important modern works on the region's avifauna, *Guide to birds of the Falkland Islands* (1988) and *Atlas of breeding birds of the Falkland Islands* (co-authored with his wife),

but also many other manuscripts on Falkland birds in the periodical literature. His connection with the archipelago goes back more than 60 years, starting in 1956.

Although the total number of islands is 780, most of the land area of the archipelago (12,200 km²) comprises just two of these, East and West Falkland. The islands' capital, Stanley, is located in the north-east corner of East Falkland, which island is certainly the most frequently visited, not just by ornithologists.

In contrast to his 1988 work, which provided accounts for 185 species, Woods' latest checklist recognises 205 bird species as occurring in the islands, of which 55 are resident breeders, six breeding summer visitors, nine possible breeders, seven are former breeders, 11 non-breeding visitors, 12 transient visitors and 105 are vagrants, the latter group unsurprisingly being predominantly of New World origin. Another 54 species have been mentioned as occurring, but definite proof is unavailable at present. These latter are the subject of the one of the book's penultimate sections, whereas the bulk of the volume, 126 pages, comprises the accounts pertaining to the confirmed species.

The format and design of the species accounts will be at once distinctive yet familiar to frequent purchasers of the checklist series. Regular sections include: 'Alternative names', 'Distribution' (covering world range), 'Falklands' (status and distribution within the archipelago), 'Taxonomy', 'Comments' and 'Study material' (relevant specimens located at museums throughout the world). The level of detail should satisfy most users. Scattered across 32 pages within this section of the work, the colour plates (maps, plus photographs of habitats and birds) provide welcome accompaniment. The checklist's 'top' and 'tail' comprises a series of introductory sections then appendices, references and index, respectively. Among the preparatory material are checklist mainstays such as 'Geography', 'Climate and weather', 'Habitats', 'Human impacts and responses', 'Ornithological history', 'Overview of the avifauna' and 'Palaeornithology', while the seven appendices comprise a gazetteer of place names, complete list of confirmed species, tables of species by status, whereabouts of specimens (listing total holdings museum by museum), Important Bird Areas, a list of non-avian taxa mentioned in the volume, and alternative scientific and vernacular names. The 23 pages of references attest to a thorough review of the available literature.

Robin Woods' legacy and enduring association with Falkland Island birds is cemented with this important work, which I foresee being collectively welcomed by students of island avifaunas, those interested in the birds of South America or the Western Hemisphere in general, or 'mere' collectors of the series. My one regret is that, with the switch to a softback design, the series will lose some of its more physical durability—my copy displays a rather worrying amount of 'wear and tear' following but a few months of largely undisturbed shelf-life.

Guy M. Kirwan

REFEREES

I am grateful to the following, who have reviewed manuscripts submitted to the Bulletin during the last year (those who refereed more than one manuscript are denoted by an asterisk in parentheses): Jason Anderson, Juan I. Areta, John Atkins, Jorge Avendaño (*), Bas van Balen (*), Bruce M. Beehler, Peter Boesman (*), Vincent Bretagnolle, Mark Brigham, Michael Brooke, Diego Calderón (*), Caio J. Carlos, Alice Cibois (*), Nigel Cleere, Mario Cohn-Haft, Charles T. Collins, Marco Aurélio Crozariol, Richard Dean, Thomas M. Donegan (*), Dale Dyer, Andrew Elliott, Anthony J. Gaston, Héctor Gómez de Silva, Manuel Grosselet, David T. Holyoak, Steve N. G. Howell (*), Julian P. Hume, Johan Ingels, Morton L. Isler, Lia Kajiki, Mary LeCroy, Gabriel Leite, Manuel Marín, Jeff Marks, Michael Mills, Ricardo Palma, Storrs L. Olson, José Fernando Pacheco (*), Glauco Pereira, Vítor Piacentini, Aasheesh Pittie, Thane K. Pratt, Richard O. Prum, Robert Prŷs-Jones, Paulo C. Pulgarín, Peter Pyle, Sébastien Reeber, Frank Rheindt, Phil Round (*), Richard Schodde (*), Karl Schuchmann, Thomas S. Schulenberg, Frederick Sheldon, Hadoram Shirihai, Frank D. Steinheimer, Michael Tarburton, Alan Tennyson, Bert Theunissen, Jean-Claude Thibault (*), Andrew Vallely, Bianca Vieira, Dick Watling, André Weller, David R. Wells and John van Wyhe. —THE HON. EDITOR

The authenticity of 'Iwi *Drepanis coccinea* (G. Forster, 1781) skins from Cook's third voyage: what taxidermy can add to the discussion

by Justin J. F. J. Jansen & Frank D. Steinheimer

Received 29 January 2017; revised 1 November 2017; published 11 December 2017

<http://zoobank.org/urn:lsid:zoobank.org:pub:E3E6A5EE-D75B-49A2-A50D-987D8B2091D2>

SUMMARY.—The 'Iwi *Drepanis coccinea* was discovered during James Cook's third circumnavigation (1776–80) and described by G. Forster in 1781. Several possibly authentic specimens and data sources linked to the original expedition exist. However, investigations into preparation style of the various 'Iwi specimens in question identified five different workshops and thus provenances. Only one specimen (at Göttingen, Germany) can unequivocally be considered authentic Cook material.

The first mention of the 'Iwi *Drepanis coccinea* (G. Forster, 1781) was made during the third circumnavigation of the globe captained by James Cook (1728–79). Cook & King (1784 pt. II: 207–208) stated: 'local collectors supplied them with often bundles up to twenty or more 'Iwi's [...] (21 January 1779)'. However, it was specified that the natives removed the contents of the heads and dried the specimens. The next note on these birds was in Cook & King (1784 pt. II: 227), with a remark dated from February 1779 that the species was never seen alive, presumably because of its absence from coastal regions (Pratt 2017). The first painting is from Waimea, Kauai, Hawaii, made in January–February 1778 by John Webber (Rijksmuseum, Amsterdam). Georg Forster described the species on 16 December 1780 (Forster 1781) as *Certhia coccinea*, but publication was in early 1781.

The ornithological exploits from Cook's voyages have been the subject of ongoing scientific debate, e.g. Merrem (1784), Sharpe (1906), Gyldenstolpe (1926), Lönnberg (1926), Stresemann (1949, 1950), Lysaght (1959), Burton (1969), Whitehead (1969, 1971, 1978), Sweet (1970), Medway (1976, 1979, 1981, 2002, 2004, 2009), Wagstaffe (1978), Elter (1986), Largen (1987), Hauser-Schäublin & Krüger (1998), Bauernfeind (2003, 2004) and Steinheimer (2003a,b, 2005, 2006a,b). In general, there is disagreement concerning preparation style and the number of skin specimens that have survived from Cook's expeditions.

For this paper, we examined all known 'Iwi specimens collected prior to 1826. This paper aims to link certain taxidermy traits to different workshops to achieve a better understanding of what constitutes authentic Cook material.

Material and Methods

We personally examined the following specimens: RMNH.AVES.148551 (Fig. 1), NHMUK 1845.2.21.295 (Fig. 12), NHMUK A.1845.2.21.297 (spirit specimen; Fig. 5), NHMUK 1845.2.21.297 (Fig. 12), NHMUK 1845.2.21.368, NHMUK 1845.2.21.387, SMNH A 533670, SMNH A 533669 (Fig. 6), GAU 345 (Fig. 10) and NMS_Z 1926.21.95 (Fig. 14). Additionally we received data pertaining to the following specimens: LivCM D511a, LivCM D511b (Fig. 3), MRSN 2240 and MRSN 2241 (Fig. 8). Accompanying material was consulted in the libraries, archives and collections of MfN, NMS and MNHN (museum acronyms follow Roselaar 2003 except NMHUK = BMNH; GAU = Ethnographic Collection of the Georg



Figure 1. Adult 'Iwi *Drepanis coccinea*, Naturalis Biodiversity Center, Leiden (RMNH.AVES.148551) (Justin J. F. J. Jansen, © NBC)

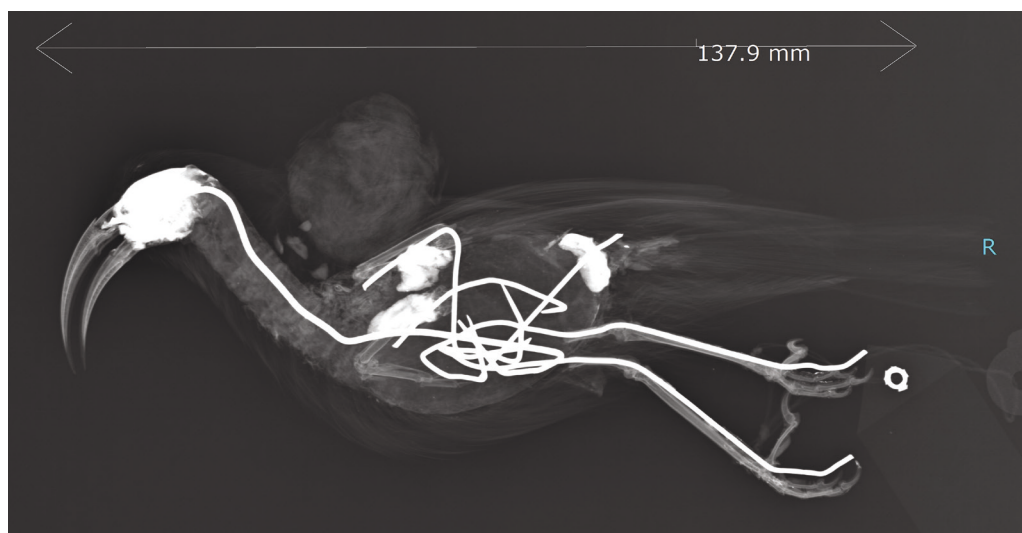


Figure 2. Adult 'Iwi *Drepanis coccinea*, Naturalis Biodiversity Center, Leiden (RMNH.AVES.148551) (© NBC)

August University Göttingen, see also Acknowledgements). Most specimens were X-rayed ($n = 10$) or physically examined ($n = 2$). For comparative purposes, another 104 X-rays of bird skins from the late 18th and early 19th centuries have been studied.

Known expeditions to Hawaii pre-1825

HMS Resolution and *HMS Discovery*.—James Cook's third circumnavigation of the globe (1776–80) with the *HMS Resolution* and *Discovery* spent several periods at the archipelago of Hawaii, on 18–23 January 1778 and 1–8 March 1779 (Kauai), 29 January–1 February 1778 (Niihau) and 17 January–23 February 1779 (Hawai'i) (Stresemann 1950, Medway 1981, Olson 1989, Olson & James 1994, Steinheimer 2006a). Those persons known to have possessed bird specimens from the third expedition are: William Wade Ellis (1751–85), Charles Clerke



Figure 3. Juvenile male 'Tiwi *Drepanis coccinea* (upper bird) (LivCM D511b) and adult male (lower) (LivCM D511a), National Museums Liverpool (Tony Parker, © World Museum, Liverpool)

(1741–79)¹, Thomas Davies, Barthold Lohmann (1749–1812), David Nelson (d. 1789), David Samwell (1751–98), Heinrich Zimmermann (1741–1805) and probably several unnamed shipmen (Plitschke 1931, Stresemann 1950, Whitehead 1978, Medway 1981). Zimmermann (1781) and Samwell (1957, 1967) described three extended land excursions at Kealakekua Bay, on the island of Hawai'i between 24 and 30 January 1779 (cf. Steinheimer 2006b). No original notes are attached to any of the known / supposed / suspected specimens. Subsequently, George Humphrey, Georg Forster and a certain Mr Dalmer (Merrem 1784) had seen or possessed 'Tiwis by 1783.

HMS Astrolabe.—Louis Dufresne visited Hawaii briefly with the ill-fated *Astrolabe* voyage (1785–87); however, it is notable that no Hawaiian Honeyeaters are mentioned in Dufresne's 1815 (archives at MfN) and 1818 catalogues (archives at NMS).

HMS Queen Charlotte and *HMS King George*.—The *HMS Queen Charlotte* and *King George* first visited Hawaii in 1786 (Beresford & Dixon 1789), calling at Oahu in 1786 and 1787, and collected a few birds (Dixon 1789: 111–112, Munro 1944, Banko & Banko 1981: 196, Frohawk *et al.* 1989: 60). It is unknown if any avian specimens have survived.

Private vessel *Venus*.—During his visit to the Hawaiian Islands, George Bass (1771–1803) documented spells on Hawai'i, Oahu, Kauai and Molokai (dates from original correspondence ZML MSS 6544 Mitchell Library, Sydney, Bowden 1980: 86–87, Estensen 2005: 151–154). He is a known bird collector (Jansen 2014, Jansen & van der Vliet 2015), and a few of his birds are still housed at MNHN, but none from Hawaii has been discovered.

¹ Clerke did not survive the voyage and his bird specimens came into the possession of an unknown crew member.



Figure 4 (left). 'Tiwi *Drepanis coccinea*, National Museums Liverpool (right LivCM D511a and left LivCM D511b) (Tony Parker, © World Museum, Liverpool)

Figure 5 (right). 'Tiwi *Drepanis coccinea*, Natural History Museum, Tring (NHMUK A.1845.2.21.297) (© Natural History Museum, London)

HMS Blonde.—Anchored at Hilo, Hawai'i (3 May 1825 and 7 July 1825), Lahaina, Maui (4 May 1825) and Honolulu, Oahu (6 May–7 June and 9–18 July 1825; Olson 1996). The expedition's main collector was Andrew Bloxham. His few surviving specimens are at what are now NHMUK and NMS (Olson & James 1994, Olson 1996).

Distribution of the specimens

Twelve 'Tiwi specimens from the first four decades following the species' discovery have been traced. Additional specimens have been mentioned in literature and some of them may belong to the 12 discussed here.

The largest number of specimens ended up in Joseph Banks' collection in London. Banks (1743–1820) was the naturalist on Cook's first voyage. Jonas Dryander compiled a handwritten catalogue of Joseph Banks' avian collection (see Medway 1979: 316) listing



Figure 6. Adult male 'Tiwi *Drepanis coccinea*, Swedish Museum of Natural History, Stockholm (SMNH A533669, A533670) (Justin J. F. J. Jansen, © SMNH)

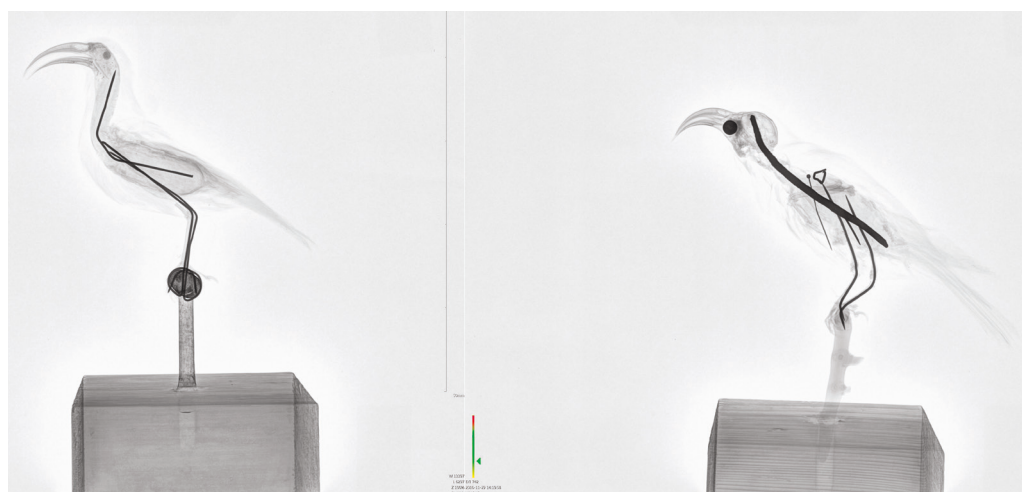


Figure 7. Adult male 'Tiwi *Drepanis coccinea*, Swedish Museum of Natural History, Stockholm, Sweden (SMNH A533669, A533670) (© SMNH)

among others a *Certhia rubra* (list 3 / 4: no. 51). According to Medway (1979: 323, lot 35) 12 'Tiwi specimens were once present in Banks' collection. In 1792, Banks' birds were divided



Figure 8. Juvenile male 'Tiwi *Drepanis coccinea* (left) (MRSN 2241) and adult male (right) (MRSN 2240), Museo Regionale di Scienze Naturali di Torino, Turin (Giovanni Soldato, © MRSN)

between the British Museum and John Hunter (Medway 1981: 122). From the latter just one 'Tiwi arrived, via the Royal College of Surgeons, at NHMUK (Burton 1969). Others might have been acquisitioned by William Bullock in 1813. Bullock's collection was auctioned in 1819 (Anon. 1819). Two 'Tiwis listed in the auction catalogue (Medway 1981: 124) were acquired by Franco Andrea Bonelli and subsequently ended up in the Turin museum.

'Tiwis were also noted in other private collections. That held by Willem Sebastiaan Boers (1752–1811) was (eventually) purchased by a Mr Voigt on 14 August 1797 (Cleef & Schreurleer 1797)². Another 'Tiwi—noted on 14 October 1793 in a shop owned by the Leverian and British Museum's taxidermist John Thompson (d. 1811)—is not recorded as being in present in any collection today (Medway 1981: 138). 'Tiwis in the museum of Sir Aston Lever (1729–88) were described in 1782 by John Latham (1782: 704). Sarah Stone (1760–1844) (Bernice Pauahi Bishop Museum, Honolulu, Hawaii, vol. 3: no. 20: Jackson 1998: 124) depicted one of these birds. The museum apparently held two males and two females or younger birds. Lever's collection went by lottery to the estate agent James Parkinson (c.1730–1813) on 23 March 1786 and was auctioned in June 1806. Lot 2790, a male and a female, were sold to John Latham, Lot 3070, containing a single bird, was acquired by an unknown purchaser and Lot 4750, comprising two specimens, purchased by Thompson on behalf of Lord Stanley, later 13th Earl of Derby (1775–1851) (Thompson's annotation cat. NHMUK Donovan *et al.* 1806³, Stanley's annotation reprint King & Locheé 1979a)—both are still in Liverpool. Two 'Tiwis (NMW 1806.I.535 and 535a) are no longer present at Naturhistorisches Museum, Vienna (H.-M. Berg *in litt.* 2016), although they were recorded in the first inventory of 1806. The origin of those specimens is unknown. Lot 103, sold on 27 May 1819 during the Bullock auction, was acquired by a collector named Mr Fector (King & Locheé 1979b). Georg Forster, in describing the species, had just one specimen (that belonging to Lohmann) of the species (Forster 1781: 346), but he knew of three other

² He could have received the specimen from Robert Jacob Gordon at the Cape when the Cook expedition docked there in April/May 1780 on the return journey—Dutch merchants had an outpost there.

³ Registered at NHMUK London as NHMUK 2RB 85AS.L.

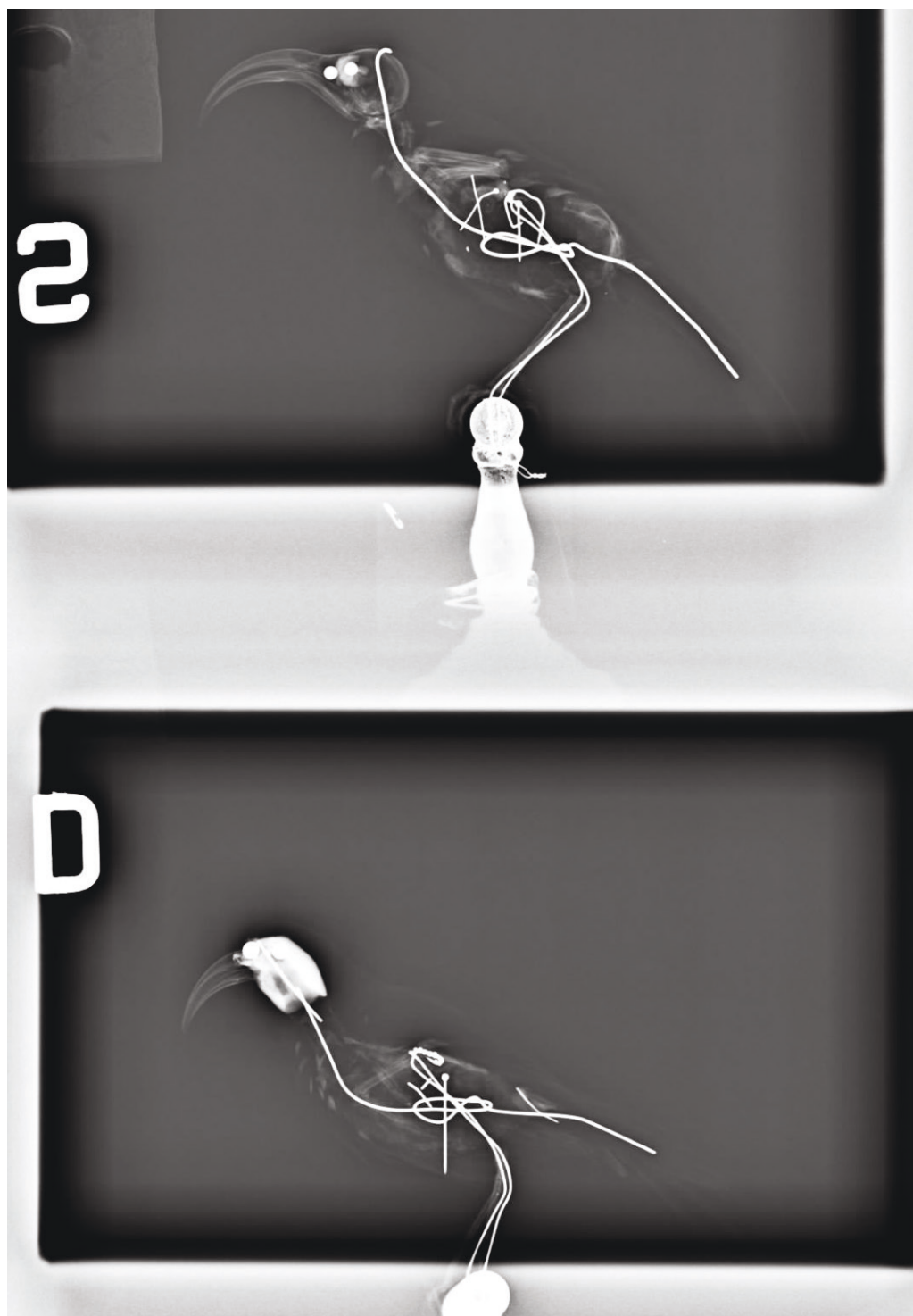


Figure 9. 'Tiwi *Drepanis coccinea*, Museo Regionale di Scienze Naturali di Torino, Turin (above, MRSN 2241; below, MRSN 2240) (Giovanni Soldato, © MRSN)



Figure 10. Adult 'Tiwi *Drepanis coccinea*, Ethnographic Collection of the Georg-August-Universität Göttingen (GAU 345) (Justin J. F. J. Jansen, © Göttingen)

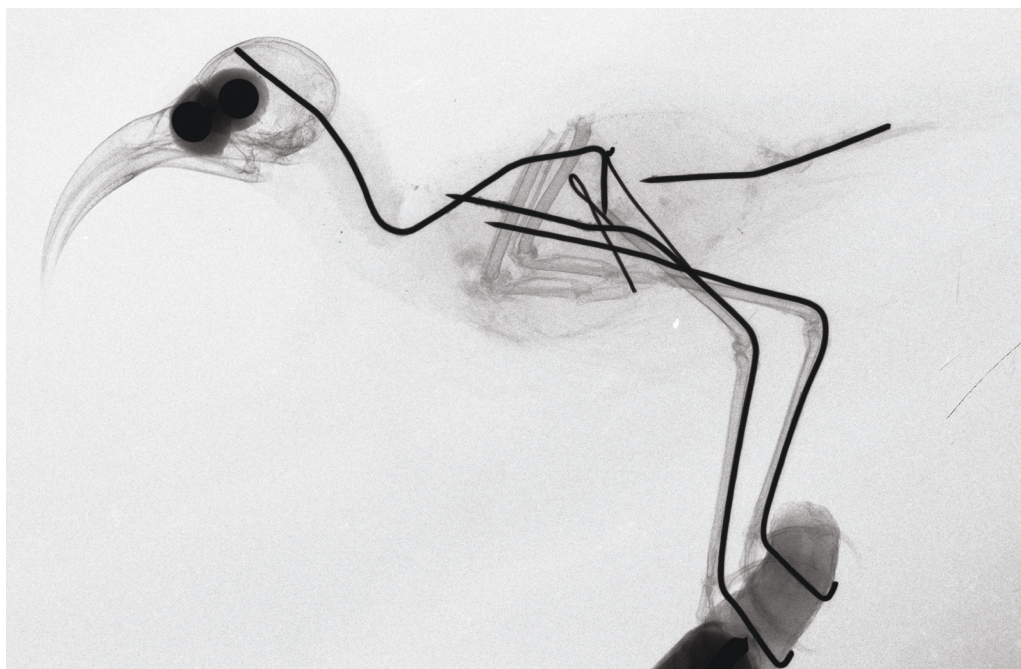


Figure 11. Adult 'Tiwi *Drepanis coccinea*, Ethnographic Collection of the Georg-August-Universität Göttingen (GAU 345) (Gert Tröster, © Göttingen)

specimens (Forster 1781: 347) (*contra* Merrem 1784: 9, Medway 1981: 118). He may have learned of their existence from correspondence with Joseph Banks, but we have not looked



Figure 12. Adult male 'Tiwis *Drepanis coccinea*, Natural History Museum, Tring (NMHUK 1845.2.21.295 and 1845.2.21.297) (Alex Bos, © Natural History Museum, London)

deeper into the Banks archive. The type specimen was studied at Kassel, Germany, and most likely it was one of the two 'Tiwis still held by the local natural history museum in the late 1930s. In an undated three-volume MS list (prepared at the end of the 1930s) one can find amongst the 2,413 birds, under no. 1405 two 'Tiwis (one from Verein für Naturkunde zu Kassel). The same catalogue also included two Hawaiian Apapane *Himatione sanguinea* registered as no. 1406 (two 'first-year females' from the Verein für Naturkunde zu Kassel) and a Bristle-thighed Curlew *Numenius tahitiensis* as no. 1070 (unregistered archive material, Naturkundemuseum in Ottoneum Kassel). However, the sources and origin of these specimens as well as their acquisition date/s remain unknown, although a third-voyage origin is more than likely. The entire collection was destroyed on the night of 22/23 October 1943 in a WWII raid (P. Mansfeld *in litt.* 2015). The fate and origin of the three other known specimens, retrospectively seen by Forster, are unknown.

Results

Workshops.—No fewer than five different workshops (identified by the method of wiring, the make of the artificial body and the treatment of the original bird) were responsible for the mounting of the pre-1826 'Tiwi specimens that have been studied by X-radiation for this paper. On the X-rays the use of arsenic soap / powder is not conclusive, but three birds appear to show dust on the outside of the body (NHMUK 1845.2.21.297, LivCM D511a, D511b); however, further tests are needed.

MRSN 2240 and 2241 (Fig. 9): these originate from the same workshop as for example another 'Tiwi (RMNH.

TABLE 1
Data and notes on preparation of twelve *Tiwi Drepanis coccinea* (G. Forster, 1781) specimens with an origin pre-1826 which are found in collection worldwide. For acronyms see Methods / Acknowledgments.

Acronym	Specimen No.	provenience	X-ray	skull opened	remaining post-cranial bones	wiring	workshop/school
RMNH	AVES.148551	Coenraad Jacob Temminck, ex. coll. Bullock / Hullet or earlier	yes	partly destroyed	wing bones, broken tibiotarsus, few caudal vertebrae	hooked / bent wires, twisted with each other, soft body	1
MRSN	2240	Franco Andrea Bonelli, ex coll. Bullock	yes	not opened	wing bones, no visible tibiotarsus, neck & caudal vertebrae, parts of pelvic girdle	hooked / bent wires, twisted with each other, soft body	1
MRSN	2241	Franco Andrea Bonelli, ex coll. Bullock	yes	partly destroyed	wing bones, no visible tibiotarsus, few caudal vertebrae, parts of pelvic girdle	hooked / bent wires, twisted with each other, soft body	1
SMNH	A 533669	Gustaf von Paykull, ex coll. ?von Carlson, Grill, Lever	yes	opened	broken tibiotarsus, wing bones not visible (close to modern skin)	2 leg wires, 1 neck wire, pinned, hard body	2
SMNH	A 533670	Gustaf von Paykull, ex coll. ?von Carlson, Grill, Lever	yes	opened	wing bones, broken tibiotarsus, caudal vertebrae, parts of pelvic girdle	1 thick wire and additional pins, rather soft body	3
NHMUK	1845.2.21.297	Lord Byron, ex coll. ?HMS Blonde	yes	opened	wing bones, leg bones (subsequently) broken	1 thick wire and additional pins, rather soft body	3
GAU	345	Johann Friedrich Blumenbach, ex coll. Humphrey, ?Samwell	yes	not opened	wing bones, broken tibiotarsus, caudal vertebrae	several pins & sharp wires (including tail wire), hard body	4
NHMUK	1845.2.21.295	Royal College of Surgeons, ex coll. ?HMS Discovery / Resolution, Astrolabe, Queen Charlotte, King George	yes	not opened	wing bones, broken tibiotarsus, caudal vertebrae	single wires each for neck, legs, tail, wings, bended, loosely connected, soft body	5 (similar to 1)
LivCM	D511a	Lord Stanley, ex. coll. Lever	yes	not opened	wing bones, (subsequently?) broken tibiotarsus, parts of pelvic girdle	1 wire (not in legs), ?wires subsequently removed	no workshop assignment
LivCM	D511b	Lord Stanley, ex. coll. Lever	yes	not opened	wing bones, (subsequently?) broken tibiotarsus, parts of pelvic girdle	2 wires (1 in leg), ?wires subsequently removed	no workshop assignment
NHMUK	A.1845.2.21.297	Royal College of Surgeons, ex coll. ?Cook, HMS Astrolabe, Queen Charlotte, King George	no	not opened	complete skeleton	[spirit specimen]	no workshop assignment
NHMUK	1845.2.21.368 // 387	Lord Byron, ex coll. HMS Blonde	no	unknown	unknown	not investigated	no workshop assignment
NMS	Z 1926.21.95	ex coll. ?HMS Blonde	no	unknown	unknown	not investigated	no workshop assignment

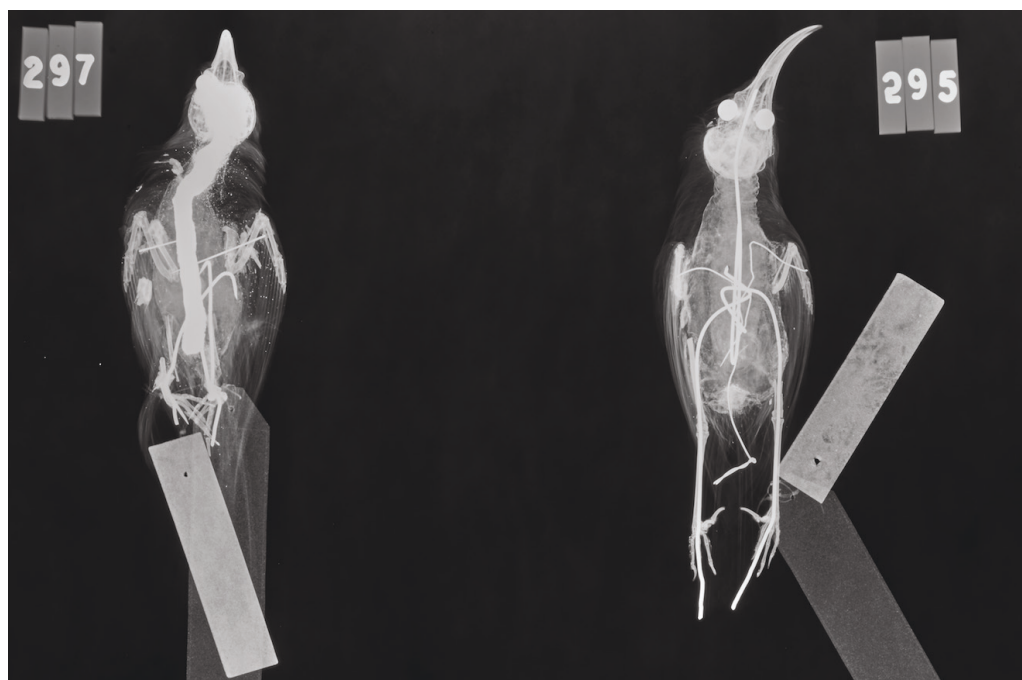


Figure 13. Adult male 'Tiwis *Drepanis coccinea*, Natural History Museum, Tring (NMHUK 1845.2.21.295 and 1845.2.21.297) (© Natural History Museum, London)

AVES.148551), an Apapane *Himatione sanguinea* (RMNH.AVES.148558) and a Kaka *Nestor meridionalis* (NHMUK 1837.6.10.379).

SMNH A533669 (Fig. 7): similar to birds from the workshop that also worked on specimens collected by Anders Sparrman during the second Cook voyage, i.e. a White Tern *Gygis alba* (SMNH A569927), Blue Lorikeet *Vini peruviana* (SMNH A569914), Red-crowned Parakeet *Cyanoramphus novaezelandiae* (SMNH A569923), Tui *Prothemadera novaeseelandiae* (SMNH A533743), Piopio *Turnagra capensis* (SMNH A568806), Cape Cormorant *Phalacrocorax capensis* (SMNH A558970), Tahiti Flycatcher *Pomarea nigra* (SMNH A569917) and Tahiti Reed Warbler *Acrocephalus caffer* (SMNH A569913).

SMNH A533670 (Fig. 7): this specimen has a thick wire inside. Other specimens possibly from the same workshop are another 'Tiwi (NHMUK 1845.2.21.297), a Marbled Murrelet *Brachyramphus marmoratus* (NMW 53422), a Moorea Kingfisher *Todiramphus youngi* (NMW 50633), a Raiatea Parakeet *Cyanoramphus ulietanus* (NMW 50687) and a Tahiti Reed Warbler (NMW 58499).

GAU 345 (Fig. 11): similar to a stuffed Hawaii Oo *Moho nobilis* (Hanover Museum) of the same origin, but wires slightly less bent.

NHMUK 1845.2.21.295 (Fig. 13): prepared with single wires each for the neck, legs, tail and wings, which are loosely connected and bent within a soft body. Another bird from the same workshop is perhaps a Blue Lorikeet (NHMUK 1845.2.21.329). The make of their mounts is very similar or nearly identical to the specimens of workshop 1, but the wires are more loosely connected.

Discussion

It can be noted that preparation in the field determines whether certain skeletal and muscle parts remain in the specimens. Bent wires can be used only when bodies of the skins



Figure 14. Adult 'Iwi *Drepanis coccinea*, National Museums Scotland, Edinburgh (NMS 1926.21.95) (Bob McGowan, © NMS)

remained soft; hard bodies (e. g. mummies, dried muscles) require pinned wires (Morris 2012). One can identify two schools during the voyages of James Cook, those crew members trained or influenced by Joseph Banks during the first voyage and subsequently by Banks or workshops that Banks recommended in London, and those taught their taxidermy skills by J. R. Forster and / or Anders Sparrman during the second voyage. The third voyage had no official trained naturalist on board so one can assume that all taxidermy skills of crew members were gathered beforehand. No literature or archival material confirms any training of crew members before leaving British shores, but it is known that Banks (who, e.g., had a plant collector on board the third voyage) and Forster had significantly influenced crew members to collect specimens.

Forster (1771) preferred a rather quick preparation method of partly mummifying specimens and simultaneously using heavy poison (arsenic soap or dust) to control insect pests, rather than preparing them completely (preferred by Banks who probably was unaware of the use of arsenic soap at the time). Forster had a big influence on the taxidermy skills of crew members. He might have directly or indirectly trained or advised crew members to use dried native skins for mounting museum specimens. This method was much quicker and easier than re-working native dried specimens to modern mounts without part-mummification.

Wiring probably occurred in Britain before disposal of specimens to collections abroad, but always after leaving the vessels. One can assume that mounting occurred in different workshops in Britain and Sweden.

Another obstacle to a systematic review is that native Polynesians of the Hawaiian archipelago were also skillfully preserving bird specimens, as feathers and dried birds played a large part in their culture. Native bird skins probably were partially prepared, leaving vertebrae and long bones as well as an unopened skull in the skin. Therefore, especially during visits by Europeans to Hawaii, already skinned and dried specimens were acquired rather than fresh dead birds. The different 'schools' subsequently used probably the ready skins without altering the bone composition so that the workshops' typical bone assemblages most probably would not be diagnostic in early Hawaiian skins. Once the specimens arrived home, wires were anchored in the dried bodies probably after some relaxation by humidity, and the belly cavities filled with any dry and soft material. Furthermore, pinned eyes were mainly used (little black balls on wire), as the alternative, fragile concave glass lenses, were better placed during the skinning process. Arsenic soap, if already known, could be applied only in the lower body cavity or externally.

One of the workshops was run by John Thompson who received the official expedition material and was therefore responsible for most bird specimens in the Leverian and British Museums (*fl.* 1785–1811; British Museum archives PPA331622, PPA331624, Anon. 1811), another workshop by George Humphrey, who acquired specimens directly from crew members, including the Göttingen ‘Tiwi. This Göttingen specimen is the only one with continuous documentation back to 1782 and thus is the only proven Cook specimen. Taking the close similarity of preparation in account, one can assume that both Turin specimens (MRSN 2240, 2241), one Leiden specimen (RMNH.AVES.148551) and to a lesser extent one of the Tring specimens (NHMUK 1845.2.21.295) may possess the same origin. However, according to associated label data, the latter specimen is apparently from the *HMS Blonde* expedition, while the Leiden and Turin specimens had been viewed as Cook specimens (Whitehead 1969, 1978). Since it is rather unlikely that any crew member served on both voyages 36 years apart and even work traditions active for several decades would be exceptional, incorrect data association might be the more plausible scenario, although it is impossible to be conclusive about this for now.

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On Temminck's tailless Ceylon Junglefowl, and how Darwin denied their existence

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SUMMARY.—Ceylon Junglefowl was described in 1807 by the Dutch ornithologist Coenraad Jacob Temminck. The specimens he examined were tailless ('rumpless') and therefore he named them *Gallus ecaudatus*. In 1831 the French naturalist René Primevère Lesson described a Ceylon Junglefowl with a tail as *Gallus lafayetii* (= *lafayettii*), apparently unaware of Temminck's *ecaudatus*. Subsequently, *ecaudatus* and *lafayettii* were realised to be the same species, of which *G. stanleyi* and *G. lineatus* are junior synonyms. However, Charles Darwin tried to disprove the existence of wild tailless junglefowl on Ceylon in favour of his theory on the origin of the domestic chicken.

'The tailless cock inhabits the immense forests of the island of Ceylon' (Temminck 1813: 268).

'... but this statement [tailless fowls are wild in Ceylon] ... is utterly false' (Darwin 1868: 259).

Ceylon Junglefowl *Gallus lafayetii* is one of four species in the genus *Gallus* in South and South-East Asia. It is confined to Sri Lanka, where it is the national bird. At the end of the 18th century, three specimens of a tailless variety were sent from Sri Lanka to Holland, where they were added to the collections of Coenraad Jacob Temminck and Johan Raye van Breukelerwaert. Fowl without tail are called 'rumpless' by poultry keepers and geneticists, explained as the hereditary absence of some or all tail bones (Crawford 1990). In domestic fowl the condition has been known for centuries: rumpless domestic chickens were illustrated by the Italian naturalist Ulisse Aldrovandi (1600) as Persian fowl (Fig. 1). Linnaeus (1758) correctly considered the rumpless Persian fowl a variety of Red Junglefowl *G. gallus*, naming it *Phasianus gallus*, var. γ . *ecaudatus*. Latham (1790) transferred it to the genus *Gallus* and elevated it to a species as *G. ecaudatus* (see Appendix).

Darwin also was familiar with rumplessness as a variety in domestic chickens and used it as an example of deleterious variants, which in his opinion, if they occurred in animals in the wild, would be removed from the general population by natural selection (Darwin 1868). In this paper we provide evidence that Darwin did not believe in the former existence of wild rumpless junglefowl on Ceylon. Furthermore, he was unaware that these were in fact a variety of Ceylon Junglefowl and he also did not realise that the evidence for this, Temminck's specimens in Leiden, still existed.

Temminck's rumpless Ceylon Junglefowl

Coenraad Jacob Temminck (1778–1858) became the first director of the State Museum of Natural History (RMNH, now Naturalis Biodiversity Center) in Leiden following its foundation in 1820. Temminck's own ornithological collection had previously been enriched via contacts with many travellers and collectors, due to the senior position of his father Jacob in the Dutch East India Company (Hoek Ostende *et al.* 1997). Temminck started



Figure 1. Engraving of Aldrovandi's (1600) rumplless Persian hen and Persian cock (Harry Taylor, © Natural History Museum, London)

to catalogue his birds in 1799, when he allocated numbers up to 333, adding to these in subsequent years until the list was printed in 1807 (Stresemann 1953). Entry 257 catalogued two specimens of rumplless fowl from Ceylon: '(257) *Gallus ecaudatus* (primus) (Mas) Temm. Gall. – Le coq sans croupion, ou le Wallikikili de Ceylan (Mâle) (Espèce primitive) – Temm. Gall. v.1. pl. Enl.' (Temminck 1807: 145).



Figure 2. Lithograph of *Gallus ecaudatus*, based on specimen RMNH.AVES.224888 (Fig. 3), by Jean-Gabriel Prêtre prepared c.1806 for an illustrated work in three volumes that Temminck intended to publish on pigeons and Galliformes. Only the volume on pigeons was published, in 1808, and the two volumes on Galliformes never appeared due to a conflict between Temminck and the French illustrator of the first volume, Pauline Knip (Dickinson *et al.* 2010). Instead, Temminck later published *Histoire naturelle générale des pigeons et des gallinacés* in three volumes (1813–15) without any colour illustrations. The reference 'Gall. v. 1. pl. Enl.' in Temminck's published catalogue (1807) refers to the first of the two unpublished volumes on Galliformes, which would have been vol. 2 of the complete work (Naturalis Biodiversity Center, Leiden)



Figure 3. First syntype of *Gallus ecaudatus* Temminck, 1807 (RMNH.AVES.224888), adult, from Temminck's former private collection (Naturalis Biodiversity Center, Leiden)



Figure 4. Second syntype of *Gallus ecaudatus* Temminck, 1807 (RMNH.AVES.224889), juvenile, from Temminck's former private collection (Naturalis Biodiversity Center, Leiden)

The entry is bilingual, Latin and French. Therefore, both 'primus' and 'Espèce primitive' have the same meaning and suggest that Temminck thought these birds represented the ancestral type of rumpless domestic fowl. Temminck referred ('pl. Enl.') to a lithograph of one of the birds that he intended to add to a planned series of descriptions of pigeons and Galliformes; this was never published, but is preserved among his papers in the Naturalis Library, Leiden (Fig. 2).

Temminck (1813) provided more extensive details about the new species *Gallus ecaudatus*, 'named by me' (mihi). In Ceylon it was called *wallikikili* meaning 'cock of the woods'—a name later shortened to *wallikiki* by French authors and used for domestic, rumpless fowl. Temminck examined three specimens, all males (no hens): two in his own collection (as listed in Temminck 1807) and another adult owned by Johan Raye van Breukelerwaert, a rich merchant with an extensive bird collection who lived close to Temminck in Amsterdam. Temminck stated that his own tailless specimens were sent by an unnamed governor of Dutch Ceylon. The last two Dutch governors before Ceylon was ceded to the British in 1796 were Willem Jacob van de Graaf (governor 1784–94) and Johan van Angelbeek (1794–96). It is probable that Raye's specimen came from the same source. No other rumpless specimens of Ceylon Junglefowl have been recorded from Sri Lanka.

In 1820, Temminck's private collection became the nucleus of the new museum in Leiden, where many of these specimens are still present, including his two mounted *G. ecaudatus* in remarkably good condition. One is an adult with fully developed comb and wattles (Fig. 3), while the other is a young bird whose comb and wattles were just starting to develop (Fig. 4). The collection of Raye van Breukelerwaert was auctioned in July 1827. According to an annotated copy of the sales catalogue in the Naturalis Library, Lot 885



Figure 5. Holotype of *Gallus lafayetii* Lesson, 1831 (MNHN 2014-393) collected by Leschenault in Ceylon between July 1820 and February 1821 (Muséum national d'Histoire naturelle, Paris)

'*Gallus ecaudatus*, le Coq sans queue' was bought by 'RM', abbreviation of 'Rijks Museum' (RMNH) in Leiden (Raye 1827). However, Raye's specimen of *G. ecaudatus* is no longer present in Leiden and could have been exchanged, sold or destroyed during the intervening 190 years; its current whereabouts are unknown.

Lesson's 'tailed' Ceylon Junglefowl

In 1816 the French botanist and ornithologist Jean-Baptiste Leschenault de La Tour visited India to collect plants and to establish a botanical garden in Pondicherry. With permission from the British authorities he also visited Madras, Bengal and Ceylon (Ponthieu 1827). Returning in July 1822, Leschenault donated the birds he had collected to the Muséum national d'Histoire naturelle in Paris, including a specimen of a junglefowl from Ceylon clearly exhibiting a tail. The collection was revised by the French surgeon and naturalist René Primevère Lesson, who recognised the junglefowl as a new species *Gallus lafayetii* (Lesson 1831). The specific name commemorated the French aristocrat Gilbert du Motier, Marquis de La Fayette, who was a key figure in the French Revolution of 1789 and the July Revolution of 1830. Lesson (1831, 1836, 1838) consistently spelled the specific name *lafayetii*, while referring to the bird in French as 'Coq Lafayette'. Hence the spelling *lafayetii*



Figure 6. Oeillet Des Murs, *Iconographie ornithologique* (1845–49), pl. 18: ‘*Gallus lafayetii* (Lesson) Coq de Lafayette’ (Harry Taylor, © Natural History Museum, London)

is considered a lapsus (ICZN 1999, Art. 32.5.1) and the corrected spelling *G. lafayettii* is in common use (McGowan *et al.* 2017).

The brief description in Lesson (1831) provided only the provenance (‘Coq sauvage de Ceylan’) and plumage colour (in the male). Subsequently, Lesson may have discussed the classification of junglefowl with Temminck and his assistant Hermann Schlegel, who visited the Paris museum in April–June 1835 (Schlegel 1837, 1839, Zijderveld 2014). This is reflected in his subsequent publications (Lesson 1836, 1838), wherein he referred to Temminck (1813) and used the latter’s more elaborate description. He copied the vernacular names for the species used by Temminck (Le Coq sans croupion ou wallikikili) which referred to the tailless form, and listed his *lafayettii* as a synonym of Temminck’s *ecaudatus*.

The holotype of *G. lafayettii* Lesson, 1831, collected by Leschenault is still in Paris (Fig. 5). It was figured in the third part (dated 1846) of the *Iconographie ornithologique* (Pl. 18) by Oeillet Des Murs (1845–49), after a drawing by Alphonse Prévost (Fig. 6).

Darwin’s monophyletic theory on origin of domestic fowls

Research continues as to whether the origin of the domestic chicken is monophyletic (from one species) or polyphyletic (from multiple species, e.g. Erikson *et al.* 2008). It could be derived exclusively from *G. gallus* (formerly *G. bankiva*), or also contain elements of other species, extinct or otherwise. Temminck (1815) opined that domestic poultry breeds descended from six ancestral wild species, five living and one possibly extinct, and Lesson

(1836) shared this view. One of the extant ancestral species, in Temminck's opinion, was the rumpless *G. ecaudatus* from Ceylon, which he considered the wild ancestor of the domestic rumpless poultry breed 'Persian fowl'. The French zoologist Georges Cuvier (1832) also agreed with this, despite '*ecaudatus*' having the characteristic rumplessness atypical for genus *Gallus*.

Charles Darwin, however, had come to the conclusion that the domestic chicken was monophyletic and had descended solely from Red Junglefowl: 'Most fanciers believe that they are descended from several primitive stocks. ... Most naturalists, with the exception of a few, such as Temminck, believe that all the breeds have proceeded from a single species' (Darwin 1868: 230). Darwin is known to have consulted Temminck (1813) from an entry in one of his notebooks (Darwin 1838–51). He also quoted it (Darwin 1868) and in 1858 wrote to his friend William B. Tegetmeier that 'I know Temminck's work' (Darwin 1858). To protect his theory as to the monophyletic origin of domestic chickens, Darwin appeared keen to disprove the (former) existence of Temminck's *ecaudatus*.

However, the two remaining specimens in the Leiden museum are silent witnesses to the former occurrence of *ecaudatus*; wild, rumpless Ceylon Junglefowl on the island at the end of the 18th century. These specimens do not display any characters to suggest hybridisation with domestic *G. gallus*. The rumpless condition probably arose as a spontaneous mutation in the wild population of Ceylon Junglefowl and then disappeared again. When the mutation first occurred, or how long such birds persisted is unknown. A similar mutation occurs in domestic chickens, wherein the lack of tail is a disadvantage in competing with rivals for mating, and mating success (i.e. fertilisation) is much lower in rumpless individuals, mainly because the tail serves as a counterbalance during copulation (Crawford 1990). This presumably also applied to the rumpless Ceylon Junglefowl and it can be assumed that this explains why the variety did not become established in the wild.

Darwin's rejection of rumpless Ceylon Junglefowl as ancestor

The proposition that Red Junglefowl is the sole ancestor of the present domestic breeds of chicken was an important part of Darwin's reasoning for his theory of evolution. In *The variation of animals and plants under domestication* (1868), Darwin disclosed his monophyletic theory on the origin of domestic chickens. He provided rationale to prove the significance of Red Junglefowl, and argued against the involvement of the other three wild junglefowl species. The possible role of extinct species, as Temminck had suggested, was not favoured: 'The extinction, however, of several species of fowls, is an improbable hypothesis, seeing that the four known species have not become extinct in the most anciently and thickly peopled region of the East' (Darwin 1868: 237).

Darwin, unaware that *ecaudatus* and *lafayetii* were the same species, discussed the possibility that Ceylon Junglefowl is an ancestor of the domestic chicken, but found that the evidence argued against this: 'Ceylon possesses a fowl peculiar to the island, viz. *G. Stanleyi*; this species approaches so closely (except in the colouring of the comb) to the domestic fowl, that Messrs. E. Layard and Kellaert [*sic*] would have considered it, as they inform me, as one of the parent-stocks, had it not been for its singularly different voice. This bird crosses readily with tame hens, and even visits solitary farms and ravishes them. Two hybrids, a male and female, thus produced, were found by Mr. Mitford to be quite sterile: both inherited the peculiar voice of *G. Stanleyi*. This species then, may in all probability be rejected as one of the primitive stocks of the domestic fowl' (Darwin 1868: 234). Darwin here used the name *G. stanleyi* for Ceylon Junglefowl following then common usage in Britain (see Appendix). He relied on two independent experts on Ceylonese birds: Edgar Leopold

Layard, a British colonial civil servant and ornithologist, and Edward Frederik Kelaart, a Ceylon-born physician and naturalist.

When Darwin discussed the four wild species of Asian junglefowl, he made no reference to the wild rumpless specimens Temminck named *G. ecaudatus*. Darwin (1868) was aware of Temminck's claim that wild rumpless specimens had been found in Ceylon, but his informants rather forcibly denied this. Layard (1851: 619) was undeniably clear that 'The rumpless fowl is not a wild inhabitant of this island, in spite of Temminck. It is a rather tame introduction from Cochin, I am told. I am sure it is not found wild in these parts. It may appear like boasting, but I can confidently say I am more acquainted with the Ceylon Fauna than any man living, and that if the bird had existed wild, I must have seen it.' Kelaart (1852), his second informant, failed to list rumpless junglefowl in his catalogue of birds of Ceylon. When Darwin met Kelaart by chance at the British Museum in 1856, he was offered help in regard to Ceylonese poultry (Darwin 1856) and must have been assured again that no wild rumpless junglefowl inhabited Ceylon (Darwin 1868). Edward Blyth, curator of the Museum of the Asiatic Society of Bengal in Calcutta, also proffered information about Asian wild junglefowl. In a letter to Darwin, Blyth stated 'Of the three wild typical *Galli*, one (*G. Stanleyi*, v. *Lafayettei*) is quite peculiar to Ceylon, and is abundantly distinct, specifically, from all domestic fowls' (Blyth 1855). None of them, apparently, realised that Temminck's birds constituted a rumpless variety of *G. lafayettei*.

Darwin, therefore, could quote adequate authority to state that a wild rumpless junglefowl did not exist in Ceylon in that era, and therefore could not have been ancestral to the domestic chicken. He did not believe that the rumpless fowls were a distinct species, as argued by the French surgeon and physiologist Paul Pierre Broca (1859). In fact he was quite adamant in his statement: 'An eminent physiologist [Dr. Broca] has recently spoken of this breed as a distinct species; had he examined the deformed state of os coccyx he would never have come to this conclusion; he was probably misled by the statement, which may be found in some works, that tailless fowls are wild in Ceylon; but this statement, as I have been assured by Mr. Layard and Dr. Kellaert [*sic*], who have so closely studied the birds of Ceylon, is utterly false' (Darwin 1868: 259).

Discussion

Darwin was misinformed and clearly unaware that Temminck's description of *G. ecaudatus* was based on actual specimens, and that these still existed in Leiden. He also appears not to have known about Lesson's publications, wherein *ecaudatus* and *lafayettei* are stated to be the same species. On the other hand, he was convinced by the statements of Blyth, Layard and Kelaart that there was no wild rumpless junglefowl on Ceylon, and that any tailless specimens had been in fact been imported domesticated ones. Of course, we now know that Temminck's specimens represent only a heritable aberration of Ceylon Junglefowl, but the fact remains that despite the belief of Darwin, Blyth, Layard and Kelaart, rumpless wild Ceylon Junglefowls did once occur on Ceylon.

Temminck and Lesson died long before Darwin published. Their role to correct Darwin's mistake could possibly have been assumed by Herman Schlegel, who succeeded Temminck as director of the Leiden museum in 1858. Schlegel (1860) acknowledged that Temminck's *G. ecaudatus* was not a species, but he believed that domestic, rumpless chickens derived from the rumpless variant of *G. lafayettei*. Schlegel considered species as fixed, and consequently he was strongly opposed to Darwin's theory of evolution (Zijdeveld 2014). Darwin knew of Schlegel's opinions on species and evolution from remarks by his close friend, the British botanist and explorer Joseph Dalton Hooker (1845): 'I talked much with Schlegel, he is strongly in favour of a multiple creation & against migration.' Hence the two

men were discouraged to contact each other. If they had, Schlegel could have informed him that *ecaudatus* and *lafayettii* are the same species and that Temminck's specimens still existed, but so far no correspondence between Darwin and Schlegel has been found. However, if Darwin had known of the rumpless Ceylon Junglefowl it might have confused him. He may have changed his view on the origin of domesticated fowl and decided that the chicken was polyphyletic after all, just as he thought (incorrectly) was true of the domesticated dog (Darwin 1868). But these remain matters for speculation alone.

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Appendix: the confused nomenclature of the Ceylon Junglefowl

Ceylon Junglefowl *Gallus lafayetii* was scientifically named four times in a period of 40 years: *ecaudatus* Temminck, 1807; *lafayetii* (= *lafayettii*) Lesson, 1831; *stanleyi* Gray, 1832; and *lineatus* Blyth, 1847.

1. Temminck (1807) described the 'Coq sans croupion' from Ceylon as *Gallus ecaudatus*. This name is preoccupied by *Phasianus ecaudatus* (Linnaeus, 1758), transferred to the genus *Gallus*, for a domestic variety of Red Junglefowl. However, this name might be invalid as domestic forms should not be named separately (ICZN 1999). If Temminck's *ecaudatus* is not preoccupied for that reason, it remains unavailable as it has not been used as a valid name for Ceylon Junglefowl post-1899 (ICZN 1999, Art. 23.9.1.1).
2. Lesson (1831) described the 'Coq Lafayette' from Ceylon as *Gallus lafayetii*. Lesson's name *lafayetii* should be corrected to *lafayettii*. It is commonly used and therefore takes priority (ICZN 1999, Art. 23.9.1.2).
3. Gray (1832) named the 'Stanley Hen' (without locality) as *Gallus stanleyi*. J. E. Gray, assistant keeper of zoology at the British Museum, together with T. Hardwicke, an army officer and naturalist, produced a major folio work, the *Illustrations of Indian zoology* (1830–35) containing 200 coloured plates, published without accompanying text. Pl. 43, painted by Benjamin Waterhouse Hawkins and published in April 1832 (Kinnear 1925), shows three hens of two species (Green Junglefowl *G. varius* and Red Junglefowl *G. gallus bankiva*) as



Figure 7. J. E. Gray, *Illustrations of Indian Zoology* (1832), pl. 43, which shows the females of three species of junglefowl, from left to right: Green Junglefowl *Gallus varius*, Ceylon Junglefowl *G. lafayettei* and Red Junglefowl *G. gallus bankiva*. Gray incorrectly thought that the Ceylon Junglefowl was a new species and named it Stanley Hen, or (in the index) Lord Stanley's Hen (Harry Taylor, © Natural History Museum, London)

well as a supposedly new species (Fig. 7) that Gray called 'Stanley Hen. *Gallus stanleyi*' in the caption to the plate, emended to 'Lord Stanley's Hen. *Gallus Stanleyi*, Gray' in the index of May 1832. It was named for Lord Edward Smith Stanley, 13th Earl of Derby, a passionate collector of animals, both living and dead (Fisher 2002) and President of the Zoological Society of London (ZSL) at the time. It is unknown where Waterhouse Hawkins saw the specimen shown on the plate. The other two species on Pl. 43 were kept at the time in the Gardens of the Zoological Society in Regent's Park (ZSL 1831, 1832), and perhaps the third species was held there as well. Alternatively, this hen might have been kept by Lord Stanley. However, there were no junglefowl in Lord Stanley's aviary at Knowsley Hall near Liverpool at that time (Woolfall 1990), nor are there any relevant specimens in Stanley's skin collection, now at the World Museums Liverpool (T. Parker pers. comm.). Consequently, the whereabouts and provenance of the type specimen are unknown. Sykes (1832), followed by Gray (1844), suggested that *Gallus stanleyi* was in fact a female Grey Junglefowl *G. somnerati*.

4. Blyth (1847) described a new junglefowl from Ceylon as *Gallus lineatus*. The Museum of the Asiatic Society of Bengal in Calcutta in 1846 received a shipment of birds 'from Dr. Templeton, including some of considerable interest, – as the *Gallus stanleyi* of Gray, hitherto I believe only known from Hardwicke's published figure of the hen' (Blyth 1846: 314). The next year, Robert Templeton sent from Ceylon 'a second and new species of Jungle-fowl from that island (*Gallus lineatus*, nobis) additional to *G. stanleyi* of Hardwicke's illustrations – which latter has, I believe, been first verified from an actual specimen, previously transmitted to the Society by the same gentleman' (Blyth 1847: 211). Blyth provided no characteristics and his name must be regarded as a *nomen nudum* (ICZN 1999, Art. 12). When, in 1848, Blyth received a male junglefowl from Ceylon from Edgar Leopold Layard, he recognised that all three specimens were of the same species, which he listed as *Gallus stanleyi*, of which both *lafayettei* (erroneously spelled *Lafayettei*) and his *lineatus* were synonyms (Blyth 1849). Perhaps due to Blyth's authority, many British ornithologists continued to use the specific name *stanleyi* instead of *lafayettei* for Ceylon Junglefowl (e.g. Kelaart 1852, Layard 1854, Jerdon 1864, Blyth 1867, Legge 1875).

Observation of an all-dark *Pseudobulweria* petrel in the Bismarck Sea, with a review and discussion of recent records

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SUMMARY.—The observation of an all-dark *Pseudobulweria* petrel in the Bismarck Sea, Papua New Guinea, in April 2017, is described, together with a review of similar at-sea observations. The affinity of these birds to Fiji Petrel *P. macgillivrayi* is discussed and some suggestions made as to how knowledge of this population might be advanced so that, ultimately, its conservation can be facilitated along with a suite of imperilled Pacific petrels that urgently require safeguards.

The last decade has witnessed a spate of ornithological discoveries in the seas of Melanesia (e.g. Shirihai 2008, Shirihai *et al.* 2009, Bretagnolle & Shirihai 2010, Shirihai & Bretagnolle 2010). These relate to highly threatened populations of Procellariiformes and all represent urgent conservation priorities. Adding to the growing list of enigmatic observations are several sightings of an unidentified all-dark *Pseudobulweria* petrel in the Bismarck Sea (Shirihai 2004, 2008, Flood *et al.* 2017). Here I report an additional sighting and review all records to date.

Observation of an all-dark *Pseudobulweria* petrel in the Bismarck Sea

On 22 April 2017, I observed an all-dark *Pseudobulweria* petrel in Silur Bay, south-east New Ireland, Papua New Guinea, at 04°28'S, 153°06'E, while participating in BirdLife International's recent project researching Beck's Petrel *P. becki* (BirdLife International 2017a). Field work was focused on at-sea capture of Beck's Petrels within Silur Bay to deploy satellite transmitters, with the hope that any tracked individuals might lead us to the species' hitherto unknown breeding sites, by providing accurate fixes for localities on land. I had paddled by kayak to within 200 m of a raft of petrels. At this distance an unfrozen chum mix of ground fish discards, fish oil and fish liver was deployed in a mesh onion bag suspended from a coconut to prevent it from sinking. The raft numbered c.20 birds—the swell was obscuring all or part of the raft at any one time, making a more accurate estimate impossible. The birds were identified as Beck's Petrels at a distance from the PNG Explorer, and then a motorised tender. Optical and camera equipment had been left aboard PNG Explorer.

After 20–30 minutes waiting on the kayak the raft of petrels took flight. The birds scattered in various directions, but several flew towards the chum slick. The first bird to reach it appeared all dark from c.50 m range. As the individual flew closer, it banked revealing that its underparts, as well as the head and back, were all dark, in stark contrast to the Beck's Petrels which have brown upperparts, head, neck and breast, and white posterior underparts. The bird continued towards the chum making two passes, eventually within 5 m. I fired the net gun on the first close pass the bird made, as it turned across the slick c.7 m away. The bird banked easily away from the oncoming net. It made a second pass, fluttering

briefly over the chum bag and, after lingering over the slick with 6–8 Beck's Petrels, it flew off west, further into Silur Bay. In total the observation lasted *c.* 2 minutes.

The bird appeared identical structurally to the Beck's Petrels that it accompanied, but it was noticeably smaller. I estimate it was 20% smaller than a Beck's Petrel in wingspan and body length. In terms of overall bulk, it appeared substantially smaller again. The plumage was uniform dark brown, darker than the head and back of Beck's Petrel, approaching black. It was darkest on the head, back and breast, with warmer rustier tones on the belly. In strong light there was a marginally paler underwing panel where the paler bases to the coverts were visible, but this effect was slight. Based on the bird's shape, with Beck's Petrels for direct comparison, there can be no confusion with any of the all-dark tern or shearwater species that could occur in the area. Although I have never seen a *Bulweria* petrel, the most likely confusion species, the uniformly dark upperparts lacking any hint of a paler panel on the greater coverts, and the bird's structure and flight action separate it from that genus. It had the robust bill and rounded head, abrupt cigar-shaped tapering rear body and tail, and stiff-winged flight action of a *Pseudobulweria*, rather than the square storm-petrel-like head and thin bill, long tapering body and erratic flight of a *Bulweria* (Shirihai *et al.* 2009).

This sighting builds on those reported by Shirihai (2004, 2008) and Flood *et al.* (2017) in the Bismarck Sea. With the growing body of sightings of a mystery petrel in the region, the key questions are what is it and what to do next?

To what species/population do these observations pertain?

Fiji Petrel *P. macgillivrayi* is the only all-dark *Pseudobulweria* recorded in the Pacific. Structurally, Shirihai (2009) noted that Fiji Petrel, to some degree, is close in size and structure to Beck's Petrel with which it shares a square head and bulbous compressed bill, but *becki* lacks the distinctive tapering rear of Fiji Petrel. Both Shirihai (2008) and Flood *et al.* (2017) noted that the all-dark birds they observed had a more robust body, larger head and heavier bill, more rounded wings, and shorter and squarer tail than *becki*. I was unable to note any differences in structure between the all-dark bird I saw and the adjacent *becki*—rather one was a miniature version of the other. Following his at-sea observations of Fiji Petrels in Fiji in 2009, Shirihai (2009) concluded that previous observations of all-dark *Pseudobulweria* petrels in the Bismarck Sea in 2003 and 2007 did not involve Fiji Petrel based on shape and flight behaviour, especially jizz. Flood *et al.* (2017) did not specifically comment on structural differences between the all-dark birds they observed and Fiji Petrel. I have seen Fiji Petrel once in Fiji waters (Bird 2012a) and am unable to discern any noticeable difference between that bird and the one seen in April 2017. On structure, there appears to be no conclusive evidence as to whether the Bismarck birds are Fiji Petrels or another taxon.

In terms of size, Shirihai (2008) reported that two of the three all-dark petrels he observed in the Bismarck Sea were overall slightly smaller than *becki*. Flood *et al.* (2017) reported their bird as being *c.* 10% smaller than a Beck's Petrel, while I estimated the bird I observed to be 20% smaller based upon direct and close comparison with adjacent Beck's. Comparison of biometrics of Fiji Petrels (from Fiji) with Beck's Petrels suggests their wings are 6–18% shorter, tails 9–16% shorter and they weigh 19–33% less (Table 1). This suggests the all-dark birds observed in the Bismarck Sea are within the same size range as Fiji Petrel, but this is obviously a coarse assessment.

Table 2 updates Priddel *et al.* (2008) and collates sightings of all-dark *Pseudobulweria* petrels at-sea. Although the veracity of reports has not been checked, it is immediately apparent that they come from two geographic areas: ten observations are from Fijian/Tongan waters, and eight from Papua New Guinea. These reflect concentrated efforts to observe Fiji Petrels around Fiji, and Beck's Petrel / Heinroth's Shearwater *Puffinus heinrothi*

TABLE 1
Comparative measurements of Fiji *Pseudobulweria macgillivrayi* and Beck’s Petrels *P. becki*.

	Individual	Wing	Tail	Mass (g)	Source
Fiji Petrel specimens	1:	205.0	83.7		Shirihai <i>et al.</i> (2009)
	2:	217.0	91.0	120.0	Shirihai <i>et al.</i> (2009)
	3:	215.0			Shirihai <i>et al.</i> (2009)
	4:	225.0	90.0	145.0	Shirihai <i>et al.</i> (2009)
Fiji Petrel mean		217.0	88.2	132.5	Shirihai <i>et al.</i> (2009)
Beck’s Petrel specimens	1:	251.0	100.0		Shirihai (2008)
	2:	244.0	98.0		Shirihai (2008)
	3:	240.0	99.3		Shirihai (2008)
	4:	250.0	103.7	185.0	BirdLife International unpubl. data
Beck’s Petrel mean		246.3	100.3	185.0	
Fiji : Beck’s difference—max.		82%	84%	65%	
Fiji : Beck’s difference—min.		94%	91%	78%	
Fiji : Beck’s difference—mean		88%	88%	72%	

in Papua New Guinea. That there have been no reports from intervening waters around the Solomon Islands and Vanuatu, where several at-sea surveys during the last decade have focused on Vanuatu *Pterodroma occulta* and Collared Petrels *P. brevipes* (e.g. Bretagnolle & Shirihai 2010, Shirihai & Bretagnolle 2010, Flood *et al.* 2017), is interesting. Fiji Petrel is listed as Critically Endangered due to its presumed tiny population being confined to a very small breeding area (BirdLife International 2017b). Although species’ ecologies differ markedly, it is worth considering, for comparison, other petrels breeding in the western tropical Pacific with purportedly small and range-restricted breeding populations. Vanuatu, ‘Magnificent’ *P. brevipes magnificens* and Beck’s Petrels all meet this description (Bretagnolle & Shirihai 2010, Shirihai & Bretagnolle 2010, Bird *et al.* 2013). Despite increasing ornithological coverage within the region, none of these species has been recorded with certainty more than a few hundred kilometres from the core of their known ranges. This is not to reject the possibility that all of these species do disperse widely, merely that a dilution effect reduces the frequency / likelihood of encounters as distance from the colony increases. For a population as apparently rare as Fiji Petrel is on Gau, it seems very unlikely that birds would be seen with any degree of regularity in the Bismarck Sea, without records from the intervening ocean. Based on the limited comparative evidence available, the most parsimonious explanation is that birds observed in the Bismarck Sea, and those observed in Fiji represent two disjunct populations, and possibly separate taxa.

What next?

Melanesia hosts numerous imperilled petrel populations. Threats are most severe on land, so identifying their breeding colonies is a prerequisite for conservation. Species in the region can be categorised as: (i) studied breeding populations for which threatening processes have been confirmed and / or there are sufficient data to evidence declining population trends, e.g. Collared Petrel on Gau, Fiji (O’Connor *et al.* 2010) and Gould’s Petrel *Pterodroma leucoptera* in New Caledonia (BirdLife International 2017c); (ii) known breeding populations where no studies are underway, but declines are inferred or suspected, e.g. Vanuatu Petrel and Collared Petrel on Vanua Lava, Vanuatu (Totterman 2009, Tennyson

TABLE 2
At-sea observations of all-dark *Pseudobulweria* petrels in the western tropical Pacific.

Year	Date	No. of birds	Latitude	Longitude	Approximate location	Source
1964	8 November	1	19°30'S	176°30'W	550 km ESE of Suva, Fiji	Bourne (1967)
1964	31 December	1	24°00'S	178°30'E	650 km S of Suva, Fiji	Bourne (1967)
1965	1 January	1	21°30'S	176°30'W	140 km WSW of Nuku'alofa, Tonga	Bourne (1967)
1965	23 May	1	10°00'S	180°00'E	360 km NE of Rotuma, Fiji	Bourne (1967)
1986	12 June	1	18°00'S	179°13'E	Herald Bay, Gau Island, Fiji	D. Watling in Priddel <i>et al.</i> (2008)
1986	August	1	18°10'S	178°50'E	Between Suva and Gau Island, Fiji	A. Tabaiwalu in Priddel <i>et al.</i> (2008)
1999	early October	1	16°13'S	179°10'E	20 km N of Vanua Levu, Fiji	D. Watling in Priddel <i>et al.</i> (2008)
1999	early October	1	15°55'S	171°59'W	230 km ENE of Tafahi, Tonga	D. Watling in Priddel <i>et al.</i> (2008)
2003	14 August	1	05°00'S	150°20'S	Kimbe Bay, West New Britain, Papua New Guinea	Shirihai (2008)
2007	12 April	1	01°42'S	153°56'E	400 km N of Bougainville, Papua New Guinea	Howell (2007)
2007	31 July	1	04°20'S	153°18'E	Between New Ireland and Feni Islands, Papua New Guinea	Shirihai (2008)
2007	7 August	1	03°51'S	151°31'E	Cape Lambert, New Britain, Papua New Guinea	Shirihai (2008)
2008	April	1			Bismarck Sea, Papua New Guinea	Shirihai <i>et al.</i> (2009)
2009	13–18 May	8	18°27'S	179°10'E	Locations SW of Gau Island, Fiji	Shirihai <i>et al.</i> (2009)
2011	4 May	1	19°00'S	179°58'E	Yasayasa Moala, Fiji	Bird (2012)
2017	21 January	1	04°25'S	153°06'E	Silur Bay, New Ireland, Papua New Guinea	Flood <i>et al.</i> (2017)
2017	22 January	1?			Cape St. George, New Ireland, Papua New Guinea	Flood <i>et al.</i> (2017)
2017	22 April	1	04°28'S	153°06'E	Silur Bay, New Ireland, Papua New Guinea	This study

et al. 2012); (iii) unconfirmed populations suspected to breed on particular islands where threats can be inferred, e.g. Collared Petrels on several Fijian islands (O'Brien *et al.* 2016) and Beck's Petrel on New Ireland (Bird 2012b); and (iv) species only recorded at sea where there is very little evidence to suggest where they might breed, but for which nesting is suspected in the region, e.g. Polynesian Storm Petrel *Nesofregatta fuliginosa* in Fiji and 'Coral Sea Storm Petrel' in New Caledonia. Following the assertion (made above) that observations of an all-dark *Pseudobulweria* in the Bismarck Sea represent a different population to Fiji Petrels around Fiji, this population falls into the final category above. For these populations it is most difficult to know what to do next. Indeed, for most of the known populations there are no conservation actions planned or underway. Conservation capacity in the region is low, there are few resident ornithologists able to gather further data, and field work is both logistically challenging and expensive.

Given these challenges and constraints, adding another population to an already unmanageable list of conservation priorities runs the risk of diluting effort or exacerbating

existing conservation challenges. There is an obvious conservation pathway that could be adopted, from birders identifying populations at sea, to conservation projects that build on that knowledge to identify populations on land, to conservation programmes that implement on-ground actions. Key considerations when collecting at-sea observations are to: record effort in terms of voyage routes (GPS tracks) and start and end times of observation periods; and to publish observations—either in peer-reviewed literature or simply via online repositories such as eBird (<http://ebird.org/content/ebird/>). If future observations identify reliable locations to encounter the all-dark taxon, BirdLife International's recent work on Beck's Petrel provides proof of concept that *Pseudobulweria* petrels can be captured at sea to deploy satellite trackers (BirdLife International 2017a), which in turn has proved an effective tool for locating petrel breeding sites. However, any future attempts to employ this approach should learn from previous work in the region, to improve the reliability of luring birds within capture range, and to develop methods to land birds on the water for easier capture.

The all-dark taxon in the Bismarck Sea should be treated with the same importance as Fiji Petrel, i.e. one of the highest and most urgent avian conservation priorities in the Pacific (BirdLife International 2017b). However, it would be unwise to divert the effort of conservation organisations in the region into searching for unknown breeding grounds while known populations slip away. Overall, it is clear that a substantial investment in the region is needed if we are to avoid losing several petrel populations and species. This population should be included in any strategic plan for Pacific petrels.

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A New Zealand Storm Petrel *Fregetta maoriana* off Gau Island, Fiji, in May 2017

by Robert L. Flood & Angus C. Wilson

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SUMMARY.—We document a sighting of the Critically Endangered New Zealand Storm Petrel *Fregetta maoriana* made during a pelagic expedition in May 2017 off Gau Island, Fiji. This is the first confirmed record of this recently rediscovered species away from New Zealand, and provides evidence of long-distance dispersal by failed or non-breeders to tropical waters. It expands the known range by c.2,000 km north. Identification necessitated a thorough review of the ‘streaked storm petrels’ of the Pacific Ocean and this is summarised.

We undertook an expedition on 17–26 May 2017 to observe tubenoses off Gau (Ngau) Island, Fiji. The vessel used was the 18-m sailing yacht *Sauvage*. The weather map for 17 May shows the large-scale weather conditions preceding the expedition (Fig. 1). At chosen locations, we drifted, set up an oil slick using Menhaden fish *Brevoortia*, and then added other fish products to the slick. Morning and evening chumming sessions lasted 3–5 hours. The 15–20-knot south-easterly winds spread the smell of the chum widely and assisted storm petrels to forage.

Results

On 20 May 2017, c.26 miles south-west of Gau airport, at 18°26'S 179°08'E, a New Zealand Storm Petrel *Fregetta maoriana* visited our oil slick during both the morning and

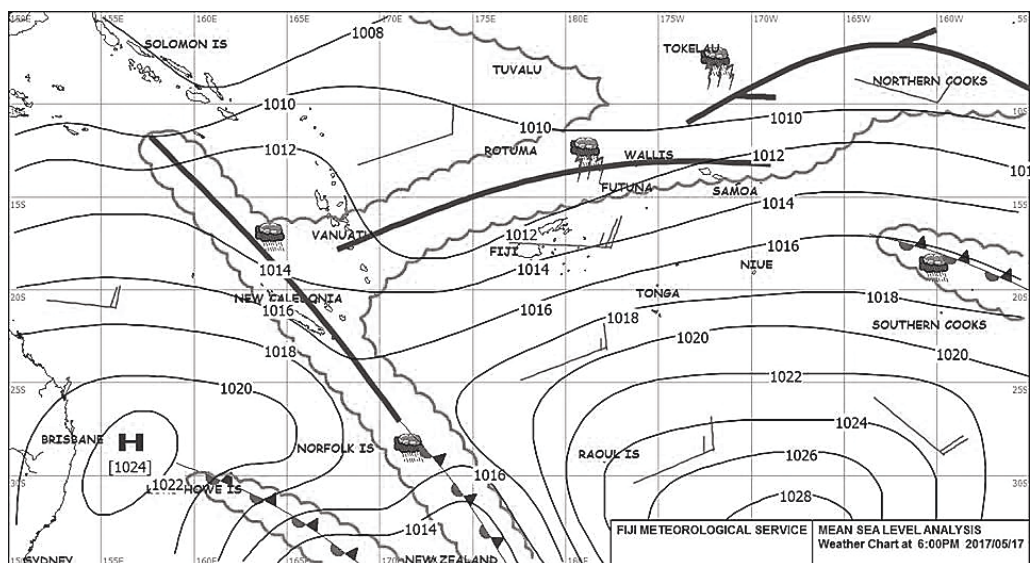


Figure 1. Large scale weather map for the south-west Pacific, 17 May 2017 (courtesy of Fiji Meteorological Service).



Figures 2–3. New Zealand Storm Petrel *Fregetta maoriana*, off Gau Island, Fiji, 20 May 2017 (John & Jemi Holmes). Note clean-looking, largely white central underwing panel and dark streaks mainly restricted to sides of lower breast and belly, as well as white bases to underside of outer rectrices (at least r5 and r6).



Figures 4–5. New Zealand Storm Petrel *Fregetta maoriana*, off Gau Island, Fiji, 20 May 2017 (Angus C. Wilson). Dorsal view suggests Wilson's Storm Petrel *Oceanites oceanicus* but the bird's foot-pattering shown in Fig. 5 is inconsistent with the 'dance' of Wilson's Storm Petrel (Flood & Fisher 2013).

afternoon chumming sessions (Figs. 2–5). Photographs revealed that just one individual was involved. Feather abrasion featured distinctive nicks and notches (Fig. 3). Identification was based on our previous experience of the species and the criteria in Flood (2003) and Stephenson *et al.* (2008a).

Description

Jizz Like a Wilson's Storm Petrel *Oceanites oceanicus* with a *Fregetta* head shape, white central underwing panel, and dark-streaked white belly and flanks. In the afternoon, it

arrived with three Wilson's Storm Petrels from which it most obviously differed by its white underparts and foraging behaviour.

Size Slightly larger than Wilson's Storm Petrel and moderately smaller than Black-bellied Storm Petrel *F. tropica*, based on comparative views (unanimous judgement of all observers, named in Acknowledgements). Nominate Wilson's Storm Petrel from the subantarctic on average is smaller than *O. o. exasperatus* from Antarctica, although size variation may be clinal (Marchant & Higgins 1990).

Flight behaviour When moving towards the oil slick—strong, direct, and purposeful low flight, with continuous, fast, fairly stiff wingbeats. On reaching the slick—slowed to forage, skimmed across surface, with some gliding, often changing direction using one foot to push off from the surface. Frequently stalled, hovered, foot-pattered and dipped head to collect food. Wings held in V shape when hovering and foot-pattering. Long legs often left dangling when progressing short distances after foot-pattering.

Structure Bill slim, slightly decurved, tip hooked and pointed. Nasal tubes c.40% of bill length. Head fairly large and squarish, at times looked disproportionately large compared to body. In profile, forehead slope reasonably steep. Angle of forehead slope to chin slope 'squared off'. Crown slightly convex. Neck quite thick and shortish. Body mid-length and rather slim-looking. Wings medium length: short broad inner wings, medium-length outer wings, pointed wingtips. In travelling flight, leading edge moderately angular and smoothly rounded at carpal joint; trailing edge straight or slightly concave. Paddle-shaped when manoeuvring and foot pattering. Straightened when viewed head-on. Projection behind wings fairly long: long base, mid-length tail, long toe projection c.35% of length of outermost tail feather. Tail closed and somewhat concave in travelling flight, spread and somewhat rounded when manoeuvring and foot pattering. Mid-toe / tarsus ratio 0.80–0.84 estimated from photographs, middle toe longest.

Plumage aspect Overall dark, except white uppertail-coverts and central underwing panel, and dark-streaked white belly and flanks. Head and neck darkest (blackish) affording subtle dark-hooded look. Brownish-black back and remiges contrasting moderately with somewhat paler / browner upperwing-coverts. Dull paler / greyer upperwing ulnar bars on median and greater coverts. Brownish-black rump. White uppertail-coverts formed U shape from above. Broad dark leading edge to underwings, linking blackish upper breast to dark greyish-brown underside of primaries (involving marginal and most of lesser coverts). Clean-looking, largely white central underwing panel, involving axillaries, and greater and median primary- and secondary-coverts. Greyish underside to greater primary-coverts becoming progressively paler inwards. Dark fingers in median coverts protruded into white underwing panel (photographs lack sufficient detail, but dark outer webs and white inner webs to these coverts are considered diagnostic of New Zealand Storm Petrel: Stephenson *et al.* 2008a). Dark of upper breast bled into white of lower breast. Mainly thick (and some narrow) dark streaks either side of lower breast, tending to converge towards thighs, creating dark thigh patches. Flanks less heavily streaked and central belly largely unstreaked. Border of dark upper breast and white lower breast aligned with rear of dark leading edge to underwings. Dirty look to undertail-coverts; dark lateral undertail-coverts with narrow pale fringes and some dark in central undertail-coverts. White bases to outer rectrices (r5 and r6 at least) evident from below when tail spread.

Bare parts Bill blackish. Eyes blackish. Legs and feet blackish, no evidence of pale / coloured webs.

Moult and wear No evidence of moult. Worn primaries, some with heavily abraded tips.

Discussion

The sighting is significant for three reasons. (1) It is the first confirmed record of New Zealand Storm Petrel away from New Zealand (bar one or two pending records off eastern Australia—see below). (2) It provides the first evidence of long-distance dispersal by the species (Fiji is c.2,000 km north of New Zealand, so presumably it was a failed or non-breeder). (3) New Zealand Storm Petrel is listed as Critically Endangered (IUCN 2017).

Identification was far from straightforward because multiple taxa of streaked storm petrels occur in the Pacific Ocean, so below we establish our rationale for identifying this bird as a New Zealand Storm Petrel.

Streaked storm petrels

The term ‘streaked storm petrel’ makes reference to storm petrels with dark streaks on a white belly that occur in the Pacific Ocean. The precise taxonomic relationships and geographical ranges of these streaked storm petrels has been a lasting conundrum.

However, the rediscovery of the streaked New Zealand Storm Petrel in 2003, off the Coromandel Peninsula and in the Hauraki Gulf, North Island (Flood 2003, Saville *et al.* 2003, Stephenson *et al.* 2008b), provided a breakthrough in our understanding of streaked storm petrels, while simultaneously refuting Murphy & Snyder’s (1952) argument that all such individuals are plumage variants of known species (the so-called *Pealea* phenomenon). Live captures of streaked storm petrels in the Hauraki Gulf followed these sightings and subsequent morphological and molecular studies indicated that they are the same species as three historic specimens at the Muséum national d’Histoire naturelle, Paris (France) and Natural History Museum, Tring (UK), i.e. a distinct taxon—the New Zealand Storm Petrel—and not a plumage variant (Stephenson *et al.* 2008a, Robertson *et al.* 2011). Further research established that New Zealand Storm Petrel breeds in February–July in the Hauraki Gulf (e.g. Rayner *et al.* 2013, Tennyson *et al.* 2016).



Figure 6. Specimen AMNH 194110 (American Museum of Natural History, New York) collected by Rollo Beck off Huapu Island (Ua Pou), Marquesas Islands, 15 September 1922, during the Whitney South Seas Expedition (Angus C. Wilson). A distinct form of White-bellied Storm Petrel *Fregetta grallaria* (Cibois *et al.* 2015, Robertson *et al.* 2016). Note streaking across underparts, including central belly, albeit not as heavy as the Samoa specimen (USNM A15713; see Fig. 7).

Recent molecular analysis indicates that another of these historical streaked storm petrel specimens, AMNH 194110 (American Museum of Natural History, New York), collected off Huapu (Ua Pou) Island, Marquesas Islands, on 15 September 1922 (Fig. 6), is a distinct form of White-bellied Storm Petrel *Fregetta grallaria* (Cibois *et al.* 2015, Robertson *et al.* 2016), in agreement with Murphy & Snyder's (1952) conclusion that it is allied with White-bellied Storm Petrel. Subfossil bones of *Fregetta* storm petrels have been found on two of the Marquesas Islands (Cibois *et al.* 2015), supporting the theory of a former local breeding population. A tantalising view of two streaked storm petrels on 30 September 2013, south-west of Fatu Hiva Island, Marquesas Islands, by a group of birdwatchers (P. Hansbro & R. Johns *in litt.* 2017), provides hope that the Marquesas streaked storm petrel survives.

A further historic streaked storm petrel specimen, USNM A15713 (National Museum of Natural History, Smithsonian Institution, Washington DC), obtained perhaps in October / November 1839 at Upolu, Samoa (Fig. 7) was considered by Murphy & Snyder (1952) to be a Black-bellied Storm Petrel *Fregetta tropica*. This conclusion has been endorsed by regional authorities (e.g. Gill *et al.* 2010). Bourne (2008) presented circumstantial evidence that the specimen's actual collecting location may have been Antarctic seas, where Black-bellied Storm Petrel is common. That said, since 1839, no similar streaked storm petrel has been reported / documented in Antarctic seas despite widespread coverage by birdwatchers and ornithologists.

The following recent developments cast further light on the streaked storm petrel conundrum. On 7 April 2008, a single (or two) streaked storm petrel was photographed off southern New Caledonia during a Western Pacific Odyssey expedition cruise, operated by Heritage Expeditions (RLF was an observer). Howell & Collins (2008) made the reasonable suggestion, at the time, that it was possibly a New Zealand Storm Petrel. However, given further sightings in subsequent years, in the same region, it is apparent that these birds—now labelled 'New Caledonian Storm Petrel'—are not New Zealand Storm Petrel (Collins 2013). In 2013 and again in 2014, separate teams led by C. Collins and P. Harrison tried to



Figure 7. Specimen USNM A15713 (Smithsonian Institution, Washington DC) obtained perhaps October / November 1839, US Exploring Expedition 1838–42, Upolu, Samoa (Brian K. Schmidt). Considered to be a Black-bellied Storm Petrel *Fregetta tropica* (Murphy & Snyder 1952, Gill *et al.* 2010). Note heavy streaking across underparts, including the central belly; outer and middle toes of comparable length.

capture birds to record morphometrics and take blood samples for DNA analysis, but these efforts were unsuccessful (C. Collins *in litt.* 2017, P. Harrison *in litt.* 2017).

Meanwhile, since 2010, streaked storm petrels have been seen in various pelagic locations off eastern Australia. Again, the initial sighting, off south-east Australia, was thought to involve a New Zealand Storm Petrel. However, subsequent sightings, documented with good photographs, revealed structure and plumage of the great majority of them to be like New Caledonian Storm Petrel, not New Zealand Storm Petrel. By 2017, pelagic trips to Queensland and Britannia Sea Mounts, in the Coral Sea, led by P. Walbridge, had encountered 62 streaked storm petrels (P. Walbridge *in litt.* 2017). Photographs of streaked storm petrels off New Caledonia and in the Coral Sea show that their structure and plumage bear a striking resemblance. One of the Coral Sea birds was captured in April 2014 on the Britannia Sea Mount off southern Queensland and the results of research into this bird are in preparation, including its relationship to the Samoa streaked storm petrel that it also resembles (P. Walbridge *in litt.* 2017). Streaked storm petrel sightings off Australia currently await final assessment by the BirdLife Australia Rarities Committee until the taxonomy of New Caledonian / Coral Sea storm petrels is resolved. However, the Committee considers that just one or possibly two records exhibit the credentials of New Zealand Storm Petrel (T. Palliser & J. Davies *in litt.* 2017).

Additionally, a feather louse, possibly from a *Fregetta* storm petrel, collected ashore in Vanuatu from a Collared Petrel *Pterodroma brevipes* in 2011 (Tennyson *et al.* 2012) hints that this country might host another undiscovered breeding site for a *Fregetta* taxon.

Process of identification

Photographs show that the middle toe of the Fiji streaked storm petrel was longest, whereas in White-bellied Storm Petrel the outer toe is longest (Marchant & Higgins 1990). White-bellied Storm Petrel lacks or has a short toe projection beyond the tail tip (Flood & Fisher 2013); the Fiji streaked storm petrel had a long toe projection. In addition, White-bellied Storm Petrel has broader wings and a chubbier body. The streaked form



Figure 8 (left). Coral Sea Storm Petrel (undescribed taxon?), Britannia Seamount, Coral Sea, Australia, 13 April 2014 (Raja Stephenson). Extensive dark markings in the white underwing panels, mainly in the primary-coverts, and heavy streaking on the white belly, including the central belly, give a dirty appearance. Figure 9 (right). New Caledonian Storm Petrel (undescribed taxon?), New Caledonia, south-west Pacific Ocean, 20 March 2013 (Kirk Zufelt). Note long front-end projection, long tail and broad wings compared to the Fiji New Zealand Storm Petrel *Fregetta maoriana*, which is an altogether more compact bird.

of White-bellied Storm Petrel from the Marquesas Islands also differs from the Fiji bird (Fig. 6). It has similarly proportioned legs with a ratio of toes / tarsus length of 0.58 (Murphy & Snyder 1952) to other White-bellied Storm Petrels, which is unlike the ratio of the Fiji streaked storm petrel, estimated from photos to be 0.80–0.84. Further, dark streaking on the Marquesas streaked storm petrel is quite dense across the entire lower breast, and also occurs on the central belly, albeit is finer and less dense. The central lower breast and belly of the Fiji streaked storm petrel were largely unstreaked.

In Black-bellied Storm Petrel the outer toe is slightly longer than the middle toe (Marchant & Higgins 1990) and it has broader wings and a chubbier body than the Fiji streaked storm petrel. The streaked storm petrel from Samoa (Fig. 7) also differs from the Fiji bird in that the dark streaking is thicker, denser and more widespread.

The Coral Sea / New Caledonian Storm Petrels (Figs. 8–9) can be ruled out because they are larger (using the size of Wilson's Storm Petrel as a guide), with a longer front-end projection, longer tail and broader wings. The Fiji streaked storm petrel is an altogether more compact bird. The Coral Sea / New Caledonian storm petrels consistently exhibit extensive dark markings in the white underwing panels, mainly in the primary-coverts, and heavy streaking on the white belly, including across the central belly, which combine to give a rather dirty appearance to the underparts. Conversely, the underparts of the Fiji streaked storm petrel had a relatively clean appearance, with the underwings less heavily marked and central belly virtually unstreaked.



Figure 10 (left). New Zealand Storm Petrel *Fregetta maoriana*, off North Cape, North Island, New Zealand, 2 March 2013 (Kirk Zufelt). In dorsal view very similar to Wilson's Storm Petrel *Oceanites oceanicus*, but the head is *Fregetta*-like (see main text) and the ulnar bars on the upperwing are subdued.

Figure 11 (right). New Zealand Storm Petrel *Fregetta maoriana*, Hauraki Gulf, North Island, New Zealand, 1 February 2017 (Kirk Zufelt). Greyish underside to greater primary-coverts becomes progressively paler towards innermost feathers; dark fingers in median primary-coverts protrude into white underwing panel.

We therefore conclude that the Fiji streaked storm petrel was a New Zealand Storm Petrel as it satisfies published criteria for the species' field identification (Flood 2003, Stephenson *et al.* 2008a; compare the description above to New Zealand Storm Petrels; Figs. 10–11), rather than other streaked storm petrels. Furthermore, the bird strongly resonated with our experience of New Zealand Storm Petrel in the Hauraki Gulf. It seems highly unlikely that we observed a new taxon in the Fiji archipelago because previous mass-chumming efforts off Gau Island at the same time of year yielded no streaked storm petrels (Shirihai *et al.* 2009). Pending final review of the Australian records, ours is the first documented example of New Zealand Storm Petrel away from New Zealand.

Given that the breeding season of New Zealand Storm Petrel is February–July (Rayner *et al.* 2013, Tennyson *et al.* 2016), the Fiji New Zealand Storm Petrel was either a non-breeder or a failed breeder. A non-breeder could be an immature or an adult that did not achieve breeding condition. Heavy abrasion to the primary tips could be caused by burrow activity by an adult or result from daily wear to the feathers of a juvenile (assuming no complete pre-formative moult). Whether the species regularly disperses to tropical waters north of New Zealand is an open question. Our expedition was preceded by a huge high-pressure system over the south-west Pacific Ocean (Fig. 1) providing favourable winds for long-distance northward movement by a storm petrel from New Zealand.

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Hadoram Shirihai paved the way for modern-day pelagic expeditions of discovery and his efforts in Fiji inspired our visit. Our thanks to Mark Adams (Natural History Museum, Tring), Paul Sweet (American Museum of Natural History, New York) and Brian K. Schmidt (Smithsonian Institution, Washington DC) for help with specimen review. Many thanks to Chris Collins and Paul Walbridge for providing information concerning the yet to be described taxon / taxa of streaked storm petrel in the Coral Sea and off New Caledonia. Jeff Davies and Tony Palliser kindly discussed details of streaked storm petrel submissions to the BirdLife Australia Rarities Committee. Dick Watling kindly briefed us on tubenose sightings in Fiji. Thanks to Raja Stephenson and Kirk Zufelt for permission to publish their photographs. The following provided opinions concerning the identity of the Fiji streaked storm petrel: Jeff Davies, Peter Harrison, Sav Saville, Hadoram Shirihai, Brent Stephenson, Paul Walbridge and Kirk Zufelt. Nevertheless, we take responsibility for our identification. We are grateful for the helpful comments of Alice Cibois and Alan Tennyson on the submitted manuscript. As ever, we warmly acknowledge our fellow team members, Mike Danzenbaker, John & Jemi Holmes and John Shemilt, for their companionship and sharing of photographs, and Didier & Sophie Wattrelot for their hospitality and unparalleled seamanship aboard their yacht *Sauvage*.

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Morphometric differentiation between subspecies of Resplendent Quetzal (*Pharomachrus mocinno mocinno* and *P. m. costaricensis*) based on male uppertail-coverts

by Ulrich Schulz & Knut Eisermann

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SUMMARY.—Resplendent Quetzal *Pharomachrus mocinno* is endemic to montane cloud forests of Middle America. Disjunct populations in the highlands north (southern Mexico and northern Central America) and south of the lowlands of Nicaragua (Costa Rica and Panama) have been recognised subspecifically by several authorities (e.g. Ridgway 1911, Cory 1919, Dickinson & Remsen 2013, Gill & Donsker 2017), but have also been suggested to merit species status (Solórzano & Oyama 2010). We present morphometric differences in the elongated uppertail-coverts of adult males. We analysed width and length of the uppertail-coverts of 73 adult male specimens in European ornithological collections. Mean width and mean length of the uppertail-coverts were significantly greater in northern *P. m. mocinno* compared to southern *P. m. costaricensis*. Our data support a previously published proposal to treat the two taxa as species based on molecular and other morphological data.

Resplendent Quetzal *Pharomachrus mocinno* ranges in the highlands from southern Mexico to Panama. Populations of the northern subspecies *P. m. mocinno* are geographically isolated by the lowlands of Nicaragua from southern *P. m. costaricensis* (Fig. 1). *P. mocinno* was described by de la Llave (1832) based on specimens from Guatemala and Chiapas, Mexico. The name *P. costaricensis* was introduced in an editorial footnote by J. Cabanis in Frantzius (1869: 313) for quetzals in Costa Rica. Both taxa were subsequently treated as subspecies (Ridgway 1911, Cory 1919, Johnsgard 2000, Collar 2001, Forshaw & Gilbert 2009, Dickinson & Remsen 2013, Gill & Donsker 2017, del Hoyo & Collar 2014). Solórzano & Oyama (2010) proposed species status for both forms based on molecular and morphometric data (including body, wing and uppertail-coverts length, as well as bill width and depth). Salvin (1870) and Ridgway (1911) also mentioned differences in the width of uppertail-coverts, without providing data. Here, we present for the first time data on the width of the uppertail-coverts, documenting differences between the two taxa. We also analyse differences in the length of the uppertail-coverts, augmenting previous data (Solórzano & Oyama 2010).

Methods

US examined 149 specimens of Resplendent Quetzal (121 males, 28 females) in 11 European collections. Of the 121 males, 48 were not included in our analysis because of ambiguous locality data or incomplete or damaged uppertail-coverts. We presume that males with relatively short uppertail-coverts (longest covert extending beyond the rectrices by only c.10 cm) are after-hatch-year immatures. It is possible that several years (moult) are required for males to obtain the longest uppertail-coverts. The species' moult has not been described. To reduce the risk of bias from immature males, we excluded from analysis

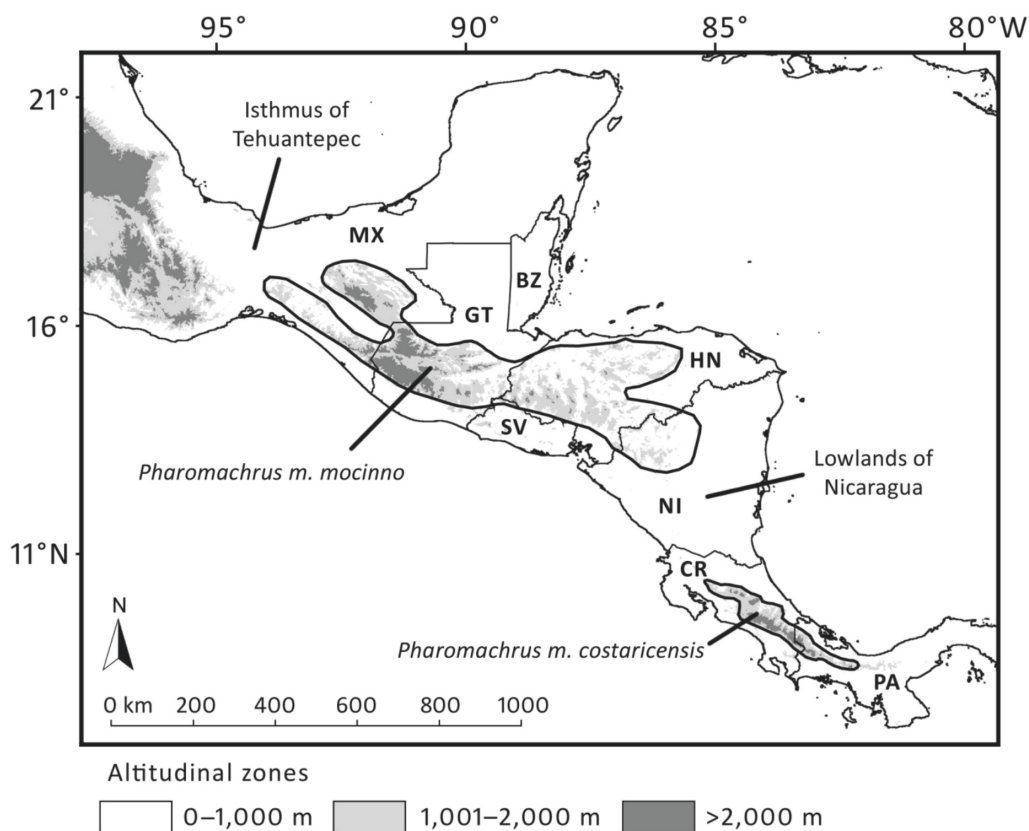


Figure 1. Approximate ranges of the subspecies of Resplendent Quetzal: *Pharomachrus mocinno mocinno* in the highlands of southern Mexico and northern Central America, and *P. m. costaricensis* in the highlands of southern Central America (based on Collar 2001). Country codes: BZ = Belize, CR = Costa Rica, GT = Guatemala, HN = Honduras, NI = Nicaragua, MX = Mexico, PA = Panama, SV = El Salvador.

all individuals with uppertail-coverts <300 mm. Consequently, we analysed morphometric data for 73 males. These were: 46 individuals of *P. m. mocinno* collected in Guatemala ($n = 32$), Mexico ($n = 9$), Honduras ($n = 4$), and Nicaragua ($n = 1$), and 27 *P. m. costaricensis* from Costa Rica ($n = 22$) and Panama ($n = 5$). Numbers of specimens in each collection are listed in Appendix 1.

Adult males of both subspecies of Resplendent Quetzal usually have two pairs of elongated uppertail-coverts, which extend beyond the tips of the rectrices considerably. US measured the length of the longest uppertail-covert (from tip to point of insertion) on 73 specimens of adult males using a tape measure and the width of the same feather at its widest point using callipers. The widest point was located between the centre of the feather and the limit between the basal first and second thirds.

We applied a Randomisation Test using software SsS (Engel 2016) with $\alpha = 0.05$ to test for differences between the means of two independent samples (Manly 2006), to compare mean feather width and length in our measurements of *P. m. mocinno* and *P. m. costaricensis*. Means are reported ± 1 standard deviation (SD).

Results

The width of the uppertail-coverts of *P. m. mocinno* measured 39–79 mm (median: 51 mm, mean: 53.2 ± 9.2 mm, $n = 46$) and of *P. m. costaricensis* 26–49 mm (median: 39 mm, mean: 37.7 ± 4.8 mm, $n = 27$). The mean values were significantly different (Randomisation Test: $p < 0.0000005$) (Fig. 2).

The length of the longest uppertail-covert in *P. m. mocinno* measured 310–1005 mm (median: 750 mm, mean: 722 ± 164 mm, $n = 46$), and in *P. m. costaricensis* 320–860 mm (median: 630 mm, mean: 614 ± 123 mm, $n = 27$). The mean values were significantly different (Randomisation Test: $p < 0.005$).

Discussion

We found a significant difference in the width of the uppertail-coverts between adult male Resplendent Quetzals of the northern (*P. m. mocinno*) and southern subspecies (*P. m. costaricensis*), confirming the unsupported observations of Salvin (1870) and Ridgway (1911). These differences in width of the uppertail-coverts add to the morphological and molecular differences reported by Solórzano & Oyama (2010), who proposed species status for these taxa. Solórzano & Oyama (2010) reported greater mass, longer wings, broader and deeper bill, and longer uppertail-coverts in the northern subspecies. Our data also confirm differences in the length of the uppertail-coverts. Resplendent Quetzals in northern Middle

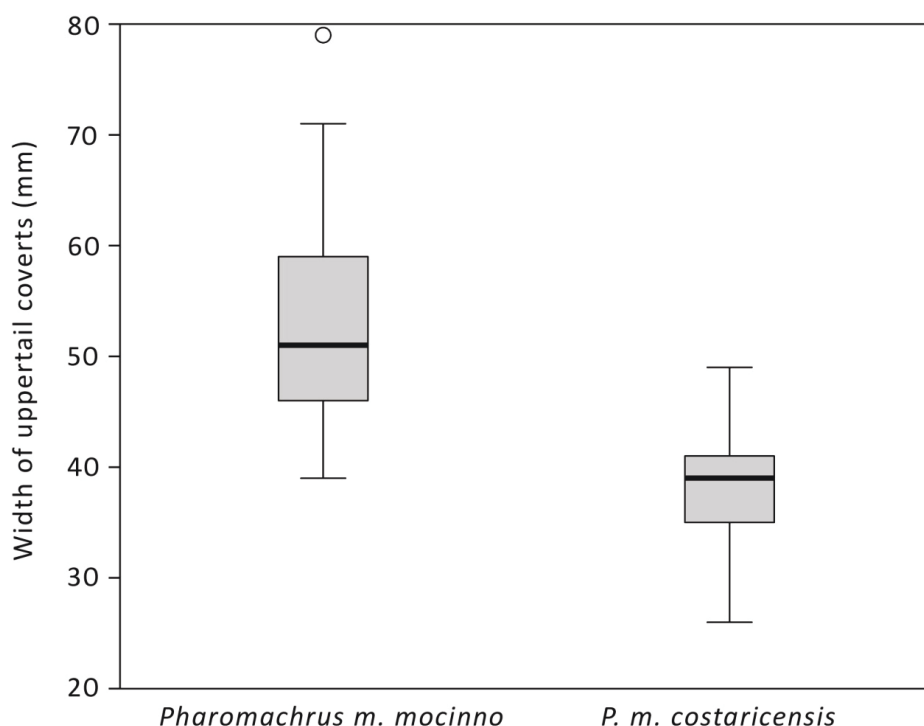


Figure 2. Box-and-whisker diagram of the distribution of the width of the uppertail-coverts of male Resplendent Quetzals of the northern subspecies (*Pharomachrus mocinno mocinno*, $n = 46$) and the southern subspecies (*P. m. costaricensis*, $n = 27$). Data shown: median = heavy horizontal line within the shaded box, Inter Quartile Range = range between upper and lower limits of the shaded box, min. and max. value = upper and lower whiskers, suspected outlier = circle.

America are larger and heavier than individuals in the south (Solórzano & Oyama 2010), and the width of the uppertail-coverts is the most obvious character to distinguish males of both subspecies. Morphological differences between northern and southern populations of Resplendent Quetzal may have evolved due to long-term geographic and genetic isolation. Solórzano & Oyama (2010) estimated that the populations have been separated for c.3 million years. The lowlands of Nicaragua mark an approximately 300 km-wide barrier between the highlands of northern and southern Central America (Fig. 1). Dispersal across this lowland barrier appears unlikely as only short-distance migrations have been documented in Resplendent Quetzal (Powell & Bjork 1994, Paiz 1996). Potential ecological and behavioural differences between the subspecies have not been investigated (Solórzano & Oyama 2010).

Cloud forests in northern Central America are increasingly threatened by land conversion for agriculture, driven by a rapidly growing human population (Eisermann *et al.* 2006, Renner *et al.* 2006). In addition to genetic and morphological differences between populations of Resplendent Quetzal north and south of the lowlands of Nicaragua, Solórzano *et al.* (2004) also found genetic differences between populations ascribed to the northern subspecies, which lends urgency to local conservation efforts intended to protect cloud forest, the species' primary habitat.

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Appendix 1. Numbers of specimens of Resplendent Quetzal *Pharomachrus mocinno mocinno* and *P. m. costaricensis* from European collections used for the morphometric analysis.

Collection	<i>P. m. mocinno</i>	<i>P. m. costaricensis</i>
IZUW: Institut für Zoologie der Universität Wien, Austria	5	1
MTD: Senckenberg Naturhistorische Sammlungen Dresden, Germany	0	2
NHMUK: Natural History Museum Tring, UK	11	5
NRM: Naturhistoriska Riksmuseet Stockholm, Sweden	3	1
SMF: Forschungsinstitut und Naturmuseum Senckenberg Frankfurt am Main, Germany	7	10
SMNS: Staatliches Museum für Naturkunde Stuttgart, Germany	3	2
UMB: Übersee Museum Bremen, Germany	7	1
ZMB: Zoologisches Museum Berlin, Germany	3	5
ZMH: Zoologisches Museum Hamburg, Germany	2	0
ZMUU: Zoologiska Museet Uppsala Universitets, Sweden	1	0
ZSM: Zoologische Staatssammlung München, Germany	4	0

Fiery-necked Nightjar *Caprimulgus pectoralis* development and behaviour from hatching to fledging, including attendant parental care

by H. D. Jackson

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SUMMARY.—Four pairs of Fiery-necked Nightjars *Caprimulgus pectoralis*, each with two young, were observed from hatching to fledging at four different localities in Zimbabwe, two pairs of *C. p. fervidus* in Mashonaland and two pairs of *C. p. crepusculans* in Manicaland. Development of the young was measured and their behaviour recorded daily, as was adult behaviour. My observations provided corrections and additions to the literature. *C. p. pectoralis* and *C. p. fervidus* remove eggshells from the nest area after hatching, but *C. p. crepusculans* does not. Chicks provide a feeding stimulus by grasping the adult's bill in its own. By not responding until this stimulus, the adult ensures that each chick receives its fair share of food. Chicks do not return to the nest to be fed. They move towards a calling adult, on or off the nest. The 'wooting' call is not a warning call, but is used by adults to summon their chicks, which respond immediately by running towards the sound. Rectal bristles appear on day 18, and are only 2 mm long on day 19, providing no protection for the eyes during the first days of flight. On days 18–19, when the middle claw is 3–4 mm long, the inner flange splits to form a comb of four teeth 1 mm deep, the start of the pectinate claw. Primaries emerge centrifugally, as in adult moult pattern, wherein primaries moult descendantly. Adults leave their territories soon after breeding, whereas chicks, which become independent at 19–23 days, remain in their natal areas.

This paper is a sequel to Jackson (1985a) which dealt with those aspects of the breeding biology of Fiery-necked Nightjar *Caprimulgus pectoralis* prior to the hatching of the eggs, thus it deals with hatching to fledging. These aspects include development of the chicks and all aspects of their behaviour, as well as adult behaviour toward the chicks, especially brooding, feeding and distraction displays.

Methods

Study areas.—Research was conducted at the following four localities in Zimbabwe on the dates shown, with the number of hours of observation in brackets, and a very brief habitat description. **Nest 1.** 17 September–7 October 1969 (30.25 hours). Atlantica Ecological Research Station, now Boulton Atlantica Centre for Conservation Education, Zimbabwe National Parks and Wildlife Management Authority (17°49'S, 30°49'E, 1,397 m), 25 km south-west of Salisbury (now Harare). Miombo woodland (*Brachystegia–Julbernardia*) with termitaria thickets. **Nest 2.** 15 October–2 November 1969 (12.25 hours). Retreat Farm (17°55'S, 31°02'E, 1,460 m), 9 km south of Harare. Bluegum *Eucalyptus globulus* plantation (full habitat description in Jackson 2002a). **Nest 3.** 21 November–9 December 1971 (47.75 hours). Muneni River (18°59'S, 32°41'E, 990 m), Umtali (now Mutare). Miombo woodland (*Brachystegia–Julbernardia*) on a 30° slope adjacent to riparian forest (full habitat description

in Jackson 1972). **Nest 4.** 7 November–9 December 1975 (17.75 hours). Ranelia Farm (19°22'S, 32°37'E, 885 m), 45 km south of Mutare. Miombo woodland (*Brachystegia–Julbernardia*) with numerous granitic outcrops and termitaria thickets (full habitat description in Jackson 1985a).

Nightjar research.—Night lighting (Jackson 1984) was used to find and capture Fiery-necked Nightjars on the nest at night. Their mates were captured during the day by flushing them from the nest into mist-nets erected nearby. Most birds trapped were ringed for individual identification and weighed to the nearest gram, using a Pesola spring balance, before release at the capture point. Four nests, which permitted chick development to be followed from hatching to fledging, were the subject of this study.

The aim was to record the physical development of the chicks on a daily basis, by weighing them with a Pesola spring balance and measuring their wing, tail, tarsus and culmen (to nostril) lengths with callipers. This was achieved at Retreat and Muneni alone, while the Ranelia chicks were weighed daily but measured only on day 19 (day 1 = day of hatching). The Atlantica chicks were neither weighed nor measured, but their vocalisations, and those of the adults, were taped using an Uher tape recorder and a microphone placed near the nest. Copies of the recordings are lodged in the Fitzpatrick Bird Communication Library, Transvaal Museum (now Ditsong National Museum of Natural History), Pretoria, South Africa. Rectal body temperatures of one of the Muneni chicks were measured daily with a clinical thermometer, from day 3 to day 16, between 11.00 h and noon, immediately after the brooding female was flushed.

The behaviour of the chicks and the adults was observed for a total of 108 hours, usually from a small canvas hide placed 2–3 m from the nest. An assistant accompanied the observer to the hide at the start of an observation period and then left the area, returning later to 'release' the observer. At times the nest was surrounded by a wire mesh fence, 15 cm high and 1 m distant, to prevent the chicks from leaving the nest area. Detailed notes were dictated quietly into a pocket recorder at the time of observation and subsequently transcribed.

No night vision equipment was used, other than a Starlight Scope (AN/PVS-2) that was available for just two nights (at Ranelia), so lamps fitted with red filters were attached to the top of the hide to illuminate the nest area at night. The Starlight Scope is a night vision image-intensifier that produces a light amplification of *c.*1,000. It was quite bulky and required moonlight to function properly but nevertheless provided valuable data. Windows in the hide enabled use of binoculars and cameras, with remote flash-guns fixed to the top of the hide.

Results

Hatching.—At Retreat the chicks hatched on successive days. When the female was flushed from the nest at 17.50 h, a damp chick that must have stuck to her breast feathers was thrown a short distance from the nest, which contained an egg showing a few tiny cracks. Next day at 05.56 h the egg showed signs of chipping, with the shell lifting in two areas, one star-shaped, the other like a small trapdoor. By 13.20 h these had developed into two holes and by 17.40 h the chick had emerged. By then its down was much drier than on the other chick when first seen, so it must have hatched earlier than its sibling, but both clearly hatched in the late afternoon. At Muneni both chicks hatched on the same day, one between 04.30 h and 14.50 h, probably in the morning, the other in the afternoon between 15.45 h and 16.45 h. At Ranelia there were two young in the nest at 15.15 h, one showing a damp dorsum, so here too it is probable that both chicks hatched on the same day, one probably in the morning, the other in the afternoon.



Figure 1. Three pieces of abandoned eggshell (arrowed), the largest immediately in front of the adult Fiery-necked Nightjar *Caprimulgus pectoralis* tending the chicks on day 1 at Muneni, a smaller piece in the lower centre and a very small piece in front of the stones to the right (H. D. Jackson)

Egg tooth.—Once a chick had hatched, it no longer needed the small straw-coloured or off-white egg tooth on the tip of the maxilla, used for cutting its way out of the shell, and so could shed it immediately. The chicks at Atlantica had shed their egg teeth by day 5 and those at Muneni by day 6, so it is remarkable that at Retreat egg teeth were still visible on both chicks on day 12 and persisted on chick 1 until day 15.

Eggshells.—At Ranelia and Muneni the broken eggshells were not removed from the nest area, despite being extremely conspicuous, and remained scattered 10–50 cm from the nest for up to nine days. On day 1 eggshells could even be seen on or beside the nest (Fig. 1). At Muneni the sitting female, with a chick and egg in the nest, was very restless, rocking from side to side. Half an eggshell lay 10 cm in front of her and the other half was underneath her right side. One of the violent rocking spells ejected it on her left side, where it remained against her body. At Ranelia too, the sitting female was seen with half an eggshell against her body but neither bird made any effort to remove it.

At dusk on day 3 at Muneni, when the male arrived for the first changeover at 18.30 h, he appeared to settle on an old eggshell that was lying convex side up. A few seconds later the female on the nest flew off and the chicks started calling, so he ran towards them. The concave side of the eggshell was now facing up.

Only once was a nightjar observed to remove an eggshell from the nest area and this was under unnatural circumstances. A small fence had been erected below the nest at Muneni on day 9 to prevent the chick moving too far, but the female settled outside it and called the chick, which reached the fence and ran back and forth along it while the female continued calling. Eventually she moved towards it but was stopped by the fence, where she too moved back and forth searching for a way through. At 18.30 h she flew up and landed inside the fenced area, and the chick immediately ran to her and was brooded. This was c.10 cm from the third of an old eggshell. The female stretched over, picked up the eggshell in her bill, paused for a few seconds with her head up and her back to me, so that when she tilted her head I could see the whole eggshell above her bill. She then took off,



Figure 2. Fiery-necked Nightjar *Caprimulgus pectoralis* chick 2 on day 4 at Muneni, showing the well-developed legs (H. D. Jackson)

apparently dropping the eggshell somewhere, for she had returned within a few seconds, minus the eggshell, landing next to the chick before brooding it.

At Retreat, when I flushed the bird off the nest at 17.50 h on day 1, it appeared to be carrying an egg between its legs as it flew away. In the nest there was just one egg. However, 40 cm from the nest, where it could easily have been overlooked among the leaf litter, lay a newly hatched chick, still damp and sticky. It had probably been briefly stuck to the adult during take-off. Meanwhile the adult had flown 5 m to perch on a thin branch and was tugging at an eggshell stuck to its breast. The shell came free and dropped to the ground, before the bird flew to a higher perch further from the nest. Adhering to the sticky albumen on the inside of the shell were several adult breast feathers. On day 2 at 17.55 h there was no eggshell in the immediate vicinity of the nest and on day 13 I found an eggshell 12 m east of the nest site, where it had probably been dropped by an adult.

The Atlantica nest was found by one of the Research Station staff, who at 12.00 h on day 1 reported that the eggs had hatched, and that when he flushed the bird from the nest it carried an eggshell between its legs, dropping it 3–5 m away. I first visited this nest on day 4 at 16.00 h, when no eggshells were present. Not having seen their removal, I cannot be certain but I suspect that the eggshell observed being carried away from the nest between the legs of an adult had been stuck there briefly, as happened at Retreat. Although it is uncertain whether the adults at Retreat and Atlantica deliberately removed any eggshells after hatching, as some were accidentally removed, they probably did so.

Hatchlings.—The hatchlings were no larger than my thumb, measuring < 50 mm in length and weighing just 5–6 g. At first they appeared naked, but after drying out could be seen to possess downy plumes up to 4 mm long in some areas. Most obvious were the dark brown stripes running from the lores through the eyes, then across the wings and along the dorsal tracts to join a cluster of plumes around the preen gland. There were many russet plumes around the face and on the wings, while the crown was adorned with fuzzy pale buff plumes.

The egg tooth was conspicuous at the tip of the culmen. While there was no sign of a rictal bristle or a tail, and the wings were rudimentary, the legs were already extremely well developed (Fig. 2), with the toes having claws of 1–2 mm, but without pectination on the claw of the middle toe. The hatchlings could move well in short runs and while walking

around on the palm of my hand could climb a slope of $c.50^\circ$. While standing, their heads often wobbled from side to side as they had difficulty holding them up.

The hatchlings were already gular fluttering whenever they became hot. Their eyes were still closed, so there was no evidence of them attempting to adopt the cryptic posture in response to movement, instead they responded to sound. As I worked on one and it cheeped, so the other in the nest gradually worked its way over obstacles towards the one I was holding. While they could not see, they vocalised loudly in response to the sound of an adult.

Vocalisations.—Not only did the chicks call well on day 1, they could be heard calling inside the egg prior to hatching. The normal cheeping of the chick was a quiet *wee-you* repeated at $c.1$ -second intervals, with the bill closed. When handled, most chicks became more vocal, their cheeping increasing in volume and duration. As they grew older, they protested more violently at being handled by opening their gapes wide and uttering a variety of subdued shrieks, hoarse growls, wheezy squawks and harsh hisses. The adult that had been flushed from the chicks, and was watching from a nearby perch, responded to the distress calls by uttering a series of *chuck* calls, either when perched or flying nearer.

The *chuck* call served mainly as an alarm, so that whenever chicks moving on the ground heard it they immediately froze into immobility. Adults foraging in woodland uttered a *chuck* or *chuck-chuck* each time they pursued an insect, and whenever they came across an owl they would mob it with a continuous series of rapid staccato chucks. Quite frequently, when an adult at Muneni arrived with food, it would utter two or three chucks on approach. The sitting bird would then take off and the chicks would run towards the sound, cheeping loudly. In contrast, a *Ranelia* bird seldom chucked when arriving with food. The first sound I heard was usually the wing-flapping as it landed close to the nest. A Muneni chick uttered a few soft chucks in flight on day 18, while one at Retreat did so on day 19.

In the evenings, at $c.18.30$ h, *chuck* calls nearby would sometimes be followed by quiet squawks from the bird on the nest. Once the brooding bird took off and flew up to a perch where it uttered a deep squawk while its mate fed the chicks. Occasionally the adults indulged in aerial chases 10–20 m from the nest, accompanied by much loud calling (both chucks and some squawks). Once, when one was giving rapid and continuous *chuck* calls from a low branch, the other adult perched next to it and uttered a peculiar squawk. Another time, as an adult approached with many *chuck* calls, a perched bird uttered two or three deep squawks and the approaching bird appeared to settle either on top of or next to the perched individual, resulting in both taking off. While both birds gave *chuck* notes, it appeared that only the female squawked.

The sound heard most frequently from the female was made when she was calling the chicks to her after they had been weighed and measured in the morning. We usually returned the chicks to the nest, but the female more often than not settled a few metres away and called until the chicks reached her. While calling, the two gular patches fluttered prominently, so could have acted as a guide for the chicks once their eyes had opened. However, they responded immediately on day 1, when still blind, by running towards her and were clearly guided by the sound alone.

Her calling was described variously as a continuous *woot-woot-woot*, *what-what-what*, *cube-cube-cube* or *cue-cue-cue*, perhaps reflecting some minor differences between the four females or, more likely, changes in my hearing over the six years. These calls I refer to as 'wooting'. Whenever the chicks became restless during brooding, the female would utter a quiet *woot* or *woot-woot* and they would immediately settle down. The male also used 'wooting' to call the chicks to him or to settle them.



Fig. 3. Male Fiery-necked Nightjar *Caprimulgus pectoralis* at Muneni singing from an elevated perch while a female flies around, during the courtship stage (H. D. Jackson)

The microphone near the Atlantica nest sometimes detected quiet sounds that were inaudible to me in the hide <3 m away. For example, on day 14 at c.22.00 h the chicks were being brooded by an adult and were very restless. Through headphones I could hear them tittering continuously, and the adult soothing them with quiet 'wooting'. Without the headphones I could hear none of this. As the chicks grew older their cheeping grew deeper and could better be described as chirping, which they not only uttered from the ground, but also in flight. On day 16 at 11.50 h the remaining Muneni chick called 120 times at fairly regular intervals of 1.0–1.5 seconds, while looking around with its eyes three-quarters open and rocking from side to side. The calling was not loud, but was huskier and deeper than previously.

The liquid whistling song of the species was heard in the vicinity of the nest only once at Retreat (day 1 = 15 October), Ranelia (day 4 = 10 November) and Muneni (day 10 = 30 November), but more often at Atlantica (days 7, 9, 14 and 18 = 23 September–4 October). It appears that the earlier breeding at Atlantica accounts for the higher incidence of song there, perhaps a carry-over from the courtship phase. The phrase 'Good Lord, deliver us' aptly captures the song's cadence. All songs were given from elevated perches (Fig. 3) apart from one from the ground at Atlantica on day 9 at 18.10 h, and a remarkable record of five songs in quick succession by a female on the nest at Muneni on day 5 at 18.27 h. This was the only occasion on which a female was heard singing. I had entered the hide overlooking her nest at 17.45 h, when she was quietly brooding the remaining chick. Aside from occasionally opening her eyes slightly, nothing happened until 18.20 h, when she became restless, then at 18.27 h she called five times from the nest, the complete 'Good Lord, deliver us' song, but very quietly. Shortly afterwards, *chuck* notes were heard nearby and the male arrived.

Solicitation, feeding and defecation.—At all nests, chicks became restless when the light faded at c.18.20 h, often emerging from below the brooding females and soliciting



Figure 4. Male Fiery-necked Nightjar *Caprimulgus pectoralis* at Ranelia feeding chicks (arrowed) at 18.40 h on day 6; the chick on the left has been fed and is settled, while that on the right is stretching up to grasp the male's bill to provide the feeding stimulus (H. D. Jackson)

food by seizing their bills, but with no food forthcoming crawled underneath the adult again. Males arrived with the first feed at c.18.30 h and the females departed to go hunting; they then took turns to tend the chicks, and while one adult was away hunting the other was usually feeding or brooding the chicks. Sitting birds occasionally took off vertically to capture a flying insect, and sometimes the chicks were left alone, but they started calling after a few minutes and this brought a parent back.

Whenever there was a changeover at the nest, the chicks immediately stood tall, craning upwards and looking towards the arriving bird. Any movement by the adult caused a frenzy of excitement, the young calling noisily while moving towards the adult and standing upright against its chest trying to get a grip on its bill (Fig. 4, on day 6). The adult always waited until a chick, presumably the hungrier of the two, had grasped its bill tip, before feeding the young. Once the chick secured a firm grip with its own bill, the adult tipped its head vertically down, raising its neck simultaneously, and, with a rapid series of up-and-down head movements, regurgitated food into the chick's throat. This movement was extremely rapid, with the adult's bill clearly well inside the chick's gape, at times accompanied by a low growling.

Once a chick had been fed it was brooded and settled down for a while before starting to solicit again. The adult sat up with its head held high and its bill rapidly opening and closing c.2 mm, while its throat pulsed in rhythm to the movement of the mandibles. This may have served to settle the food still in the crop, perhaps working the items into a food ball to transmit during the next feed. The feeding performance was repeated several times until the adult had no more food. The chicks continued their frenzied activity until the adult 'wooted' quietly, on which signal they submitted to brooding. Gentle palpation of their stomachs revealed that they were often full by 20.00 h. The adults continued hunting after twilight whenever there was sufficient moonlight. For example, on day 1 at Ranelia, when

the half-moon set at c.22.30 h, there was a changeover at the nest at 21.40 h, with the new bird feeding the chicks before settling to brood them.

On day 4 at Ranelia one of the chicks reversed out from under the female at 14.25 h, backed away a few paces, elevated its posterior and deposited a dropping, a dark brown coil with a white centre, 4 cm from the adult, then scuttled back underneath. I had previously noticed this behaviour at other nests and recorded it again at Ranelia on day 16 at 18.20 h. The number of characteristic small droppings around most nests revealed that this was a regular occurrence. Occasionally there was a much larger dropping in the nest, clearly from an adult, so it was clear that the adults practised little or no nest sanitation. At no stage did I see an adult carrying faeces away from the nest, but ants were regularly observed doing so and this helped to keep the nest clean.

When finding the female and chicks each day, they had often moved well away from the nest area, but each spot where they had roosted for a while was easily identified by the droppings, the number indicating how much time they had spent there and the freshness how recently they had moved on. Fresh droppings were soft and friable, but dried rapidly in the sun. Only once did I find what appeared to be a pellet of hard insect parts that might have been regurgitated by an adult.

Brooding and role of the sexes.—Females, whose plumage is even more cryptic than that of males, performed all brooding by day, while males roosted some distance away. At 04.45 h on day 2 at Muneni the female landed 0.5 m from the nest to take over the day shift, and the male took off shortly afterwards. She then moved to the nest and for the next 15 minutes rocked from side to side, while rotating left or right, before finally settling to brood. Much of the day was spent in low profile, with her head held just above mantle level and her eyes closed to a narrow slit. All brooding females slept sometimes by day. At such times their eyelids were closed to the point of touching in the centre, but on either side a small slit remained open. The whole eyelid occasionally would droop rapidly and when this happened the head tipped forward 4–5 mm. Quite frequently this would be sufficient to cause her to wake up suddenly.

Despite dozing, brooding females were alert to sounds and movements in their surroundings, opening their eyes slightly whenever a noisy bird flock, group of people, car or train passed by. At Muneni at 11.45 h the female opened her eyes and rocked sideways as a millipede gradually approached her at a distance of c.40 cm. After the millipede moved away she settled down with eyes closed again. This female always showed great concern whenever a noisy flock of Helmeted Guineafowl *Numida meleagris* roosted nearby in the evening. She turned her head to look in their direction and crouched slightly, as she also did whenever medium- to large-sized mammals passed nearby. A large raptor flying over, or settling in the canopy above the nest area, caused a brooding female to crouch down to the maximum, her plumage sleeked and her eyes narrowed to a slit. She would freeze like this until the danger passed.

Once in the brooding position, the female sat very still, but occasionally the chicks became restless and heaved, causing her to lift slightly. When this occurred, she ruffled her feathers, rocked sideways, made the comforting noise and they all settled down again. However, when it was very hot, she spent much time gular fluttering and only stopped when alarmed. While gular fluttering, her bill was held open c.2–4 mm and her throat patches flickered rather conspicuously. At Ranelia on day 4 at 13.15 h the chicks were clearly feeling the heat and before the female covered them they too were gular fluttering regularly. At 13.55 h the female rocked several times, yawned, turned and walked away from the chicks. She probed the fence with her bill a few times, stopped, turned and returned to the chicks, fluffing out her plumage over them. One chick sat in front of her, but they both very



Figure 5. While brooding at night, the male Fiery-necked Nightjar *Caprimulgus pectoralis* at Muneni stretched its right wing and spread its tail after rocking from side to side (H. D. Jackson)

soon started gular fluttering again. The body temperature of chick 2 at Muneni was taken daily between 11.00 h and noon from day 3 to day 16 just after the female had flushed. This ranged from 39.2–40.6°C (mean 39.6°C), but rose as high as 42.6°C if the chick had been handled or had exerted itself.

Brooding females occasionally preened the breast feathers and the upper and lower surfaces of the scapulars during the heat of the day, between bouts of gular fluttering. While preening, they fluffed out their plumage and rocked sideways. Sudden rocking frequently coincided with gusts of wind, as shown, for example, by the female at Muneni: 'At 15.40 h she rocked eight times and bobbed her head as the wind blew. Again at 15.45 h she rocked six times because of the wind and then closed her eyes. 16.05 h rocked four times with wind blowing and eyes closed. 16.15 h rocked seven times with eyes closed when wind blew. No noise. 16.26 h rocked six times with wind blowing, eyes closed.' Once, on day 2 at 13.46 h, in response to a strong gust of wind, the *Ranelia* female stretched upwards and yawned with her gape wide open.

Some unusual rocking by the female at Muneni occurred on day 1 at 14.50 h after it had been drizzling for some time. She stood and rocked violently from side to side, while shaking her head repeatedly and bending forward, presumably to clear water. At the same time she performed frequent minor bill-claps. By 17.03 h it was raining heavily and she bent her head over to peer down at the chicks, but did not poke them with her bill. She spread her wings slightly over them and rocked sideways. She jerked each time a heavy raindrop hit her. When the male arrived to relieve her at 18.20 h he was remarkably dry and did not feed the chicks, so had apparently not been hunting. He immediately brooded them and this seemed to calm them, as they had been cold, wet and restless under the female.

During evening twilight and early moonlight, adults took turns to feed and brood the chicks but once they had settled down in the dark of the night, it was usually the male that



Figure 6. Cryptic posture adopted by female Fiery-necked Nightjars *Caprimulgus pectoralis* by day when they felt threatened, flattening the body into the substrate as far as possible, closing the eyes to a slit, sleeking the plumage and remaining immobile (H. D. Jackson)



Figure 7. An approaching hand at Muneni on day 12 at 11.10 h caused Fiery-necked Nightjar *Caprimulgus pectoralis* chick 2 to lunge aggressively at the fingers, with wings spread and gape wide open, while hissing (H. D. Jackson)

brooded. The brooding female typically waited for the male to arrive with the first feed of the evening before departing to hunt. At Ranelia on day 1 at 18.15 h, when the male arrived



Figure 8. Further provocation of the Muneni Fiery-necked Nightjar chick 2 (circled upper right) on day 12 at 11.25 h caused it to run away with wings held up (circled lower left) (H. D. Jackson)

and fed the chicks for the first time, he then, while brooding, showed great interest in flying insects silhouetted against the moon. At no stage did he take off after an insect, or even give a flight intention movement, but his head swung from side to side and occasionally arced up and over slowly as he followed an insect. While brooding the chicks at Muneni, the male made some wing and tail stretches after rocking from side to side (Fig. 5).

While an adult was brooding the chicks between feeds, its large eyes were wide open, each forming an almost complete circle, with the pupil fully dilated. It was the adult's eye-shine that enabled me to find the family in the dark. Although both chicks were being brooded, one under each wing, their heads emerging under the adult's breast, their eyes did not reflect well, so I had to approach closely to be sure both were present. At times the chicks were very restless. For example, on day 14 at Atlantica, after being brooded for more than an hour, the chicks emerged several times after 22.00 h, once even flapping their wings and walking all over and around the male.

Responses to threats.—Brooding adults initially responded to an approaching human by hugging the ground, adopting a cryptic posture with the plumage sleeked, the head withdrawn level with the mantle, and the eyes closed to a very narrow slit (Fig. 6). They remained immobile until the threat had receded. The superb camouflage of the cryptic plumage against the surrounding leaf litter made it extremely difficult to find the brooding bird by day. At night it was relatively easy to find the eye-shine of an adult in a spotlight. The confidence shown by brooding females in their camouflage was almost complete. At all four nests my assistants and I often walked within 1 m of a female without flushing her. At Ranelia on day 1 at 15.15 h, the female was in full cryptic posture as an assistant on hands and knees approached her from directly behind. He had to touch her on the tail and lift her once or twice before she took flight. Brooding females sat tight in the cryptic posture while we searched back and forth, but if one of us paused within 2–3 m and looked at the bird, it would flush off the chicks 3–10 m and perform a distraction display, usually on the ground but sometimes on an overhead branch. There was no distraction display on day 1 and only a

mild display on day 2 at any of the four nests. It should be noted that no female performed a distraction display when flushed from eggs earlier in the season.

When the adult flushed, the chicks immediately adopted the cryptic posture flat on the ground, necks stretched out and eyes closed, remaining immobile. On days 1–5 they showed no reaction to my approaching hand, other than to breathe more rapidly, and permitted me to pick them up without any aggression. On day 6 the first sign of aggression was made when one of the chicks turned its head towards my hand and gaped. As my hand approached, it raised its breast off the ground slightly, stretched its neck and lunged repeatedly, but silently, at my fingers. No aggressive display was seen again until day 12, despite my provoking all of the chicks. They maintained their frozen attitude despite being prodded with a finger, depressing their bills or tilting their heads up. One chick on day 9 eventually made a quiet *cheep*, raised its wings and stood, then turned and tried to move away with a small hop. On day 12 some chicks hissed while striking very snake-like with an open gape (Fig. 7) but others ran away with their wings held up (Fig. 8). Another on day 13 half stood and moved away slightly with a wheezy call, then hopped sideways, but permitted me to pick it up without any aggression. On day 16 two chicks kept their eyes closed to slits as my hand reached down to pick them up, then suddenly both gaped with heads up and gapes wide open, followed immediately by spreading their wings fully. The culmination was a series of hops off the ground, gapes and wings still open, lunging at my hand and even striking it. By day 18 the chicks were capable of flight, so readily took off with the female when she flushed, but occasionally one remained behind in the cryptic posture, only flushing later.

On day 14 at 17.09 h I flushed the Retreat female off its chicks and found that they were completely surrounded by cattle tracks, which I followed in both directions to find that the herd had passed through the gum plantation without stopping. There is no doubt that the chicks were there when the cattle passed because many of their droppings were very dry. There was a hoof print 46 cm south-west of the chicks and another 22 cm north-west, evidence of a lucky escape. The female may have flushed during such a close encounter, but the chicks would certainly have frozen into immobility while the cattle passed. The only casualty among the chicks was the elder Muneni chick, which vanished before 11.00 h on day 6, probably taken by an avian predator. It was the more aggressive and adventurous of the two chicks and would sometimes run away while its sibling froze immobile, so it was more likely to be noticed.

Distraction display.—Distraction displays were performed by both adults, but those seen most frequently were performed during the day by females. My notes on the distraction display of the Muneni female, after being flushed on day 3 at 11.00 h, are representative of the behaviour of all four females: ‘She flew directly away from my line of approach and flopped down onto the ground at a distance of about 5 m from the nest. As soon as she landed, somewhat hidden by the grass, she started thrashing around violently with wings and tail spread. At the same time she uttered a high-pitched rapid growling call. Both the sound and the movement attracted my attention immediately, and would presumably do the same for a predator. I followed her and when she saw that I was approaching she took off, flew about 10 m and settled on a thick, horizontal branch of about 10 cm diameter. She straddled it lengthways with wings drooping, one on each side, and tail fully spread. In this position she repeated the distraction display quite violently, moving the wings alternately up and down in a chopping motion. She was facing me and when I continued my advance toward her she took off and settled in another tree, on a thin branch, further down the slope. This happened several times, the intensity of the display diminishing according to

TABLE 1
Daily mean measurements of Fiery-necked Nightjar *Caprimulgus pectoralis* chicks from hatching to fledging.
Sample sizes shown in brackets.

Day	Wing	Mass	Tail	Tarsus	Culmen
1	10.3 (1)	5.3 (2)	0.0	7.5 (1)	1.8 (1)
2	13.6 (4)	6.2 (6)	0.0	10.2 (3)	1.8 (4)
3	14.0 (4)	8.2 (6)	0.0	10.1 (4)	1.6 (4)
4	16.9 (4)	10.2 (6)	0.0	12.1 (4)	2.0 (4)
5	21.9 (4)	13.1 (6)	1.1 (2)	12.2 (4)	1.9 (4)
6	28.3 (3)	15.4 (5)	4.7 (3)	12.6 (3)	2.1 (3)
7	35.3 (3)	18.6 (5)	6.8 (3)	13.4 (3)	2.2 (3)
8	41.1 (3)	20.9 (5)	7.8 (3)	13.6 (3)	2.4 (3)
9	47.9 (3)	23.4 (5)	10.8 (3)	13.3 (3)	2.7 (3)
10	53.1 (3)	25.5 (5)	13.7 (3)	15.1 (2)	2.9 (2)
11	61.3 (3)	27.2 (5)	17.5 (3)	15.0 (1)	3.5 (1)
12	66.5 (3)	29.4 (5)	18.0 (2)	16.5 (1)	3.5 (1)
13	71.7 (3)	30.1 (5)	22.8 (3)	15.6 (2)	3.1 (2)
14	77.7 (3)	33.0 (5)	27.7 (3)	15.3 (3)	3.5 (3)
15	83.6 (2)	34.7 (4)	26.5 (1)	15.9 (1)	3.1 (1)
16	88.1 (3)	35.2 (5)	30.0 (1)	17.5 (1)	3.5 (1)
17	93.7 (1)	37.1 (3)	34.1 (1)	17.0 (1)	3.8 (1)
18	94.4 (2)	36.6 (4)	38.3 (2)	17.3 (2)	4.1 (2)
19	95.3 (2)	39.1 (3)	39.8 (2)	19.0 (2)	4.5 (2)
20	102.0 (1)	40.0 (2)	43.0 (1)	18.0 (1)	5.0 (1)

our distance from the nest, until eventually, when we were 30–40 m from the nest, she flew off and landed at the bottom of a small gully, hidden from view.’

The most intensive distraction displays were performed by females that had been in the cryptic posture for lengthy periods while we searched for them. The longer the search continued, the more violent the initial display when she was discovered. Subsequent displays diminished in intensity according to our distance from the chicks, but immediately increased if we turned back towards them. Once we started handling the chicks, the females flew to a perch nearby and watched from there, while regularly giving *chuck* notes. When I completed my examination of the chicks I replaced them in the nest and immediately left. The female usually returned to the chicks shortly afterwards, landing nearby and calling them to her, but sometimes she walked back to the nest from some distance. At Muneni on day 4 at 11.05 h the female was on the ground c.20 m from the nest when I left. At 11.07 h she flew halfway towards the nest and then walked 8 m towards it before settling 2 m away and calling the chicks. The first part of the walk was in alert posture, with head up and eyes open, but she gradually adopted a more skulking posture, with head down and eyes half-closed. Initially this was a slow waddle but gradually became faster as she approached the chicks.



Figure 9. On day 6 at Muneni the fence shown in the background prevented the Fiery-necked Nightjar *Caprimulgus pectoralis* chicks from reaching the adult; as soon as the adult flipped over the fence the chicks ran across to be fed (H. D. Jackson)



Figure 10. Fiery-necked Nightjar *Caprimulgus pectoralis* chick 2 at Muneni on day 10, showing the growth of the flight feathers (H. D. Jackson)

During distraction displays the birds maintained a bold upright stance, standing and rocking sideways, sometimes even bouncing up and down as much as 5 cm, especially when perched on a branch. The eyes were wide open, the head held upright, the breast off the ground and the plumage raised. The tail and both wings were usually spread fully, but sometimes just one wing was spread. The *chuck* call was regularly used to warn the chicks to remain immobile. When being approached, the perched birds often bobbed their heads. After day 18, when the chicks were able to fly, the adults no longer performed distraction displays, but instead flew towards me and hovered nearby.

Relocation and locomotion.— At Muneni on day 4 at 18.25 h the female appeared to be alarmed by a camera lens projecting from the hide, taking off and flying 2–3 m downslope to settle on the ground, from where she called the chicks with the *woot-woot-woot* call. While doing so, she faced them and rocked violently from side to side, the gular patches fluttering when she called. The chicks immediately made their way downslope to her and snuggled

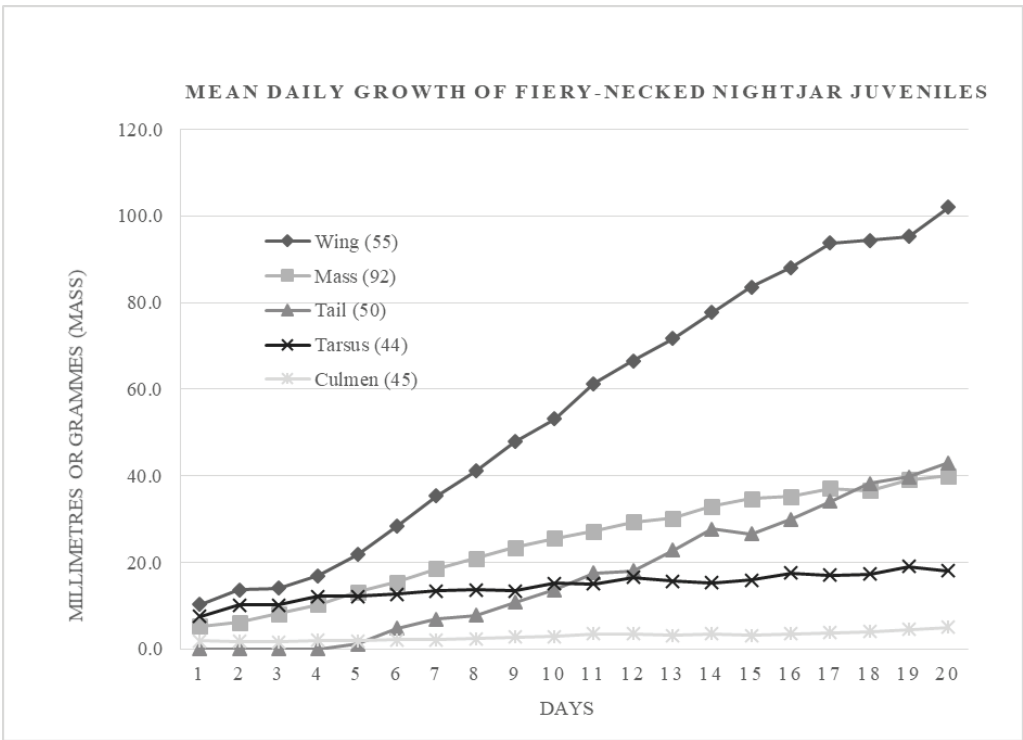


Figure 11. Mean daily growth of young Fiery-necked Nightjars *Caprimulgus pectoralis*. The figures in brackets are the number of measurements for each character.

under her wings, entering from the front, then turning round to face out either side of her breast.

When the adult tending the chicks decided to move them from a perceived threat, such as the hide, it invariably did so by first moving itself and then calling the chicks. All chicks had very well-developed legs at hatching (Table 1, Figs. 2 and 11) and were already highly mobile on day 1, so readily responded when females called them. The small fences placed around three of the nests for a few days prevented the chicks from reaching the female. They ran back and forth along the fence until the female flew into the enclosure to join them, when they would run up to her to be brooded (Fig. 9). No adult was observed taking a chick in its mouth to move it or ‘airlift’ it to a new location.

Growth rates of chicks.—Chicks were weighed and measured daily for 20 days after hatching (Table 1, Fig. 11). Body mass reached 80% of adult mass by day 20. At Ranelia I continued to weigh one of the chicks daily for another 12 days, by which time it was fully independent. An adult was last seen with this chick on day 19 and its sibling was last seen with it on day 22. Its body mass on days 20, 21, 22 and 23 was, with a full stomach on each occasion, 41, 44, 47 and 49 g, i.e. just below the adult mean of 50 g. On days 28, 29, 30, 31 and 32, with stomach half to full, its body mass was 58, 54, 54, 54 and 55 g, well above typical adult mass.

At hatching the tarsi already were almost half adult length and the toes had claws of c.1 mm. By day 6 the claw on the middle toe was 1.5 mm and slightly downcurved. On day 13 it was just over 2 mm and distinctly concave below. When it was 3–4 mm long on days 18–19, the inner edge split to form a comb of four teeth with a depth of 1 mm, the so-called pectinate claw. No adult was seen preening its rectal bristles with a pectinate claw, but this

could have occurred away from the nest. Rictal bristles did not appear until day 18, when small pin-feathers were evident at the base of the maxilla of the Atlantica and Muneni chicks. On day 19 at Muneni they were emerging from the sheath and were c.2 mm long. The contour plumage appeared to be complete by day 16.

The wings and tails of the chicks at hatching were 6% and 0% of adult lengths. By day 10 they had reached 33% and 11% respectively (Fig. 10), and on day 20 they had grown to 63% and 36% respectively. The remiges appeared on day 4, breaking their sheaths on days 8–9. By days 11–12 the primaries and secondaries projected 10–25 mm from the sheaths, while the tertials were just breaking clear. By days 16–19 the remiges were half-grown, with all of the upperwing-coverts in place, but there was no sign of the underwing-coverts. The primaries grew centrifugally from the mid-wing outwards, so the outermost primary did not break sheath until day 19. The rectrices did grow evenly, first appearing on day 5 and a few breaking sheath on day 8; by day 11 they were clear and by days 16–18 projected 1–3 cm.

From day 13 the chicks often ran from my approaching hand, their wings held up at an angle of 70°. This was not a continuous movement, but a series of short hops, suggesting that they were trying to become airborne. On day 15 at Retreat at 17.30 h, the younger chick ran 20 cm, then ran further with wings up, before taking off and flying upwards 30 cm for 1 m. It immediately made a repeat flight of 5 m at a height of 1 m. Other chicks also made their first flights on days 14–15. On day 18 at 11.00 h the Muneni chick flew 2 m downslope, then 4 m upslope and finally 25 m along the slope, climbing c.2–3 m above ground, flying very strongly and landing with much hovering. While in flight it uttered a high-pitched chirruping sound, perhaps to guide the adults to its new location.

Discussion

Comprehensive summaries of published information concerning Fiery-necked Nightjar appear in two monographs dealing with the Caprimulgiformes (Cleere 1998, Holyoak 2001) and in *Roberts* (Vernon & Dean 2005). Many of the results of my study of the four Zimbabwe nests confirm the information in these works, but there are some corrections, observations and new insights. Data obtained by Carlyon (2011) at a nest observed near Grahamstown, South Africa, are very similar to my own.

Eggshell removal.—The remarkable behaviour of the adults at two nests in Manicaland (Ranelia and Muneni) in not removing eggshells post-hatching suggests that there is a regional difference in the species' behaviour. Manicaland birds are *C. p. crepusculans*, while those in Mashonaland (Retreat and Atlantica) are *C. p. fervidus*. The accidental removal at both Mashonaland nests, as a result of some eggshell sticking to the breast plumage is notable, but evidence suggests that Mashonaland birds also deliberately remove eggshells from the nest soon after hatching. If so, the two Zimbabwe subspecies behave differently when dealing with eggshells. There may also be a difference in the amount of albumen when the eggs hatch, as eggshells appear to be stickier in Mashonaland than in Manicaland, based on my limited data. The presence of sticky albumen at the time of hatching offers a plausible explanation for many alleged cases of transportation of eggs or young by caprimulgids (Jackson 1985b). These statements appear in the literature pertaining to Fiery-necked Nightjar: 'Eggshells removed immediately' (Langley 1984, Vernon & Dean 2005); 'Parent quickly removes eggshells' (Fry & Harwin 1988); 'The eggshells are removed from the nest-site by the adult' (Cleere 1998); and 'A parent quickly removes egg-shell from the nest site' (Holyoak 2001). All were based on Langley's (1984) observations at two nests of *C. p. pectoralis* in South Africa. There is survival value in removing the conspicuous eggshells

(Fig. 1) from the nest site immediately after hatching, so it is strange that the Manicaland birds do not do so.

Feeding stimulus.—The method by which adults feed their chicks was determined in detail for the first time. The adult waited until a chick stretched up to grasp the tip of its bill in the chick's own (Fig. 4) before feeding it. Once the chick had a firm grip, the adult tipped its head vertically down, raising its neck and, with a rapid series of up-and-down head movements, regurgitated food into the chick's throat. This movement was extremely rapid, with the adult's bill clearly well inside the chick's gape. An excellent colour photograph of a chick soliciting food from a female appears in Carlyon (2011: 146), showing the chick's bill clearly engulfing that of the adult. Without this feeding stimulus from the chick, the adult was passive, thereby ensuring even distribution of food. Holyoak (2001: 86) noted that European Nightjar *C. europaeus* and several congeners use a similar method, but appeared unaware of the significance of the necessary feeding stimulus provided by the chick.

Return to nest for feeding.—Fry & Harwin (1988), after stating that chicks are brooded at increasing distances from the nest, added that they return to the nest to be fed. Cleere (1998) and Holyoak (2001) both repeated this with 'Return to nest to be fed'. The original source for this statement is Steyn & Myburgh (1975), who appear to have based it on the behaviour of two chicks they observed at Somerset West near Cape Town. However, since those chicks were never found >1.5 m from the nest during 42 days of observation, they had barely left the nest anyway. Twice, when 27 and 42 days old, they flew up with the female when approached, but returned to the nest at dusk. The question is whether the female was already at the nest, and calling them to her. At another nest near Cape Town (Langley 1984), the female regularly brooded the chick further away, until by day 28 they were c.14 m from the original site. Carlyon (2011) noted that movement around the vicinity of the nest is a feature of Fiery-necked Nightjar breeding behaviour and serves to prevent an excessive build-up of excreta in one spot.

None of the chicks in this study, or any other chicks that I have observed, some of which were relocated many metres from the nest by an adult, returned to the nest to be fed, unless an adult was there and was calling them. Firstly, there is no nest as such, i.e. no visible structure to guide a chick seeking to return to the nest. Secondly, it would not risk predation by moving to the nest, if by remaining immobile it would be exactly where the adult had left it, and to where the adult would return with food. Chick locomotion is in response to adult guidance (see below); when an adult calls, the chick moves in that direction. Only in the event of that adult being on the nest at the time can the chick be said to be returning to the nest to be fed, but it is actually returning to the adult, not to the nest.

Do nightjars sing?—Technically, only the perching birds (Passeriformes) are said to have true song. However, Holyoak (2001: 70) argued that 'this seems to be unduly restrictive, because many of the Caprimulgiformes produce elaborate, richly patterned sequences of sounds in a consistent manner and for purposes of territorial defence and attracting mates, closely similar to those termed songs in many passerines, not only in their complexity, but also in the manner of their delivery and their functions'. Throughout his monograph on the Caprimulgiformes, Holyoak (2001) referred to these sequences of sounds as 'songs', and so do I here. I cannot think of a more descriptive term for the liquid litany of Fiery-necked Nightjar.

'Wooting' call.—According to Fry & Harwin (1988) 'Warning call (of ♂ and ♀), 'woot-woot-woot ...'; adults disturbed when feeding young utter nervous 'chuck' and growling notes (H. D. Jackson, pers. comm.)'. If I was quoted correctly, I was wrong concerning the 'wooting' call, which is not a warning or alarm call, but has subsequently been described as such by Cleere (1998) and Holyoak (2001), based on the statement attributed to me by Fry

& Harwin (1988). It is in fact quite the opposite, an attraction call, used during the courtship phase, in response to the litany song (Jackson 2002b, Vernon & Dean 2005) and, during the brooding phase, to call the chicks to the adult (Jackson 1985b, Holyoak 2001, Jackson 2002a, where it was described as 'cue-cue-cue', followed by Vernon & Dean 2005, Jackson 2009, describing a captive chick at Ranelia that immediately responded to the 'wooting' of a distant adult by moving in that direction, and this study).

Chicks responded to the 'wooting' call as early as day 1, being guided by sound alone as their eyes were still closed. They must be highly mobile to reach the adult quickly. A feature of their semi-precocial development is their very well-developed legs (Fig. 2), the tarsus length at hatching already being almost half that of the adult (this study), so that they can walk strongly within four hours of hatching (Jackson 1983: 144).

The 'wooting' call was the only means by which an adult moved the chicks from perceived danger. No adult was observed to pick up and carry, or 'airlift', a chick to a new location. It invariably first moved itself and then called the chicks by wooting. They immediately responded by running towards it, even on day 1. I reviewed evidence for the translocation of eggs and young by nightjars and found that there is no satisfactory evidence of any nightjar deliberately 'airlifting' its eggs or young away from a disturbance (Jackson 2007a). Most of the evidence was based on hearsay, supposition, a misunderstanding of nightjar behaviour, or the repetition of a 200-year-old story dating from Le Vaillant and copied by Audubon. As noted by Holyoak (2001: 3) it has taken more than 100 years of observations to dispel this myth and some superstitions about nightjars.

Camouflage and flush distance.—Recent research in Zambia (Stevens *et al.* 2017) showed that individuals of some ground-nesting birds, including nightjars, appear able to assess the level of camouflage of their own plumage, and that they use this to select backgrounds that enhance their camouflage. As there is variation in plumage among individuals, they hypothesised that nesting birds choose microhabitats that improve their camouflage and predicted that birds should choose nest sites that improve their own specific camouflage compared to sites selected by conspecific individuals.

As predicted by Stevens *et al.* (2017), nightjar plumage ($n = 98$ adults) matched the pattern, luminance and colours of the individuals' chosen backgrounds better than those of their conspecifics' backgrounds. They also found that adult nightjars sit tight and flee from the nest only when a predator is nearby, their data showing a flush distance across three nightjar species, including Fiery-necked, of 1.9 ± 1.3 m ($n = 38$), meaning that nest survival should be more strongly affected by parental camouflage than by egg camouflage.

The camouflage of females at the four nests that I studied was so effective that often, while searching in daylight, we passed within 1 m of the sitting bird without flushing her. Throughout the search, she sat tight in the cryptic posture, depending totally on her camouflage. She was clearly aware of whether or not she had been seen. The act of flushing was triggered more by our behaviour than our distance from her. As soon as one of us suddenly stopped and looked at her, she took off and performed a distraction display a few metres from the nest. Only a direct approach towards the nest caused her to flush before we had spotted her.

Aggressive chick behaviour.—Reynolds (1968) described the display of a half-grown Fiery-necked Nightjar chick threatening a person by spreading its wings, opening its bill wide and lunging. This is illustrated in Fry & Harwin (1988) and photographically here (Fig. 7). The earliest full manifestation of this behaviour (which also includes hissing) that I noted, despite frequent provocation of the chicks, was on day 12, when the chicks were 60% grown. However, one chick already showed a mild example on day 6.

Chick development.—Growth rates of the chicks were much as described by Vernon & Dean (2005), which is unsurprising as most of their data were from my Retreat nest (Jackson 2002a). Vernon & Dean (2005) made no mention of the rectal bristles or the pectinate claws, and neither do the accounts in Fry & Harwin (1988) or Cleere (1998). Holyoak (2001) noted that the bases of some larger rectal bristles were pale, while their tips were black, but did not mention the pectinate claws. I have previously (Jackson 2007c) drawn attention to the omission of these notable appendages by these authors, and have commented on their possible value to nightjars. In the current study, rectal bristles appeared as small pin-feathers on day 18 and by day 19 had broken sheath by 2 mm. Chicks can fly by day 18, perhaps even by day 14 (Carlyon 2011), so the bristles provide no protection for the eyes during the early days of flight. However, the rectal bristles of Fiery-necked Nightjar develop rapidly, the longest measuring 12 mm within one month, and when fully grown can reach 20 mm (Jackson 2007c). The claw on the middle toe was 1.5 mm long and slightly downcurved by day 6. On day 13 it was just over 2 mm and distinctly concave below, while on days 18–19, when it was 3–4 mm long, the inner flange had split to form a comb of four teeth with a depth of 1 mm, the so-called pectinate claw. As the claw grows, further splitting occurs with the result that the adult has c.9 teeth in each comb (Jackson 2007c).

The remiges appeared on day 4 and began to break sheath on days 8–9. By days 11–12 the primaries and secondaries projected 10–25 mm from the sheaths, while the tertials were just breaking clear. By days 16–19 the remiges were half-grown, with all of their upperwing-coverts in place, but there was no sign of the underwing-coverts. It is interesting to note that the primaries did not grow evenly, but centrifugally from the mid-wing outward, so that the outermost primary did not break sheath until day 19. This agrees with the moult pattern in adults, where the primaries moult descendantly in regular order, the inner primaries being new by the time the outer primaries start to moult (Jackson 2007b). The rectrices grew evenly, appearing on day 5 and a few breaking sheath on day 8. By day 11 they were clear and by days 16–18 projected 1–3 cm from the sheaths. These data are within 1–2 days of those given by Vernon & Dean (2005).

Independence.—Two chicks studied by Steyn & Myburgh (1975) were still with the female when 42 days old, but when flushed at 62 days no adult was present. Langley (1984) also studied a pair of Fiery-necked Nightjars breeding near Cape Town, in Rondevlei Bird Sanctuary. This pair was double-brooded, successfully raising one chick from each brood. An adult was last seen with the first chick when it was 39 days old, and Langley (1984) noted that the second chick ‘was never seen in the company of an adult after the age of 23 days, with both adults having disappeared from the area when it was 30 days old, suggesting that it may have been independent at this age.’ This chick disappeared four days later, probably having perished, as the first chick was still in the area when 152 days old.

At the four nests in Zimbabwe, adults were seen with chicks until days 19–21, after which the chicks appeared to be independent. At Ranelia, I continued to weigh one of the chicks daily for another 12 days, by which time it was fully independent. It reached adult body mass on day 23, with a full stomach, and regularly exceeded it on days 28–32, with a half-full to full stomach. It is evident from observations at the seven nests above that independence may be achieved as early as 19–23 days after hatching, but that chicks up to the age of 39–42 days may still accompany an adult, for whatever reason. On the available evidence, most adults leave their territories post-breeding, but most chicks remain in their natal areas.

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A historical Australasian Shoveler *Spatula rhynchotis* specimen from southern South America

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Australasian Shoveler *Spatula rhynchotis* is endemic to Australia and New Zealand (Johnsgard 1978, Delacour 1973, Sibley & Monroe 1990, Fullagar 2010). We present what appears to be the first record of the species away from Australasia, a specimen at the Museu Nacional, Rio de Janeiro, Brazil. The specimen is a male shoveler identified by us as a breeding-plumage drake *S. rhynchotis* (Fig. 1). Its catalogue number is MN 19034, and the specimen has been present at Museu Nacional since at least 1897 (Miranda-Ribeiro 1928). The original label reads '♂ *Anas platalea* / Iris = brun obscur / Rep-Arg. = Entre Rios' with '*Anas cayennensis*' written on a second, more recent, label (Fig. 2). The name '*Anas cayennensis*' seems to have been taken by Miranda-Ribeiro from Buffon, but has never been made available for any wildfowl species (Salvadori 1895). Measurements taken by us were: bill length 57 mm (from the base of the feathers to the tip of the culmen); bill width 29 mm (at the widest point); and wing length 235 mm (flattened, from the carpal joint to the tip of the longest primary).

Our identification of the specimen as a male Australasian Shoveler is based on depictions of *S. rhynchotis* in the literature (e.g. Merne 1974, Scott 1977, Madge & Burn 1988, Marchant & Higgins 1990, Kear 1991, Johnsgard 1992, Todd 1996, Ogilvie & Young 1998), as well as information provided by D. M. Teixeira, curator of birds at Museu Nacional, who checked the specimen against a series housed at the Natural History Museum, Tring, in February 1993.

The brown iris mentioned on the label is not typical of drake Australian Shoveler in this plumage, when it is usually yellow (Marchant & Higgins 1990: 1346). However, the same authors mentioned that a 'captive breeding male had brown (121B) iris', in reference to Smithe's (1975) colour guide.

The specimen's immaculate plumage, with its well-defined white crescentic face patches, solid bluish-green glossed head, long unclipped wings, and the absence of corneous callosities on the soles of its feet suggest a wild bird rather than an escapee or an imported bird. Referring to the early 20th century, Phillips (1986) stated that individuals of the species 'have never been imported into Europe or America'.

As to the possibility of the specimen being a hybrid involving any of Northern Shoveler *S. clypeata*, Blue-winged Teal *S. discors*, Cinnamon Teal *S. cyanoptera* and Red Shoveler *S. platalea* (see McCarthy 2006), we do not have any evidence to support such a hypothesis, which appears discountable based on the available literature (e.g. Childs 1952, Harrison & Harrison 1959, 1963, 1965, Bolen 1979, McCarthy 2006). The main hybrid pitfall is Northern Shoveler × Blue-winged Teal, which closely recalls Australasian Shoveler and can also show brown irides. However, the bold black crescent-shaped markings on the breast are more indicative of Australasian Shoveler (usually fainter in hybrids) and similar markings are also present on the flanks and belly (often more streak-like in hybrids), while bill shape is also closer to Australasian Shoveler (S. Reeber *in litt.* 2017).

As to its provenance, we have located specimens of various other species including Fulvous Whistling Duck *Dendrocygna bicolor* (MN 21796), Tropical Parula *Parula pitaiayumi*



Figure 1 (above). Specimen of breeding-plumaged male Australasian Shoveler *Anas rhynchos* in lateral, dorsal and ventral views, deposited at Museu Nacional (MN 19034), Rio de Janeiro, Brazil, and labelled as having been collected in Entre Rios province, Argentina (Marco A. Crozariol)

Figure 2 (left). Specimen labels, showing the earlier erroneous identifications of '*Anas cayennensis*' and '*Anas platatea*'. The green label displays the specimen's catalogue number at Museu Nacional (MN 19034). (Marco A. Crozariol)

(MN 14492) and Saffron-cowled Blackbird *Xanthopsar flavus* (MN 15684) also collected in 'Entre Rios', apparently around 1877, as some labels indicate, and all of them deposited at Museu Nacional by October 1897 (Miranda-Ribeiro 1928). Their labels are in the same handwriting as that attached to the Australasian Shoveler.

To our knowledge this is the first record of the species outside Australasia, rather than a hybrid with *A. clypeata* or any of the other above-mentioned species, and is potentially the first record for Argentina (Roesler & Táboas 2016) and South America (Remsen *et al.* 2017).

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Supposed sympatry of *Corapipo* manakins in the Tacarcuna region of Colombia, and a comment on *Schiffornis*: a response to Renjifo *et al.* (2017)

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A demonstration of sympatry would be a decisive factor in the determination of species limits, which have been controversial in *Corapipo* manakins. Renjifo *et al.* (2017) claimed to document the occurrence of White-bibbed Manakin *Corapipo leucorrhoa* on the Colombian slope of Cerro Tacarcuna, a mountain straddling the border between Panama and Colombia. Their species account recognised the distinction between *C. leucorrhoa* and White-ruffed Manakin *C. altera*, which has sometimes been treated as a subspecies of *C. leucorrhoa* (AOU 1983, Ridgely & Gwynne 1989). Ridgely & Gwynne (1989) and Wetmore (1972) are cited for localities where *C. leucorrhoa* (*sensu stricto*) has been documented in Panama, and the authors claimed sympatry in Panama between *C. leucorrhoa* and *C. altera* based on these references.

However, neither Ridgely & Gwynne (1989) nor Wetmore (1972) reported nominate *C. leucorrhoa* from Panama. Wetmore's (1972) *Corapipo* records for eastern Panama were all attributed to *C. a. altera*, and comparing it with *C. leucorrhoa* he noted 'the two groups . . . are not in contact'. Ridgely & Gwynne (1989) included *altera* within *C. leucorrhoa*, but wrote 'birds from Middle America to northwestern Colombia were formerly often considered a distinct species (*C. altera*, White-ruffed Manakin) from those of northeastern Colombia and western Venezuela (*C. leucorrhoa*, White-bibbed Manakin)', so their eastern Panama records plainly also refer to *altera*. Thus, there is no previous published evidence of sympatry for *C. leucorrhoa* and *C. altera* (see also Kirwan & Green 2012). Nor did Renjifo *et al.* (2017) give a basis for their identification of their birds as *C. leucorrhoa*. The principal diagnostic character, length and shape of the outer primary, is not described in their text nor shown in their photo, and no measurements are given. If verified, this record would represent a significant range extension for *C. leucorrhoa*.

Renjifo *et al.* (2017) also reported documenting *Schiffornis* at their study site on Cerro Tacarcuna, but their text and Appendix 1 contradict each other as to which species is involved. The text (p. 59) listed *Schiffornis veraepacis acrolophites* as 'among first or second specimen records of subspecies endemic to the Darién . . . foothills'. The Appendix 1 (p. 65), a list of birds recorded, does not list *S. veraepacis* but instead refers to *S. stenorhyncha* at their study site as a visual, aural, trapped and specimen record. Both species are known from the Tacarcuna region (Wetmore 1972). Co-author J. E. Avendaño (*in litt.* 2017) subsequently reported that the specimen he collected (ICN 38178) has been identified as *S. v. acrolophites*, and that Appendix 1 was in error.

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Nest and eggs of the southern Central American endemic Tawny-chested Flycatcher *Aphanotriccus capitalis*

by Luis Sandoval

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The *Aphanotriccus*, *Lathrotriccus* and *Cnemotriccus* clade (Cicero & Johnson 2002, Ohlson *et al.* 2008, Tello *et al.* 2009) comprises five species of tyrant flycatcher that inhabit dense second growth, disturbed forest, riverine forest and forest edges (Stiles & Skutch 1989, Ridgely & Tudor 1994, Fitzpatrick 2004). These species show generally patchy distributions due to appropriate habitats being isolated from one another (Stiles & Skutch 1989, Ridgely & Tudor 1994, Fitzpatrick 2004). The breeding biology of the species in this clade is reasonably well known (Fitzpatrick 2004), with good descriptions of the nest and eggs of Fuscous *Cnemotriccus fuscatus*, Euler's *Lathrotriccus euleri* and Grey-breasted Flycatchers *L. griseipectus* (Fitzpatrick 2004, Greeney 2014). On the other hand, the breeding biology of both *Aphanotriccus* species is poorly known (Fitzpatrick 2004) and restricted to an observation of nestbuilding and an adult carrying food to another nest of Tawny-chested Flycatcher *A. capitalis* at La Selva Biological Station, Costa Rica (Young & Zook 1999).

Here, I provide for the first time information concerning nest architecture and describe the eggs of Tawny-chested Flycatcher, based on another nest found in Costa Rica. This flycatcher is endemic to the Caribbean slope of south-east Nicaragua (where it is scarce) and north-east Costa Rica, from sea level to 1,100 m (Stiles & Skutch 1989, Garrigues & Dean 2014, Martínez-Sánchez *et al.* 2014). It inhabits dense vegetation at forest edges, in secondary forest and riverine forest (Stiles & Skutch 1989, Garrigues & Dean 2014).

The nest was discovered and collected by Mario Olmos, on 2 June 1996, at Rancho Naturalista, Turrialba, in Cartago province (09°49'N, 83°33'W; 970 m). This area is in the Caribbean foothills of the Talamanca Mountains and has a natural cover of premontane forest, heavily logged around the lodge and at different successional stages across the property, ranging from grass fields with a few remnant trees to primary forest. The steep terrain has many banks, much vertical vegetation and dark conditions ideal for nesting. The nest (MNCR54) and eggs (MNCR338) were deposited at the Museo Nacional de Costa Rica, San José.

Description of the nest and eggs.—The nest was sited between the leaf bases of a bromeliad and the main trunk of a tree, 0.4 m above ground. It was an open cup composed of two layers (Fig. 1): an external layer of loosely woven plant fibres such as mosses, dead leaves and dry twigs; and an internal layer of more tightly woven pale rootlets and plant fibres. External measurements (obtained with dial callipers ± 0.01 mm) were: nest height = 85 mm, nest diameter 140 mm, and walls 89 mm and 12.5 mm. The walls varied because the inner cup was not centred within the external layer (Fig. 1). Internal measurements were: inner cup diameter = 48.10 ± 2.13 mm (mean \pm SD of four internal diameters) and inner cup depth at the centre = 23 mm. The clutch size was three eggs. Eggs were pale pinkish in ground colour with round sparse dark red spots forming a wreath at the larger end (Fig. 2). Egg size was: 17.3×12.9 mm, 17.7×13.1 mm and 16.1×12.0 mm.

Discussion.—The nest of Tawny-chested Flycatcher is cup-shaped, similar to those described for the other two genera in the clade (*Cnemotriccus* and *Lathrotriccus*), with a loosely woven external layer and a more tightly woven internal layer (Greeney 2014).



Figure 1 (above). Lateral and upper views of the Tawny-chested Flycatcher *Aphanotriccus capitalis* nest deposited at the Museo Nacional de Costa Rica collection (MNCR54) and found at Rancho Naturalista, Cartago province, Costa Rica, on 2 June 1996 (Luis Sandoval)



Figure 2 (left). One of the three eggs in the Tawny-chested Flycatcher *Aphanotriccus capitalis* nest found at Rancho Naturalista, Cartago province, Costa Rica, on 2 June 1996 (Luis Sandoval)

Unlike the previous two nests reported for this species, both of which were constructed within a tree or bamboo cavity (Young & Zook 1999), the nest reported here was 0.4 m above ground in the fork between a bromeliad and trunk, indicating that nests of this tyrant flycatcher are not necessarily sited in cavities. Furthermore, the Tawny-chested Flycatcher nest described here is very similar to nests described for Euler's and Grey-breasted Flycatchers, which species also constructs nests between epiphytes (Di Giacomo & López Lanús 1998, Fitzpatrick 2004, Greeney 2014). This may indicate that such situations do not represent unusual nesting behaviour.

The eggs' pale pinkish ground colour and spot pattern are similar to those previously reported for both *Lathrotriccus* species (Greeney 2014) and Tufted Flycatcher *Mitrephanes phaeocercus*, a closely related species whose eggs are also well described (Stiles & Skutch 1989, Cicero & Johnson 2002, Ohlson *et al.* 2008, Tello *et al.* 2009, Greeney 2014). The similarities of nest and eggs between species of different genera within the clade demonstrate that they share many nesting traits, providing further evidence of their close relationships.

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The second and third documented records of Antarctic Tern *Sterna vittata* in Brazil

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Antarctic Tern *Sterna vittata* is a medium-sized tern that breeds during the austral spring and summer (October–March) on islands in the Southern Ocean, from 37°S on the Tristan da Cunha archipelago, to 68°S on the Antarctic Peninsula. Some populations remain near their breeding grounds year-round, whereas others migrate north to waters off Argentina, South Africa and New Zealand. Vagrants have been reported as far north as Walvis Bay in Namibia, southern Australia and south-east Brazil (Burger & Gochfeld 1996, Tree & Klages 2004, Sick 1997, Favero & Rodríguez 2005, Shirihi 2008).

The species has been mentioned at least three times in Brazil. The earliest record refers to a 19th-century specimen collected by H. M. Harrison 'at sea, 147 m. S.E. of Imbituba [Santa Catarina state], south Brazil' in July 1882 and deposited in what is now the Natural History Museum, Tring (NHMUK; Saunders & Salvin 1896: 51). Meyer de Schauensee (1966: 108) reported the species as occurring 'in winter to the coast of Rio de Janeiro [south-east Brazil]'. However, this was challenged by Pacheco & Parrini (1998), who argued that no evidence has ever been provided to verify this statement. Lima *et al.* (2004: 148) listed the species among migratory terns that occur in the state of Bahia, on the country's north-east coast, but there also seems to be no evidence for this. Here, we present new documented records and review the existing evidence for the occasional presence of Antarctic Tern in Brazil.

On 3 September 2012 at 13.00 h, NWD photographed a single tern from the *F/V Maria Letícia*, a pelagic longliner operating c.90 nautical miles (c.166 km) off the state of Rio Grande do Sul (c.34°07.3'S, 51°18.7'W; Fig. 1), on the continental slope >800 m depth. Other seabirds observed included albatrosses (*Diomedea* and *Thalassarche*), giant petrels *Macronectes*, Cape Petrels *Daption capense*, White-chinned Petrels *Procellaria aequinoctialis*, prions *Pachyptila* and Wilson's Storm Petrel *Oceanites oceanicus*.

The tern had a short, slender, uniform red bill, black cap, crown and nape contrasting sharply with a narrow, white cheek-stripe, grey back and upperwing with black on the outer edge of the outermost primary, white rump and tail, and grey chin, throat and underparts, with white undertail-coverts (Fig. 2). We identified the bird as an adult breeding-plumage Antarctic Tern, based on bill proportions and colour, and plumage pattern. This is the first record for the state of Rio Grande do Sul (*cf.* Bencke *et al.* 2010).

In the western South Atlantic, Antarctic Terns in breeding plumage are most likely to be confused with Arctic *S. paradisaea* and South American Terns *S. hirundinacea* in the same plumage. Arctic Tern is usually observed in non-breeding plumage in Brazil (Dias *et al.* 2012). Nevertheless, in both breeding and non-breeding plumages their outermost primaries have narrow dark tips, forming a trailing edge (Olsen & Larsson 1995, Shirihi 2008). South American Tern is larger (41–43 cm in length vs. 32–34 cm), has a longer and heavier bill, ill-defined white cheeks, and darker outer webs to the outermost primaries (Escalante 1970, Shirihi 2008).

In addition to the specimen mentioned in Saunders & Salvin (1896) as taken off Santa Catarina (NHMUK 1894.10.28.9), another (NHMUK 1923.8.8.1) was collected on 21 July 1923

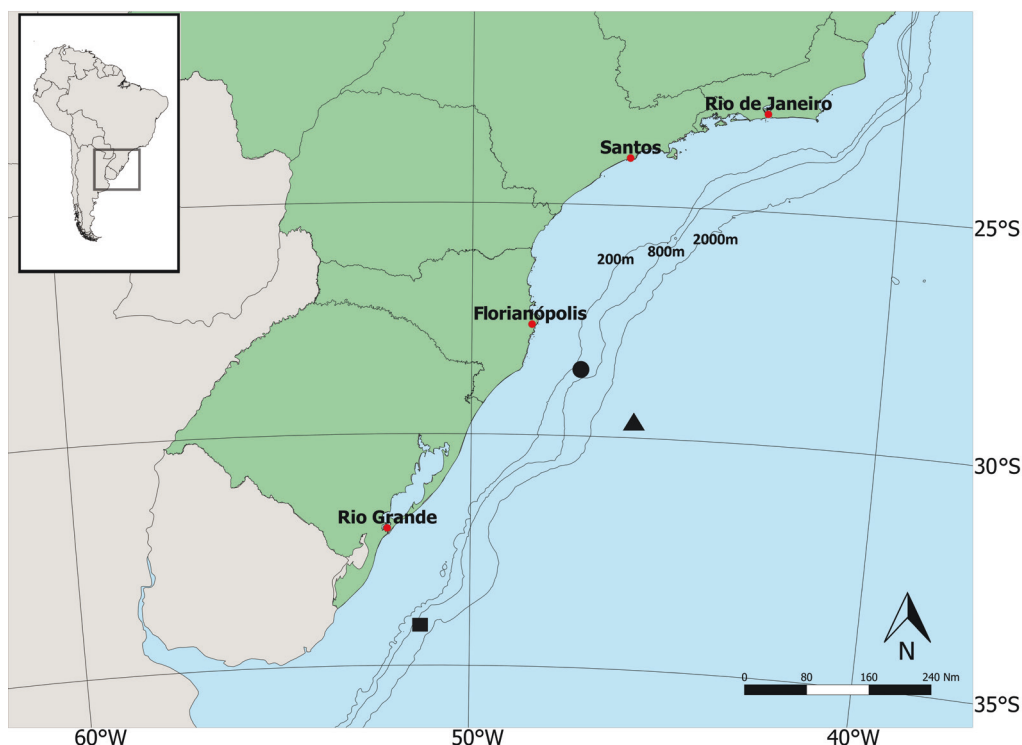


Figure 1. Records of Antarctic Tern *Sterna vittata* off southern Brazil: NHMUK 1894.10.28.9 (circle; Saunders & Salvin 1896), NHMUK 1923.8.8.1 (triangle; this work), and c.34°07.3'S; 51°18.7'W (square; this work).

by Lieutenant H. S. Tracy at '28°35'S, 47°20'W, off coast of S. Brazil' (Fig. 1). Data on their labels indicate that both specimens are males. They are in juvenile plumage with crown and nape black streaked/mottled white and buff and extending below the eye, forehead white spotted black, upperparts greyish barred brown, especially on the tertials, dark carpal bar on the upperwing, and underparts white. The bills are black and the legs and feet are blackish flesh (Fig. 3). Their measurements (in mm), taken by HvG, are as follows: exposed culmen 33.1 and 33.3; tarsus 19.5 and 17.6; and wing 250 and 255. Juvenile Antarctic Terns have the throat and breast washed brown; however, partial moult of the head and body begins in March, consequently older juveniles have generally white underparts (Harrison 1991, Shirihihi 2008).

Juvenile Antarctic and South America Terns are similar in plumage but, according to Murphy (1938), they are separable on size. However, Murphy (1938) only presented measurements of adults of the six currently accepted subspecies of Antarctic Tern. *S. v. gaini* of the South Shetland Islands and the Antarctic Peninsula, and *S. v. tristanensis* of Tristan da Cunha are largest, whereas *S. v. georgiae* of South Georgia, the South Orkney, South Sandwich and Bouvet Islands is smallest but longest-winged. The other three subspecies breed on islands in the southern Indian Ocean and New Zealand region, and are all intermediate in size (Murphy 1938, Burger & Gochfeld 1996).

Recently fledged juvenile terns are smaller than adults. For example, in Sandwich Terns *Thalasseus sandwicensis* on Griend, in the Dutch Wadden Sea, growth of body mass and wing length are almost complete within 100 days of hatching (Stienen & Brenninkmeijer 2002). Similarly, according to Murphy (1936: 1108), juvenile Antarctic Terns on Petermann Island, Antarctica, attain the size of adults within three months of hatching. We assume



Figure 2. Antarctic Tern *Sterna vittata*, at sea off Rio Grande do Sul, Brazil (c.34°07.3'S 51°18.7'W), 3 September 2012 (Nicholas W. Daudt)

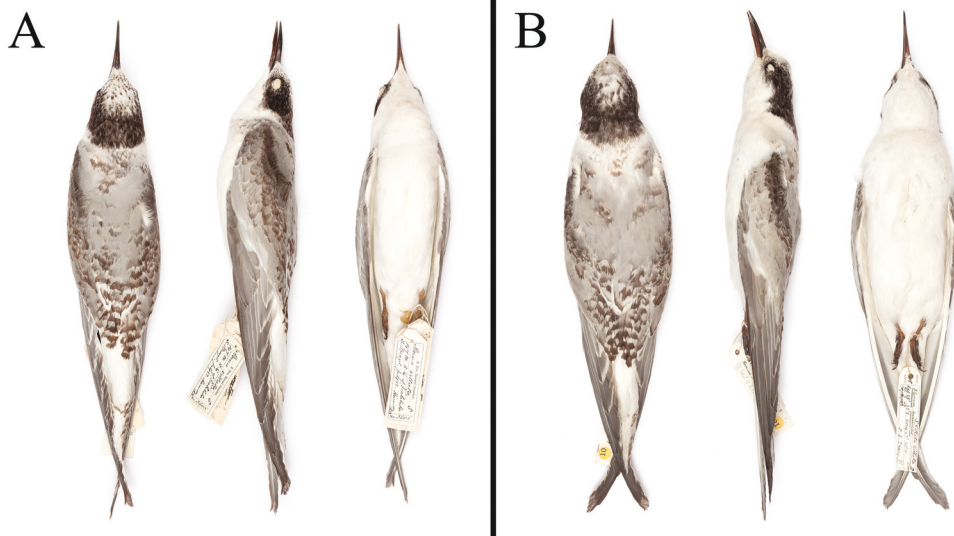


Figure 3. Brazilian specimens of Antarctic Tern *Sterna vittata* in the Natural History Museum, Tring: NHMUK 1894.10.28.9 (A) and NHMUK 1923.8.8.1 (B) (Harry Taylor, © Natural History Museum, London)

both specimens had completed their growth, since they have white underparts and were collected in July. Their measurements agree with those given by Murphy (1938) for Antarctic Terns breeding on islands in the South Atlantic and on the Antarctic Peninsula (*cf.* Table 1).

One of us (NWD) measured juvenile and adult South American Tern specimens in the Coleção de Aves Marinhas da Universidade Federal do Rio Grande—FURG,

TABLE 1
Measurements (in mm) of Antarctic Tern *Sterna vittata* subspecies from islands in the South Atlantic and the Antarctic Peninsula. (1) adults, specimens (Murphy 1938); (2) adults (sexes pooled), live birds (Tree & Klages 2004). Data = range (mean; sample size).

	<i>S. v. tristamensis</i>		<i>S. v. georgiae</i>		<i>S. v. gaini</i>
	Male	Female	Male	Female	Male
Culmen	(1) 36.3–37.7 (37.1; 6)	34.6–36.2 (35.5; 3)	30.0–32.8 (31.2; 18)	28.5–30.5 (29.4; 8)	35–37 (36.4; 4)
	(2) 33.6–42.1 (30)*		28.5–30.5 (26)*		
Tarsus	(1) 19.5–19.8 (19.7; 6)	18.4–20.0 (19.2; 3)	16.0–17.8 (16.7; 18)	15.9–17.5 (16.5; 8)	18.0–19.1 (18.6; 4)
	(2) 18.4–21.4 (36)		15.9–17.8 (26)		
Wing	(1) 252–260 (254.7; 6)	260–267 (263.3; 3)	246–270 (257.6; 18)	255–266 (262.3; 8)	278–285 (280.7; 4)
	(2) 240–270 (34)		246–270 (26)		

* Sexes pooled.

TABLE 2
Measurements (in mm) of South American Tern *Sterna hirundinacea* specimens from southern Brazil.
Data = range (mean; sample size).

	Juvenile	Adults
Culmen	33.75–38.85 (36.2; 13)	35.65–42.2 (38.77; 8)
Tarsus	20.0–23.7 (21.4; 13)	20.0–22.05 (21.08; 12)
Wing	259–285 (273; 11)	259–300 (281; 9)

Rio Grande, Brazil (Appendix). Juvenile South American Terns, which are barred blackish brown on the upperparts and buffish brown on the breast-sides and flanks (Harrison 1991, Hogan *et al.* 2010), are similar in size to Antarctic Terns, but tend to have a longer bill, tarsus and wings; adults are distinctly larger. The two NHMUK specimens have biometrics outwith the lower range of values reported

for South American Tern (*cf.* Table 2).

All three Brazilian Antarctic Tern records were made during the austral winter. For most of the year, the oceanography off the Brazilian coast is dominated by the warm South Equatorial and Brazil Currents, resulting in waters of relatively low biological productivity (Longhurst & Pauly 1987). However, in winter strong southerly winds reach the southern Brazilian coast and, as a result, the cold, nutrient-rich Malvinas/Falkland Current advances over the continental shelf (Garcia 1997). This phenomenon causes an increase in biological productivity and a rapid influx of Antarctic and sub-Antarctic organisms, including seabirds (Murphy 1936, Palacio 1982, Carlos 2009). In the western South Atlantic, migrant Antarctic Terns occur off Argentina (Burger & Gochfeld 1996, Favero & Rodríguez 2005) and may well reach southern Brazil more regularly in the wake of intense cold weather systems.

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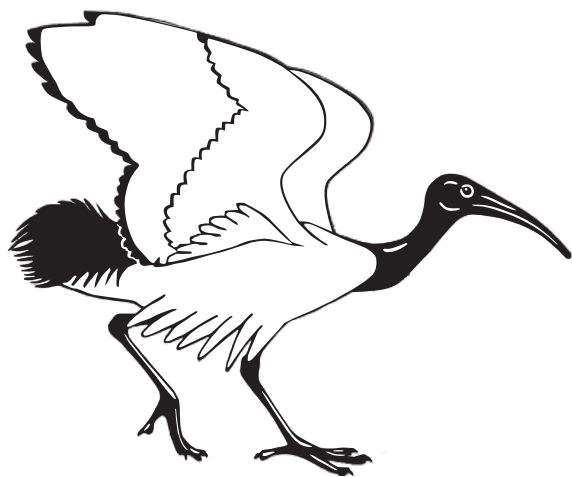
Appendix: List of South America Tern *Sterna hirundinacea* specimens examined in the Coleção de Aves da Universidade Federal do Rio Grande—FURG (CAFURG), Rio Grande, Brazil.

Juveniles—Thirteen unsexed; Brazil, Rio Grande do Sul: Lagoa do Peixe (CAFURG 137), 5/xi/1986; Praia do Cassino (CAFURG 123, 134, 142, 143, 149, 151, 154, 173, 184, 188), xi/1982, 30/vii/1982, unknown date, 19/vii/1984, winter/1984, 19/vii/1984, x–xi/1987, xi/1992, 19/viii/1984, 01/ix/1982; ‘southern Brazil’ (unregistered), unknown date; Uruguay, Rocha: La Paloma (CAFURG 111), 21/x/1986.

Adults—Four males; Brazil, Rio Grande do Sul: São José do Norte (CAFURG 402), 31/vii/2000; Praia do Cassino (CAFURG 040, 144, 150), 17/vi/1983, 17/vi/1983, 17/vi/1983; eight unsexed; Brazil, Espírito Santo: Vila Velha (CAFURG 147), vii/1984; Rio Grande do Sul: Praia do Cassino (CAFURG 140, 145, 152, 153, 181, 187, 458), 13/iv/1984, 27/vi/1982, 05/vii/1982, 28/ix/1987, 19/vii/1984, unknown date, 28/ix/2000.

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Index for Volume 137 (2017)

LIST OF AUTHORS AND CONTENTS

ALONSO-ZARAZAGA, M. A. See DICKINSON, E. C.	
AVENDAÑO, C. See EISERMANN, K.	
AVENDAÑO, J. E. See RENJIFO, L. M.	
BANWELL, A. See LAGERQVIST, M.	
BELTRÃO-MENDES, R. See RUIZ-ESPARZA, J.	
BIRD, J. P. Observation of an all-dark <i>Pseudobulweria</i> petrel in the Bismarck Sea, with a review and discussion of recent records	272
BOCK, W. J. See SCHODDE, R.	
BOMFIM, S. See RUIZ-ESPARZA, J.	
ROYER, F. See CLAESSENS, O.	
BRAMMER, F. P.. See INGELS, J.	
BRETAGNOLLE, V. See SHIRIHAI, H.	
CARLOS, C. J., DAUDT, N. W., VAN GROUW, H. & NEVES, T. The second and third documented records of Antarctic Tern <i>Sterna vittata</i> in Brazil.....	320
CLAESSENS, O., GIRAUD-AUDINE, M., ROYER, F. & SÉNÉCAUX, L. What is the breeding range and breeding season of Pearly-breasted Cuckoo <i>Coccyzus euleri</i> ? New records and breeding in French Guiana	3
COSTA, T. V. V. See INGELS, J.	
CRAIG, A. J. F. K. Blue Cranes <i>Anthropoides paradiseus</i> at Etosha Pan, Namibia: what is the origin of this isolated population?	206
CRISCOULO, A. See RUIZ-ESPARZA, J.	
CROZARIOL, M. A. & NACINOVIC, J. B. A historical Australasian Shoveler <i>Spatula rhynchotis</i> specimen from southern South America.....	312
DAUDT, N. W. See CARLOS, C. J.	
DAUDT, N. W., PEREIRA, A., RECHETELO, J., KRUL, R. & MACEDO MESTRE, L. A. Noteworthy seabird records from Paraná state, southern Brazil.....	195
DAVID, N. See DICKINSON, E. C.	
DEKKERS, W. See VAN GROUW, H.	
DICKINSON, E. C., DAVID, N. & ALONSO-ZARAZAGA, M. A. Some comments on Schodde & Bock (2016) on gender agreement.....	142
DOVE, C. J., SAUCIER, J., WHATTON, J. F., SCHMIDT, B. K. & ROBLE, H. R. First record of River Warbler <i>Locustella fluviatilis</i> and additional records for Plain Nightjar <i>Caprimulgus inornatus</i> and Lesser Masked Weaver <i>Ploceus intermedius</i> in Djibouti.....	67
DREELIN, R. A. See GULSON-CASTILLO, E. R.	
DYER, D. Supposed sympatry of <i>Corapipo</i> manakins in the Tacarcuna region of Colombia, and a comment on <i>Schiffornis</i> : a response to Renjifo <i>et al.</i> (2017).....	315
DYER, D. & VALLELY, A. C. On the female plumage of Glow-throated Hummingbird <i>Selasphorus ardens</i> Salvin, 1870.....	117
EISERMANN, K. See SCHULZ, U.	
EISERMANN, K., AVENDAÑO, C. & MATÍAS, E. Nesting evidence, density and vocalisations in a resident population of Savannah Sparrow <i>Passerculus sandwichensis wetmorei</i> in Guatemala.....	37
EPELBOIN, L. See INGELS, J.	
FERNANDEZ-DUQUE, F. See GULSON-CASTILLO, E. R.	
FERRARI, S. F. See RUIZ-ESPARZA, J.	
FLOOD, R. L. & WILSON, A. C. A New Zealand Storm Petrel <i>Fregetta maoriana</i> off Gau Island, Fiji, in May 2017	278

FLOOD, R. L., WILSON, A. C. & ZUFELT, K. Observations of five little-known tubenoses from Melanesia in January 2017	226
FLÓREZ, P. & KIRWAN, G. M. Yellow-crowned Elaenia <i>Myiopagis flavivertex</i> , new to Colombia	150
FULTON, G. R. Dr William H. James 1852–76: medical doctor and naturalist	71
GIRAUD-AUDINE, M. See CLAESSENS, O.	
GREIG, E. I. See GULSON-CASTILLO, E. R.	
GULSON-CASTILLO, E. R., DREELIN, R. A., FERNANDEZ-DUQUE, F., GREIG, E. I., HITE, J. M., ORZECOWSKI, S. C., SMITH, L. K., WALLACE, R. T. & WINKLER, D. W. Breeding biology during the nestling period at a Black-crowned Pitta <i>Erythropitta ussheri</i> nest	173
HITE, J. M. See GULSON-CASTILLO, E. R.	
HOLYOAK, D. T. See LEE, M.	
INGELS, J., COSTA, T. V. V., BRAMMER, F. P., RUSSELL, D. G. D. & EPELBOIN, L. Clutch size of Blackish Nightjar <i>Nyctipolus nigrescens</i>	135
JACKSON, H. D. Fiery-necked Nightjar <i>Caprimulgus pectoralis</i> development and behaviour from hatching to fledging, including attendant parental care	292
JANSEN, J. J. F. J. See VAN DER VLIET, R. E.	
JANSEN, J. J. F. J. & STEINHEIMER, F. D. The authenticity of 'Iwi <i>Drepanis coccinea</i> (G. Forster, 1781) skins from Cook's third voyage: what taxidermy can add to the discussion	246
JOBLING, J. A. Resolution of a case of secondary homonymy in the genus <i>Sylvia</i> Scopoli, 1769	159
KIRWAN, G. M. See FLÓREZ, P.	
KIRWAN, G. M. See SHIRIHAI, H.	
KRUL, R. See DAUDT, N. W.	
LAGERQVIST, M., BANWELL, A. & MCNEILL, R. First field observation of Karimui Owlet-Nightjar <i>Aegotheles bennettii terborghi</i>	95
LAGERQVIST, M., MCNEILL, R. & BANWELL, A. Vocal comparison between Tabar Pitta <i>Erythropitta splendida</i> and New Britain Pitta <i>E. gazellae</i>	88
LANE, D. F. & PEQUEÑO, T. A new Peruvian locality for Scimitar-winged Piha <i>Lipaugus uropygialis</i> , with the first description of flight display and other natural history notes	161
LEE, M. & HOLYOAK, D. T. 'The chequered history of Chattering Kingfisher <i>Todiramphus tutus</i> on Tahiti': a response	211
MACEDO MESTRE, L. A. See DAUDT, N. W.	
MATÍAS, E. See EISERMANN, K.	
MCNEILL, R. See LAGERQVIST, M.	
MELO, T. N. & SILVA XAVIER, R. First data on breeding ecology of Red-billed Pied Tanager <i>Lamprospiza melanoleuca</i> , including the nest and egg	237
MELO, T. N. & XAVIER, R. S. First nest description for Spot-backed Antwren <i>Herpsilochmus dorsimaculatus</i>	152
MENDONÇA COSTA, J. P. See RUIZ-ESPARZA, J.	
MITCHELL, D. K. First photographs of the endemic Tagula White-eye <i>Zosterops meeki</i> , on Sudest Island (Louisiade Archipelago), Papua New Guinea	156
NACINOVIC, J. B. See CROZARIOL, M. A.	
NEVES, T. See CARLOS, C. J.	
OCAMPO, S. See RENJIFO, L. M.	
ORZECOWSKI, S. C. See GULSON-CASTILLO, E. R.	
PEQUEÑO, T. See LANE, D. F.	
PEREIRA, A. See DAUDT, N. W.	
RECHETELO, J. See DAUDT, N. W.	

RENJIFO, L. M., REPIZO, A., RUIZ-OVALLE, J. M., OCAMPO, S. & AVENDAÑO, J. E. New bird distributional data from Cerro Tacarcuna, with implications for conservation in the Darién highlands of Colombia.....	46
REPIZO, A. See RENJIFO, L. M.	
ROBLE, H. R. See DOVE, C. J.	
ROCHA, P. A. See RUIZ-ESPARZA, J.	
ROOKMAAKER, K. See VAN GROUW, H.	
RUIZ-ESPARZA, D. P. B. See RUIZ-ESPARZA, J.	
RUIZ-ESPARZA, J., MENDONÇA COSTA, J. P., SANTOS, C., RUIZ-ESPARZA, D. P. B., BELTRÃO-MENDES, R. & FERRARI, S. F. Range extension for Buff-fronted Owl <i>Aegolius harrisii</i> in north-east Brazil and a case of <i>Heterochromia iridis</i> in Strigidae.....	91
RUIZ-ESPARZA, J., CRISCOULO, A., ROCHA, P. A., BELTRÃO-MENDES, R., SILVESTRE, S. M., BOMFIM, S., RUIZ-ESPARZA, D. P. B. & FERRARI, S. F. Range extension for Wedge-billed Woodcreeper <i>Glyphorhynchus spirurus cuneatus</i> in north-east Brazil.....	241
RUIZ-OVALLE, J. M. See RENJIFO, L. M.	
RUSSELL, D. G. D. See INGELS, J.	
SANDOVAL, L. Nest and eggs of the southern Central American endemic Tawny-chested Flycatcher <i>Aphanotriccus capitalis</i>	317
SANTOS, C. See RUIZ-ESPARZA, J.	
SAUCIER, J. See DOVE, C. J.	
SCHMIDT, B. K. See DOVE, C. J.	
SCHODDE, R. & BOCK, W. J. Interpreting Article 31.2.2 of the Code, <i>Tanagra bresilia</i> Linnaeus, and gender agreement—a response to Dickinson <i>et al.</i> (2017) towards more positive outcomes.....	145
SCHULZ, U. & EISERMANN, K. Morphometric differentiation between subspecies of Resplendent Quetzal (<i>Pharomachrus mocinno mocinno</i> and <i>P. m. costaricensis</i>) based on uppertail-coverts.....	287
SCHWEIZER, M. See SHIRIHAI, H.	
SÉNÉCAUX, L. See CLAESSENS, O.	
SHIRIHAI, H., SCHWEIZER, M., KIRWAN, G. M. & BRETAGNOLLE, V. The type of Rapa Shearwater <i>Puffinus (newelli?) myrtae</i> from the Austral Islands, Polynesia, with remarks on the morphological variation of the taxon.....	127
SILVA XAVIER, R. See MELO, T. N.	
SILVESTRE, S. M. See RUIZ-ESPARZA, J.	
SMITH, L. K. See GULSON-CASTILLO, E. R.	
STEINHEIMER, F. D. See JANSEN, J. J. F. J.	
VALLELY, A. C. See DYER, D.	
VAN DER VLIET, R. E. & JANSEN, J. J. F. J. Reply to Lee & Holyoak: how definite are 20th-century reports of Chattering Kingfisher <i>Todiramphus tutus</i> from Tahiti?.....	218
VAN GROUW, H. See CARLOS, C. J.	
VAN GROUW, H. The dark side of birds: melanism—facts and fiction.....	12
VAN GROUW, H., DEKKERS, W. & ROOKMAAKER, K. On Temminck's tailless Ceylon Junglefowl, and how Darwin denied their existence.....	261
WALLACE, R. T. See GULSON-CASTILLO, E. R.	
WELLS, D. R. <i>Zosterops</i> white-eyes in continental South-East Asia. 1: proposed refinements to the regional definition of Oriental White-eye <i>Z. palpebrosus</i>	100
WELLS, D. R. <i>Zosterops</i> white-eyes in continental South-East Asia. 2: what is <i>Zosterops auriventer</i> Hume?.....	110
WHATTON, J. F. See DOVE, C. J.	

WILSON, A. C. See FLOOD, R. L.

WINKLER, D. W. See GULSON-CASTILLO, E. R.

XAVIER, R. S. See MELO, T. N.

ZUFELT, K. See FLOOD, R. L.

CORRECTIONS TO TEXT

Page 13	line 33	<i>Monarcha</i> not <i>Monarch</i>
Page 60	Figure 8	<i>Eubucco bourcierii</i> not <i>Eubucco bourcieri</i>
Page 60	Figure 8	<i>Crypturellus kerriae</i> not <i>Crypturelus kerriae</i>
Page 64	line 33	<i>Eubucco bourcierii</i> not <i>Eubucco bourcieri</i>
Page 65	line 12	<i>Glyphorhynchus spirurus</i> not <i>Glyphorhynchus spirurus</i>
Page 201	line 22	<i>Stercorarius antarcticus</i> not <i>Stercorarius antarticus</i>

INDEX TO SCIENTIFIC NAMES

All generic and specific names (of birds only) are indexed. New specific and subspecific names are indexed in bold print under generic, specific and subspecific names. Illustrations and figures are numbered in italics.

- [atriceps] atrifrons, *Zosterops* 156
 (brevipes) magnificens, *Pterodroma* 230, 231
 (cervicalis) cervicalis, *Pterodroma* 226
 (cervicalis) occulta, *Pterodroma* 226, 231, 232
 (newelli?) myrtae, *Puffinus* 127–134, 130, 131
 (palpebrosus) 'auriventer' (=erwini), *Zosterops* 104
abyssinica, *Sylvia* 159
abyssinicus, *Lioptilus* 159
Acrocephalus 221
Acrocephalus caffer 216, 256
Actitis hypoleucos 81
aculavidus, *Thalasseus* 201
Aegolius harrisi 91–93, 91, 92
Aegotheles affinis 95
Aegotheles albertsi 96
Aegotheles bennetti 81
Aegotheles bennettii 95–99, 96–98
Aegotheles insignis 96
aequatorialis, *Androdon* 64
aequinoctialis, *Procellaria* 198, 320
affinis, *Aegotheles* 95
affinis, *Columba* 13, 18
afraoides, *Eupodotis* 207
alba, *Gygis* 256
alba, *Motacilla* 22
albertsi, *Aegotheles* 96
albertsii, *Goura* 80
albicilla, *Todiramphus* 220
albicollis, *Nyctidromus* 135, 136
albicollis, *Pseudastur* 64
albobrunneus, *Campylorhynchus* 65
albolineatus, *Lepidocolaptes* 239
alboscapulatus, *Malurus* 82
albus, *Chionis* 196, 201, 202
Alcedo meninting 220
Alcedo sacra 211
Alcedo tuta 211
Alcedo venerata 211
alcinus, *Macheiramphus* 81
Alcyon lessoni 81
Alcyon pusilla 81
alecto, *Myiagra* 82
Alectoris chukar 32
Alectoris rufa 13, 31
Alopecoenas jobiensis 80
altera, *Corapipo* 55, 315
aluco, *Strix* 13, 25
aluco, *Syrnium* 23, 24
Amazilia tzacatl 64
Amazona farinosa 64
ambiguus, *Ramphastos* 64
americanus, *Coccyzus* 9
Anabacerthia variegaticeps 46, 54, 65
analisis, *Formicarius* 52, 65
Anas cayennensis 312, 313
Anas clypeata 314
Anas platalea 312, 313
Anas platyrhynchos 32, 33
Anas rhynchotis 313
Androdon aequatorialis 64
angolensis, *Pitta* 188
Anisognathus somptuosus 164
anneae, *Euphonia* 57, 60, 66
Anous 232
Anser caerulescens 21, 28
antarcticus, *Stercorarius* 196, 201
Anthropoides paradiseus 206–210
Aphanotriccus capitalis 317–319, 318
Aplonis metallica 82
aquaticus, *Rallus* 20
aquila, *Eutoxeres* 64
Ara chloropterus 64
arcae, *Bangsia* 57, 60, 65
ardens, *Selasphorus* 117–126, 120, 121
Ardetta neoxena 13
Arremon brunneinucha 58, 66
Arremon castaneiceps 59
Arremon crassirostris 46, 58, 59
Arses telescopthalmus 82
aruensis, *Geoffroyus* 81
assimilis, *Puffinus* 127, 129, 130, 132, 133
ater, *Manucodia* 82
aterrima, *Pseudobulweria* 229
aterrimum, *Dicaeum* 13
atra, *Manucodia* 82
atratus, *Eudytes* 13
atricapilla, *Sylvia* 21, 23
atricapilla, *Zosterops* 102, 114
atricapillus, *Herpsilochmus* 152
atrinucha, *Thamnophilus* 64
atro-rufa, *Perdix* 13
aucklandica, *Coenocorypha* 13
Aulacorhynchus coeruleinctis 162
Aulacorhynchus prasinus 60, 64
aureiventer [sic], *Zosterops* 101
aureliae, *Haplophaedia* 60, 64
auricularis, *Puffinus* 127, 133
auriventer, *Zosterops* 100, 101, 110–116, 112, 113
aurorae, *Ducula* 216
australis, *Gallirallus* 13, 21, 24
australis, *Ocydromus* 24
Aviceda subcristata 81
axillaris, *Herpsilochmus* 152
azureus, *Ceyx* 81
Balearica regulorum 206
Bangsia arcae 57, 60, 65
bankiva, *Gallus* 266
Baryphthengus ruficapillus 64
Basileuterus ignotus 60
Basileuterus tristriatus 59, 60, 61, 66
baudii, *Hydromis* 184
Baza reindwardti 81
becki, *Pseudobulweria* 226, 227, 272
belcheri, *Pachyptila* 198, 202
bella, *Goethalsia* 60
bellulus, *Margarornis* 46, 54, 60, 65
bennetti, *Aegotheles* 81
bennettii, *Aegotheles* 95–99, 96, 97
Berenicornis comatus 185
bicolor, *Dendrocygna* 312

- bicolor, *Gymnopathys* 64
 bonapartei, *Coeligena* 144
 bonapartii, *Todopsis* 82
 bonasia, *Tetrastes* 13, 32
 borealis, *Calonectris* 196, 198, 199
 bourcierii, *Eubucco* 50, 60, 64
Brachygalba salmoni 60
Brachyramphus marmoratus 256
 bresilia, *Tanagra* 145–149
 bresilia, *Tangara* 143
 bresilica, *Merula* 147
 bresilius, *Ramphocelus* 143, 147
 brevipes, *Pterodroma* 230, 231, 274, 283
 brevirostris, *Rhynchocyclus* 60
 brunneinucha, *Arremon* 58, 66
 brunnescens, *Premnoplex* 60
 bryani, *Puffinus* 133
Bucco noanamae 60
Bugeranus carunculatus 206
Bulweria 229, 273
Bulweria fallax 229
bulwerii, *Pseudobulweria* 229
Buteo jamaicensis 24
Butorides javanica 81
Butorides striata 81
 caerulea, *Hydromis* 173
 caerulescens, *Anser* 21, 28
 caffer, *Acrocephalus* 216, 256
 callopterus, *Piculus* 60
Calonectris 196
Calonectris borealis 196, 198, 199
Calonectris sp. 199
Calornis viridescens 82
 camelus, *Struthio* 207
Campylorhamphus pusillus 54, 65
Campylorhynchus albobrunneus 65
 canadensis, *Caryothraustes* 60
 caniceps, *Myiopagis* 60
 capense, *Daption* 320
 capensis, *Phalacrocorax* 256
 capensis, *Turnagra* 256
 capicola, *Streptopelia* 144
 capitalis, *Aphanotriccus* 317–319, 318
Caprimulgus europaeus 308
Caprimulgus inornatus 67–70, 68
Caprimulgus macrurus 81
Caprimulgus nigrescens 135
Caprimulgus pectoralis 292–311, 294, 295, 297, 298, 300–302, 305, 306
Carpophaga muelleri 80
Carpophaga pinon 80
carunculatus, *Bugeranus* 206
Caryothraustes canadensis 60
 cassicus, *Cracticus* 82
 cassinii, *Mitrospingus* 239
 cassini, *Psarocolius* 60
 castanea, *Ortyx* 24
 castaneiceps, *Arremon* 59
 castaneiceps, *Lysurus* 60
 castaneiventris, *Monarcha* 13, 16
 castaneus, *Ortyx* 13, 23
Catharus fuscater 59, 60, 65
 cauta, *Thalassarche* 196, 202, 203
 cayana, *Piaya* 64
 cayennen[sis], *Anas* 312, 313
Centropus epomidis 13
Centropus menbeki 81
Centropus menebeki 81
Centropus phasianinus 81
Centropus senegalensis 13, 27
Centropus spilopterus 81
Cephenemyia phobifera 142
Certhia coccinea 246
Certhia rubra 250
 cervicalis, *Cyclopsittacus* 81
 cervicalis, *Pterodroma* (cervicalis) 226
Ceyx azureus 81
Ceyx pusilla 81
Chalcophaps chrysochlora 80
Chalcophaps indica 80
Chalybura urochrysa 64
 cherriei, *Thripophaga* 150
 chinensis, *Synoiacus* 32, 34
Chionis albus 196, 201, 202
Chirocylla 169
 chloricterus, *Orthogonyx* 239
 chloris, *Todiramphus* 81, 84, 211, 220
Chlorophonia flavirostris 60
Chloropungus flavigularis 46
 chloropterus, *Ara* 64
 chlororhynchus, *Thalassarche* 197
Chlorospingus flavigularis 50, 57–59, 66
Chlorospingus inornatus 60
Chlorospingus tacarcunae 57, 60, 66
 chocoensis, *Scytalopus* 51, 52, 53, 60, 66
Chroicocephalus novaehollandiae 73
 chrysochlora, *Chalcophaps* 80
Chrysococcyx lucidus 81
 chrysogaster, *Ptilinopus* 212
 chrysomelas, *Chrysothlypis* 56, 60, 66
Chrysothlypis chrysomelas 56, 60, 66
 chukar, *Alectoris* 32
Ciccaba virgata 64
 cinctus, *Rhynchortyx* 63
 cinereum, *Malacopteron* 186
Cinnyris frenatus 82
Cinnyris jugularis 82
Circus pygargus 15
Cisticola exilis 82
Cisticola rufiges 82
 clarkii, *Megascops* 46, 49, 60, 64
 climacocerca, *Hydropsalis* 135
 clypeata, *Anas* 314
 clypeata, *Spatula* 312
Cnemotriccus fuscatus 317
Cnipodectes 170
 coccinea, *Certhia* 246
 coccinea, *Drepanis* 246–260, 247–254, 256, 257
Coccyzus 9
Coccyzus americanus 9
Coccyzus euleri 3–11, 4, 6, 8
Coccyzus melacoryphus 4
 coelebs, *Fringilla* 21
Coeligena bonapartei 144
Coenocorypha aucklandica 13
Coereba flaveola 13, 15, 21, 66
 coeruleicinctis, *Aulacorhynchus* 162
 colchicus, *Phasianus* 21, 28
Colinus virginianus 13, 24, 28
 collaris, *Melidora* 79, 81, 84
 collaris, *Trogon* 60
Colluricincla harmonica 73, 80

- Colluricincla superciliosa 73, 79, 80
 colombica, Thalurania 64
 coloratus, Myadestes 46, 50, 55, 56, 65
 Columba affinis 13, 18
 Columba livia 13, 15, 16, 17, 18, 26
 Columba palumbus 15, 17
 Columbina minuta 136
 Columbina passerina 136
 Colymbus dominicus 143
 comatus, Berenicornis 185
 Contopus fumigatus 65
 Cookilaria 231
 Coracina melas 82
 Corapipo altera 55, 315
 Corapipo leucorroha 50, 55, 65, 315
 corone, Corvus 15, 18
 Corone orru 82
 coronulatus, Ptilonopus 80
 Corvus corone 15, 18
 Corvus orru 83
 cotinga, Cotinga 4
 Cotinga cotinga 4
 coturnix, Coturnix 13, 16, 18
 Coturnix coturnix 13, 16, 18
 Coturnix japonicus 14
 Cracticus cassicus 82
 Cracticus mentalis 82
 Cranioleuca erythrops 54, 65
 Craspedophora magnifica 80
 crassirostris, Arremon 46, 58, 59
 crassirostris, Lysurus 60
 Crax rubra 63
 cristatus, Oxyruncus 60
 cristatus, Pandion 81
 cristatus, Pavo 13, 31, 33
 cryptolophus, Snowornis 168, 170
 Cryptopipo holochlora 57, 65
 Crypturellus soui 63
 Crypturellus kerriae 60
 Cubanensis, Ortyx 23
 cyanicterus, Cyanicterus 4
 Cyanicterus cyanicterus 4
 cyanocephala, Eudynamis 81
 cyanocephalus, Malurus 82
 cyanoptera, Spatula 312
 cyanopus, Numenius 81
 Cyanoramphus novaezelandiae 256
 Cyanoramphus ulietanus 212, 256
 Cyanoramphus zealandicus 212
 Cyclopsittacus cervicalis 81
 Cyornis ruficauda 114
 Cyphorhinus phaeocephalus 65
 Cypsnagra 239
 Dacelo gaudichaud 81
 Dacelo gaudichaudi 81
 Dacelo intermedius 81
 Dacnis viguieri 60
 Daption capense 320
 Deconychura longicauda 65
 Dendrocincla fuliginosa 65
 Dendrocopos major 15
 Dendrocygna bicolor 312
 dialeucos, Odontophorus 60
 Dicaeum aterrimum 13
 Diomedea 320
 discors, Spatula 312
 divinus, Todiramphus 213, 215
 dominicanus, Larus 196, 201
 dominica, Tangara 143
 dominicus, Colymbus 143
 dominicus, Dulus 143
 dominicus, Tachybaptus 143
 dorsimaculatus, Herpsilochmus 152–155, 153
 Drepanis coccinea 246–260, 247, 248–254, 256, 257
 Ducula aurorae 216
 Ducula galeata 216
 dugandi, Herpsilochmus 152, 154
 Dulus dominicus 143
 dumontii, Eulabes 82
 Dysithamnus mentalis 64
 Dysithamnus puncticeps 51, 64
 ecaudatus, Gallus 261–271, 263, 264
 ecaudatus, Phasianus 270
 Edoliosoma melas 82
 Egretta novaehollandiae 73
 Egretta sacra 24
 Electron platyrhynchus 64
 elegans, Puffinus 129
 elliotii, Hydromis 189
 epomidis, Centropus 13
 epops, Upupa 15
 erythrogaster, Erythropitta 88, 187
 Erythropitta 173
 Erythropitta erythrogaster 88, 187
 Erythropitta gazellae 88, 89, 188
 Erythropitta granatina 173
 Erythropitta kochi 187
 Erythropitta macklotii 188
 Erythropitta novaehibernicae 88
 Erythropitta splendida 88–90, 89
 Erythropitta ussheri 173–194, 176, 179–185
 erythrops, Cranioleuca 54, 65
 erythropygius, Xiphorhynchus 54, 65
 Erythrura trichroa 146
 Eubucco bourcierii 50, 60, 64
 Eudynamis cyanocephala 81
 Eudyptes atratus 13
 Eudyptes pachyrhynchus 13
 Eulabes dumontii 82
 euleri, Coccyzus 3–11, 4, 6, 8
 euleri, Lathrotriccus 150, 317
 Euphonia anneae 57, 60, 66
 Eupodotis afraoides 207
 europaeus, Caprimulgus 308
 Eutoxeres aquila 64
 everetti, Zosterops 111, 113, 114, 115
 exilis, Ixobrychus 13
 exsul, Poliocrania 64
 fallax, Bulweria 229
 farinosa, Amazona 64
 ferruginea, Rectes 82
 flammula, Selasphorus 117, 119, 121, 122, 124
 flava, Piranga 58, 66
 flaveola, Coereba 13, 15, 21, 66
 flavicollis, Hemithraupis 60
 flavigularis, Chlorospingus 46
 flavigularis, Chlorospingus 50, 57–59, 66
 flavirostris, Chlorophonia 60
 flavirostris, Grallaria 60
 flavivertex, Myiopagis 150–151
 flavovirens, Phylloscartes 60
 flavus, Xanthopsar 313

- florida, Tangara 57, 65
 fluviatilis, Locustella 67–70, 68
 Formicarius analis 52, 65
 Formicarius nigricapillus 46, 51, 52, 65
 Fregata 232
 Fregata magnificens 196, 199, 200
 Fregetta grallaria 281, 282
 Fregetta maoriana 278–286, 279, 283, 284
 Fregetta tropica 282
 frenatus, Cinnerys 82
 Fringilla coelebs 21
 fucosa, Tangara 60, 65
 fuliginosa, Dendrocincla 65
 fuliginosa, Nesofregetta 275
 fuliginosa, Rhipidura 13, 15
 Fulmarus glacialis 20
 Fulmarus glacialoides 198
 fulvicauda, Myiophlyptis 66
 fumigatus, Contopus 65
 fumigatus, Picoides 64
 fuscater, Catharus 59, 60, 65
 fuscatus, Cnemotriccus 317
 fuscocinereus, Lipaugus 168, 169, 170
 fuscus, Gallirallus 13, 24
 fuscus, Perdix 12
 gaimardii, Myiopagis 150
 galatea, Tanysiptera 84
 galbula, Ploceus 68
 galeata, Ducula 216
 gallinago, Gallinago 13, 20
 Gallinago gallinago 13, 20
 Gallinago huegeli 13
 Gallirallus australis 13, 21, 24
 Gallirallus fuscus 13, 24
 Gallirallus philippensis 13
 Gallus bankiva 266
 Gallus ecaudatus 261–271, 263, 264
 gallus, Gallus 261, 266, 267, 271
 Gallus gallus 261, 266, 267, 271
 Gallus lafayetii 261, 266
 Gallus lafayettii 265, 267, 268, 270, 271
 Gallus lineatus 261, 271
 gallus, Phasianus 261
 Gallus sonnerati 271
 Gallus stanleyi 261, 267, 268, 270, 271
 Gallus varius 270, 271
 gaudichaudi, Dacelo 81
 gazellae, Erythropitta 88, 89, 188
 gentryi, Herpsilochmus 152
 geoffroyi, Geoffroyus 81
 Geoffroyius aruensis 81
 Geoffroyus geoffroyi 81
 Geokichla interpres 114
 Geotrygon goldmani 49, 60, 64
 Geotrygon lawrencii 60
 Geotrygon violacea 49, 64
 giganteus, Macronectes 198
 girrenera, Haliastur 81
 glacialis, Fulmarus 20
 glacialoides, Fulmarus 198
 Glyciphila modesta 82
 Glyphorhynchus spirurus 65, 241, 242, 241–243
 Goethalsia bella 60
 Goldmania violiceps 46, 50, 60, 64
 goldmani, Geotrygon 49, 60, 64
 Goura albertisii 80
 Goura scheepmakeri 80
 grallaria, Fregetta 281, 282
 Grallaricula flaviviridis 60
 granatina, Erythropitta 173
 gravis, Puffinus 199
 griseicapillus, Sittasomus 57, 65
 griseipectus, Lathrotriccus 317
 griseiventris, Tetrastes 13
 griseotinctus, Zosterops 156
 griseus, Puffinus 199, 202
 guianensis, Polioptila 4
 gurneyi, Hydromis 173
 guttata, Tangara 57, 65
 guttatus, Passerculus 37
 guy, Phaethornis 59, 64
 Gygis alba 256
 Gymnophis bicolor 64
 Gymnophis leucaspis 51
 gyrola, Tangara 57, 65
 Habia 239
 haematodus, Trichoglossus 81
 Haematopus unicolor 21
 Hafferia zeledoni 64
 Halcyon sanctus 81
 Haliaeetus leucogaster 73, 81, 235
 Haliaeetus sanfordi 235
 Haliaeetus leucogaster 81
 Haliastur girrenera 81
 Haliastur indus 81
 Haplophaedia aureliae 60, 64
 harmonica, Colluricincla 73, 80
 harrisii, Aegolius 91, 92, 91–93
 heinrothi, Puffinus 226, 233–235, 273
 Heliodoxa jacula 64
 heliosylos, Tigrisoma 81
 helvetica, Squatarola 81
 Hemithraupis flavicollis 60
 Henicorhina leucophrys 65
 Henicorhina leucosticta 65
 Herpsilochmus atricapillus 152
 Herpsilochmus axillaris 152
 Herpsilochmus dorsimaculatus 152–155, 153
 Herpsilochmus dugandi 152, 154
 Herpsilochmus gentryi 152
 Herpsilochmus longirostris 152, 154
 Herpsilochmus parkeri 152
 Herpsilochmus pectoralis 152
 Herpsilochmus sellowi 152, 153
 Herpsilochmus sticturus 152
 Heterophasia picaoides 144
 hirundinacea, Sterna 201, 320, 323, 324
 holochlora, Cryptopipo 57, 65
 huegeli, Gallinago 13
 Hydropsalis climacocerca 135
 Hydromis 173
 Hydromis baudii 184
 Hydromis caerulea 173
 Hydromis elliotii 189
 Hydromis gurneyi 173
 Hydromis nipalensis 188
 Hydromis phayrei 191
 Hydromis soror 189
 hypoleucos, Actitis 81
 hypoleucus, Actitis 81
 icterocephala, Tangara 57, 65
 ignotus, Basileuterus 60

- indica*, *Chalcophaps* 80
indus, *Haliastur* 81
inepta, *Megacrex* 81
inornatus, *Caprimulgus* 67–70
inornatus, *Chlorospingus* 60
insignis, *Aegotheles* 96
intermedius, *Dacelo* 81
intermedius, *Ploceus* 67–70, 69
interpres, *Geokichla* 114
iris, *Pitta* 173
Ixobrychus exilis 13
jacula, *Heliodoxa* 64
jamaicensis, *Buteo* 24
jamesii, *Phonygamma* 80
jamesii, *Phonygamus* 79
japonicus, *Coturnix* 14
javanica, *Butorides* 81
jobiensis, *Alopecoenas* 80
jobiensis, *Phlogaenas* 80
jocosus, *Pycnonotus* 190
jugularis, *Cinnyris* 82
keraudrenii, *Phonygamus* 79, 80
kerriae, *Crypturellus* 60
kochi, *Erythropitta* 187
lafayettei, *Gallus* 261, 266
lafayettei, *Gallus* 265, 267, 268, 270, 271
lagopus, *Lagopus* 33
Lagopus lagopus 33
Lagopus sp. 32, 34
Lamprococyx lucidus 81
Lamprospiza melanoleuca 237–240, 238
lanioides, *Lipaugus* 168, 170
Larus dominicanus 196, 201
Lathrotricus euleri 150, 317
Lathrotricus griseipectus 317
lawrencii, *Geotrygon* 60
leachii, *Dacelo* 81
Legatus leucophaeus 55
Lepidocolaptes albolineatus 239
Lepidocolaptes souleyetii 65
lessoni, *Alcyon* 81
leucaspis, *Gymnopathys* 51
leucocephalus, *Pandion* 81
leucogaster, *Haliaeetus* 73, 81, 235
leucogaster, *Haliaeetus* 81
leucogaster, *Sula* 196, 200
leucophaeus, *Legatus* 55
leucophrys, *Henicorhina* 65
leucoptera, *Pterodroma* 274
leucorrhoa, *Corapipo* 50, 55, 65, 315
leucosticta, *Henicorhina* 65
lherminieri, *Puffinus* 133
lineatus, *Gallus* 261, 271
Lioptilus 159
Lioptilus abyssinicus 159
Lipaugus fuscocinereus 168, 169, 170
Lipaugus lanioides 168, 170
Lipaugus uropygialis 161–172, 162, 164–166, 168
Lipaugus vociferans 165, 168, 169
Lipaugus weberi 170
livia, *Columba* 13, 15, 16, 17, 18, 26
Lobospingus sigillifer 146
Lochmias nematura 60
Locustella fluviatilis 67–70, 68
Locustella luscinioides 68
lodoisiae, *Syncoicus* 13, 20
longicauda, *Deconychura* 65
longirostris, *Herpsilochmus* 152, 154
Lophorina magnificus 73, 80
Lophotriccus pileatus 57, 65
lucidus, *Chrysococcyx* 81
lucidus, *Lamprococyx* 81
lugens, *Oenanthe* 27
Lurocalis 135
luscinioides, *Locustella* 68
Lyrurus tetrix 32, 33, 34–36
Lysurus castaneiceps 60
Lysurus crassirostris 60
macgillivrayi, *Pseudobulweria* 229, 273, 274
Macheiramphus alcinus 81
macklotii, *Erythropitta* 188
Macronectes 320
Macronectes giganteus 198
macrorrhina, *Melidora* 220
macurus, *Caprimulgus* 81
madagascariensis, *Numenius* 81
magellanicus, *Spheniscus* 196, 197
magnifica, *Craspedophora* 80
magnificens, *Fregata* 196, 199, 200
magnificens, *Pterodroma (brevipes)* 226, 230, 231
magnificus, *Lophorina* 73, 80
major, *Dendrocopos* 15
major, *Parus* 22
Malacopteron cinereum 186
Malurus albocapulatus 82
Malurus cyanocephalus 82
Manucodia ater 82
Manucodia atra 82
maoriana, *Fregata* 278–286, 279, 283, 284
Margarornis bellulus 46, 54, 60, 65
marginatus, *Microcerculus* 65
marmoratus, *Brachyramphus* 256
massena, *Trichoglossus* 81
massena, *Trogon* 64
mcleanani, *Phaenostictus* 51, 65
meeki, *Zosterops* 156, 156–158, 157
Megacrex inepta 81
Megapodius reinwardt 73
megarhyncha, *Pitta* 191
Megascops clarkii 46, 49, 60, 64
melacoryphus, *Coccyzus* 4
melanoleuca, *Lamprospiza* 237–240, 238
melanophris, *Thalassarche* 198
melanopterus, *Porphyrion* 81
melanotus, *Porphyrion* 81
melanura, *Pachycephala* 74, 80
melanura, *Rhipidura* 13
melas, *Coracina* 82
melas, *Edoliosoma* 82
meleagris, *Numida* 299
Melidora collaris 79, 81, 84
Melidora macrorrhina 220
menbeki, *Centropus* 81
menebeki, *Centropus* 81
meninting, *Alcedo* 220
mentalis, *Cracticus* 82
mentalis, *Dysithamnus* 64
Merula bresilica 147
metallica, *Aplonis* 82
michleri, *Pittasoma* 60
Microcerculus marginatus 65
microrhyncha, *Tanyptera* 79, 81, 84

- miniatus, Myioborus 57, 66
 Mino dumontii 82
 minuta, Columbina 136
 minutus, Xenops 65
 Mionectes olivaceus 65
 Mitrephanes phaeocercus 65, 318
 Mitrospingus cassinii 239
 Mitrospingus oleagineus 239
 mocinno, Pharomachrus 287–291, 288, 289
 modesta, Glyciphila 82
 modestus, Ramsayornis 82
 Moho nobilis 256
 moluccensis, Pitta 188
 Monarcha castaneiventris 13, 16
 Monarcha ugiensis 13
 montana, Perdix 12, 13, 17
 Morphnarchus princeps 49, 64
 Motacilla alba 22
 muelleri, Carpophaga 80
 mullerii, Ducula 80
 Myadestes coloratus 46, 50, 55, 56, 65
 Myiagra alecto 82
 Myiarchus tuberculifer 65
 Myioborus miniatus 57, 66
 Myiopagis caniceps 60
 Myiopagis flavivertex 150–151
 Myiopagis gaimardii 150
 Myiothlypis fulvicauda 66
 Myrmeciza zeledoni 51
 Myrmotherula 153
 Myrmotherula schisticolor 57, 64
 myrtae, Puffinus 127–134
 mystaceus, Platyrinchus 65
 nativitatis, Puffinus 132
 nematura, Lochmias 60
 Neothraupis 239
 neoxena, Ardetta 13
 Nesofregatta fuliginosa 275
 newelli, Puffinus 127, 133
 nigra, Pomarea 256
 nigrescens, Caprimulgus 135
 nigrescens, Nyctipolus 135, 135–141, 138, 139
 nigricans, Ocydromus 24
 nigricapillus, Formicarius 46, 51, 52, 65
 nigripennis, Pavo 13, 31
 nigripennis, Pterodroma 133
 nigrirostris, Patagioenas 64
 Ninox theomacha 95
 nipalensis, Hydromis 188
 nitidus, Piezorhynchus 82
 noanamae, Bucco 60
 nobilis, Moho 256
 novaeguineae, Pitta 82
 novaehibernicae, Erythropitta 88
 novaehollandiae, Chroicocephalus 73
 novaehollandiae, Egretta 73
 novaehollandiae, Recurvirostra 144
 novaeseelandiae, Prosthemadera 256
 novaeselandiae, Cyanoramphus 256
 Numenius cyanopus 81
 Numenius madagascariensis 81
 Numenius tahitiensis 254
 Numida meleagris 299
 Nyctidromus albigollis 135, 136
 Nyctipolus nigrescens 135, 135–141, 138, 139
 nympa, Pitta 173
 obscurus, Pyrocephalus 13
 occulta 231
 occulta, Pterodroma 274
 occulta, Pterodroma (cervicalis) 226, 231, 232
 oceanicus, Oceanites 279, 320
 Oceanites oceanicus 279, 320
 ocellatus, Podargus 96
 ochraceus, Troglodytes 46, 55, 56, 60, 65
 Ocydromus australis 24
 Ocydromus nigricans 24
 Odontophorus dialeucos 60
 Oenanthe lugens 27
 Oestrus phobifer 142
 oleagineus, Mitrospingus 239
 olivaceus, Mionectes 65
 olivaceus, Picumnus 64
 opisthomelas, Puffinus 133
 orientalis, Eudynamis 81
 Oriolus striatus 82
 Oriolus szalayi 82
 orru, Corone 82
 orru, Corvus 83
 Orthogonys chloricterus 239
 Ortyx castanea 24
 Ortyx castaneus 13, 23
 Ortyx Cubanensis 23
 Ortyx Virginianus 23
 Oxyruncus cristatus 60
 Pachycephala melanura 74, 80
 Pachycephala robusta 74, 79, 80
 Pachycephala sp. 82
 Pachyptila 320
 Pachyptila belcheri 198, 202
 Pachyptila vittata 202
 pachyrhynchus, Eudytes 13
 palpebrosa [sic], Zosterops 101
 palpebrosus, Zosterops 100–110, 107, 112, 114
 palumbus, Columba 15, 17
 panamensis, Scytalopus 46, 51–53, 60, 65, 66
 Pandion cristatus 81
 Pandion leucocephalus 81
 papuensis, Podargus 96
 paradisaea, Sterna 320
 Paradisaea raggiana 82
 Paradisea raggiana 82
 paradiseus, Anthropoides 206–210
 parasiticus, Stercorarius 21
 Parisoma 159
 Parisoma subcaeruleum 159
 parkeri, Herpsilochmus 152
 Parula pitiayumi 312
 Parus major 22
 Passerculus guttatus 37
 Passerculus rostratus 37
 Passerculus sanctorum 37
 Passerculus sandwichensis 37–45, 39, 40, 42, 43
 passerina, Columba 136
 Patagioenas nigrirostris 64
 Pavo cristatus 13, 31, 33
 Pavo nigripennis 13, 31
 pectoralis, Caprimulgus 292–311, 294, 295, 297, 298, 300–302, 305, 306
 pectoralis, Herpsilochmus 152
 Penelope purpurascens 63
 Perdix atro-rufa 13
 Perdix fuscus 12

- Perdix montana* 12, 13, 17
perdix, *Perdix* 12, 13, 17
Perdix perdix 12, 13, 17
peruviana, *Vini* 216, 222, 256
Phaenostictus mcleannani 51, 65
phaeocephalus, *Cyphorhinus* 65
phaeocercus, *Mitrephanes* 65, 318
Phaethornis guy 59, 64
Phaethornis striigularis 64
Phalacrocorax capensis 256
Pharomachrus mocinno 287–291, 288, 289
phasianinus, *Centropus* 81
Phasianus colchicus 21, 28
Phasianus ecaudatus 270
Phasianus gallus 261
phayrei, *Hydromis* 191
Pheugopedius spadix 65
Philentoma velata 102
philippensis, *Gallirallus* 13
Phlogaenas jobiensis 80
phobifera, *Cephenemyia* 142
phobifer, *Oestrus* 142
Phoenicircus 170
Phonygamma jamesii 80
Phonygammus jamesii 79
Phonygammus keraudrenii 79, 80
Phylloscartes flavovirens 60
Phylloscartes supercilialis 54, 60, 65
Piaya cayana 64
picaoides, *Heterophasia* 144
pica, *Pica* 15
Pica pica 15
Picoides fumigatus 64
Piculus callopterus 60
Picumnus olivaceus 64
Piezorhynchus nitidus 82
pileatus, *Lophotriccus* 65
pinon, *Carpophaga* 80
pinon, *Ducula* 80
Piranga flava 58, 66
pitiayumi, *Parula* 312
Pitta 173
Pitta angolensis 188
Pitta iris 173
Pitta megarhyncha 191
Pitta moluccensis 188
Pitta novaeguineae 82
Pitta nympha 173
Pitta reichenowi 191
Pitta sordida 82, 187
Pitta superba 187
Pitta versicolor 187
Pittasoma michleri 60
platalea, *Anas* 312, 313
platalea, *Spatula* 312
platyrhynchos, *Anas* 32, 33
platyrhynchum, *Electron* 64
Platyrinchus mystaceus 65
plicatus, *Rhyticeros* 82
Ploceus galbula 68
Ploceus intermedius 67–70, 69
Pluvialis squatarola 81
Podargus ocellatus 96
Podargus papuensis 96
Poliocrania exsul 64
Polioptila guianensis 4
Pomarea nigra 256
pomarinus, *Stercorarius* 21
Porphyrio melanopterus 81
Porphyrio melanotus 81
prasinus, *Aulacorhynchus* 60, 64
Premnoplex brunnescens 60
princeps, *Morphnarchus* 49, 64
Procellaria aequinoctialis 198, 320
Procellaria sp. 198
Prothemadera novaeseelandiae 256
Psarocolius cassini 60
Pseudastur albicollis 64
Pseudoalcippe 159
Pseudobulweria 228, 229, 230, 272–277
Pseudobulweria aterrima 229
Pseudobulweria becki 226, 227, 272
Pseudobulweria bulwerii 229
Pseudobulweria macgillivrayi 229, 273, 274
Pseudobulweria rostrata 228
Pseudorectes ferrugineus 82
Psittaculirostris desmarestii 81
Pterodroma 229
Pterodroma brevipes 230, 231, 274, 283
Pterodroma (brevipes) magnificens 226, 230, 231
Pterodroma (cervicalis) cervicalis 226
Pterodroma (cervicalis) occulta 226, 231, 232
Pterodroma leucoptera 274
Pterodroma nigripennis 133
Pterodroma occulta 274
Pteroglossus viridis 239
Ptilinopus chrysogaster 212
Ptilinopus purpuratus 212, 221
Ptilonopus coronulatus 80
Puffinus 196
Puffinus assimilis 127, 129, 130, 132, 133
Puffinus auricularis 127, 133
Puffinus bryani 133
Puffinus elegans 129
Puffinus gravis 199
Puffinus griseus 199, 202
Puffinus heinrothi 226, 233–235, 273
Puffinus lherminieri 133
Puffinus myrtae 127–134
Puffinus nativitatis 132
Puffinus newelli 127, 133
Puffinus (newelli?) myrtae 127–134, 130, 131
Puffinus newelli myrtae 130
Puffinus opisthomelas 133
puffinus, *Puffinus* 199
Puffinus puffinus 199
Puffinus sp. 199
puncticeps, *Dysithamnus* 51, 64
punicea, *Xipholena* 4
purpurascens, *Penelope* 63
purpuratus, *Ptilinopus* 212, 221
pusilla, *Alcyon* 81
pusilla, *Ceyx* 81
pusillus, *Campylorhamphus* 54, 65
Pycnonotus jocosus 190
pygargus, *Circus* 15
pyrilia, *Pyrilia* 64
Pyrilia pyrilia 64
Pyrocephalus obscurus 13
Pyrocephalus rubinus 13, 15
radjah, *Tadorna* 80
raggiana, *Paradisaea* 82

- raggiana, *Paradisea* 82
Rallus aquaticus 20
Ramphastos ambiguus 64
Ramphastos vitellinus 239
Ramphocelus bresilius 143, 147
Ramsayornis modestus 82
Rectes ferruginea 82
Recurvirostra novaehollandiae 144
regulorum, *Balearica* 206
reichenowi, *Pitta* 191
reindwardti, *Baza* 81
reinwardt, *Megapodius* 73
Rhipidura fuliginosa 13, 15
Rhipidura melanura 13
Rhynchocyclus brevirostris 60
Rhynchortyx cinctus 63
rhynchotis, *Anas* 313
rhynchotis, *Spatula* 312–314
Rhyticeros plicatus 82
Rhytidoceros ruficollis 82
robusta, *Pachycephala* 74, 79, 80
rostrata, *Pseudobulweria* 228
rostratus, *Passerculus* 37
rubinus, *Pyrocephalus* 13, 15
rubra, *Certhia* 250
rubra, *Crax* 63
rufa, *Alectoris* 13, 31
ruficapillus, *Baryphthengus* 64
ruficauda, *Cyornis* 114
ruficeps, *Cisticola* 82
ruficollis, *Rhytidoceros* 82
rufus, *Trogon* 64
rutilans, *Xenops* 60
sabinii, *Scolopax* 13, 20
sacer, *Todiramphus* 213, 215
sacra, *Alcedo* 211
sacra, *Egretta* 24
salmoni, *Brachygalba* 60
sanctorum, *Passerculus* 37
sanctus, *Halcyon* 81
sanctus, *Todiramphus* 81, 220
sandvicensis, *Thalasseus* 321
sandwichensis, *Passerculus* 37–45, 39, 40, 42, 43
sanfordi, *Haliaeetus* 235
scheepmakeri, *Goura* 80
Schiffornis stenorhyncha 65, 315
Schiffornis veraepacis 59, 60, 315
schisticolor, *Myrmotherula* 57, 64
scintilla, *Selasphorus* 117, 119, 121, 122–125
Scolopax sabinii 13, 20
Scytalopus chocoensis 51, 52, 53, 60, 66
Scytalopus panamensis 46, 51–53, 60, 65, 66
Scytalopus vicini 51, 52, 53, 66
Selasphorus ardens 117–126, 120, 121
Selasphorus flammula 117, 119, 121, 122, 124
Selasphorus scintilla 117, 119, 121, 122–125
Selasphorus simoni 117
Selasphorus torridus 117
sellowi, *Herpsilochmus* 152, 153
senegalensis, *Centropus* 13, 27
setifrons, *Xenornis* 60
sharppei, *Stictolimnas* 13, 23
sigillifer, *Lobospingus* 146
simoni, *Selasphorus* 117
Sittasomus griseicapillus 57, 65
Snowornis cryptolophus 168, 170
Snowornis subalaris 168, 170
solstitialis, *Troglodytes* 55, 56
somptuosus, *Anisognathus* 164
sonnerati, *Gallus* 271
sordida, *Pitta* 82, 187
soror, *Hydornis* 189
soui, *Crypturellus* 63
souleyetii, *Lepidocolaptes* 65
spadix, *Pheugopedius* 65
Spatula clypeata 312
Spatula cyanoptera 312
Spatula discors 312
Spatula platalea 312
Spatula rhynchotis 312–314
Spheniscus magellanicus 196, 197
spilopterus, *Centropus* 81
spirurus, *Glyphorynchus* 65, 241, 242, 241–243
Spizaetus tyrannus 64
splendida, *Erythropitta* 88–90, 89
Squatarola helvetica 81
squatarola, *Pluvialis* 81
stanleyi, *Gallus* 261, 267, 268, 270, 271
steadii, *Thalassarche* 203
stenorhyncha, *Schiffornis* 65, 315
Stercorarius antarcticus 196, 201
Stercorarius parasiticus 21
Stercorarius pomarinus 21
Stercorarius sp. 201
Sterna 232
Sterna hirundinacea 201, 320, 323, 324
Sterna paradisaea 320
Sterna sp. 201
Sterna vittata 320–324, 321, 322
Stictolimnas sharppei 13, 23
sticturus, *Herpsilochmus* 152
Streptopelia capicola 144
striata, *Butorides* 81
striatus, *Oriolus* 82
strigularis, *Phaethornis* 64
Strix 24
Strix aluco 13, 25
Strix uralensis 24, 25
Struthio camelus 207
subalaris, *Snowornis* 168, 170
subalaris, *Syndactyla* 60, 65
subcaeruleum, *Parisoma* 159
subcoerulea iohannis **nom. nov.**, *Sylvia* 159
subcoerulea, *Sylvia* 159
subcristata, *Aviceda* 81
Sula 232
Sula leucogaster 196, 200
Sula sp. 201
superba, *Pitta* 187
superciliaris, *Phylloscartes* 54, 60, 65
superciliosa, *Colluricincla* 73, 79, 80
Sylvia 159
Sylvia abyssinica 159
Sylvia atricapilla 21, 23
Sylvia subcoerulea 159
Sylvia subcoerulea iohannis **nom. nov.** 159
Syma torotoro 220
Syndactyla subalaris 60, 65
Synoicus chinensis 32, 34
Synoicus lodoisiae 13, 20
Syrnium aluco 23, 24
Syrnium willkonskii 13

- szalayi, Oriolus 82
 tacarcunae, Chlorospingus 57, 60, 66
 Tachybaptus dominicus 143
 Tadorna radjah 80
 tahanensis, Zosterops 101, 104
 tahitiensis, Numenius 254
 Tanagra bresilia 145–149
 Tangara 239
 Tangara bresilia 143
 Tangara dominica 143
 Tangara florida 57, 65
 Tangara fucosa 60, 65
 Tangara guttata 57, 65
 Tangara gyrola 57, 65
 Tangara icterocephala 57, 65
 Tanyiptera galatea 81, 84
 Tanyiptera microrhyncha 79, 81, 84
 telescopthalmus, Arses 82
 telescopthalmus, Arses 82
 tenebricosa, Tyto 98
 Tetrastes bonasia 13, 32
 Tetrastes griseiventris 13
 tetric, Lyrurus 32, 33, 34–36
 Thalassarche 320
 Thalassarche cauta 196, 202, 203
 Thalassarche chlororhynchos 197
 Thalassarche melanophris 198
 Thalassarche sp. 198
 Thalassarche steady 203
 Thalasseus acufavidus 201
 Thalasseus sandvicensis 321
 Thalurania colombica 64
 Thamnophilus 153
 Thamnophilus atrinucha 64
 theomacha, Ninox 95
 Thripophaga cherriei 150
 Tigrisoma heliosylos 81
 Todiramphus albicilla 220
 Todiramphus chloris 81, 84, 211, 220
 Todiramphus divinus 213, 215
 Todiramphus sacer 213, 215
 Todiramphus sanctus 81, 220
 Todiramphus tutus 211–225, 213
 Todiramphus veneratus 211, 213, 214, 215, 218, 220–223
 Todiramphus youngi 222, 256
 Todopsis bonapartii 82
 torotoro, Syma 220
 torridus, Selasphorus 117
 Trichoglossus haematodus 81
 Trichoglossus massena 81
 trichroa, Erythrura 146
 tristriatus, Basileuterus 59, 60, 61, 66
 Troglodytes ochraceus 46, 55, 56, 60, 65
 Troglodytes solstitialis 55, 56
 Trogon collaris 60
 Trogon massena 64
 Trogon rufus 64
 tropica, Fregetta 282
 tuberculifer, Myiarchus 65
 Turnagra capensis 256
 tuta, Alcedo 211
 tutus, Todiramphus 211–225, 213
 tyrannus, Spizaetus 64
 Tyto tenebricosa 98
 tzacatl, Amazilia 64
 ugiensis, Monarcha 13
 ulietanus, Cyanoramphus 212, 256
 unicolor, Haematopus 21
 Upupa epops 15
 uralensis, Strix 24, 25
 urochrysis, Chalybura 64
 uropygialis, Lipaugus 161–172, 162, 164–166, 168
 ussheri, Erythropitta 173–194, 176, 179–185
 variegaticeps, Anabacerthia 54, 65
 varius, Gallus 270, 271
 velata, Philentoma 102
 venerata, Alcedo 211
 veneratus, Todiramphus 211, 213, 214, 215, 218, 220–223
 veraepacis, Schiffornis 59, 60, 315
 versicolor, Pitta 187
 vicinior, Scytalopus 51, 52, 53, 66
 viguieri, Dacnis 60
 Vini peruviana 216, 222, 256
 violacea, Geotrygon 49, 64
 violiceps, Goldmania 46, 50, 60, 64
 virgata, Ciccaba 64
 virginianus, Colinus 13, 24, 28
 Virginianus, Ortyx 23
 viridescens, Calornis 82
 viridis, Pteroglossus 239
 vitellinus, Ramphastos 239
 vittata, Pachyptila 202
 vittata, Sterna 320–324, 321, 322
 vociferans, Lipaugus 165, 168, 169
 weberi, Lipaugus 170
 willkenskii, Syrniopsis 13
 Xanthopsar flavus 313
 Xenops minutus 65
 Xenops rutilans 60
 Xenornis setifrons 60
 Xipholena punicea 4
 Xiphorhynchus erythropygius 54, 65
 youngi, Todiramphus 222, 256
 zealandicus, Cyanoramphus 212
 zeledoni, Hafferia 64
 zeledoni, Myrmeciza 51
 Zosterops atricapilla 102, 114
 Zosterops [atriceps] atrifrons 156
 Zosterops aureiventer [sic] 101
 Zosterops auriventer 100, 101, 110–116, 112, 113
 Zosterops everetti 111, 113, 114, 115
 Zosterops griseotinctus 156
 Zosterops meeki 156, 156–158, 157
 Zosterops palpebrosa [sic] 101
 Zosterops palpebrosus 100–110, 107, 112, 114
 Zosterops (palpebrosus) 'auriventer' (erwini) 104
 Zosterops tahanensis 101, 104

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CONTENTS

Club Announcements.....	244
JANSEN, J. J. F. J. & STEINHEIMER, F. D. The authenticity of 'Tiwi <i>Drepanis coccinea</i> (G. Forster, 1781) skins from Cook's third voyage: what taxidermy can add to the discussion.....	246
VAN GROUW, H., DEKKERS, W. & ROOKMAAKER, K. On Temminck's tailless Ceylon Junglefowl, and how Darwin denied their existence.....	261
BIRD, J. P. Observation of an all-dark <i>Pseudobulweria</i> petrel in the Bismarck Sea, with a review and discussion of recent records.....	272
FLOOD, R. L. & WILSON, A. C. A New Zealand Storm Petrel <i>Fregetta maoriana</i> off Gau Island, Fiji, in May 2017.....	278
SCHULZ, U. & EISERMANN, K. Morphometric differentiation between subspecies of Resplendent Quetzal (<i>Pharomachrus mocinno mocinno</i> and <i>P. m. costaricensis</i>) based on uppertail-coverts.....	287
JACKSON, H. D. Fiery-necked Nightjar <i>Caprimulgus pectoralis</i> development and behaviour from hatching to fledging, including attendant parental care.....	292
CROZARIOL, M. A. & NACINOVIC, J. B. A historical Australasian Shoveler <i>Spatula rhynchotis</i> specimen from southern South America.....	312
DYER, D. Supposed sympatry of <i>Corapipo</i> manakins in the Tacarcuna region of Colombia, and a comment on <i>Schiffornis</i> : a response to Renjifo <i>et al.</i> (2017).....	315
SANDOVAL, L. Nest and eggs of the southern Central American endemic Tawny-chested Flycatcher <i>Aphanotriccus capitalis</i>	317
CARLOS, C. J., DAUDT, N. W., VAN GROUW, H. & NEVES, T. The second and third documented records of Antarctic Tern <i>Sterna vittata</i> in Brazil.....	320
Index for Volume 137 (2017).....	325

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