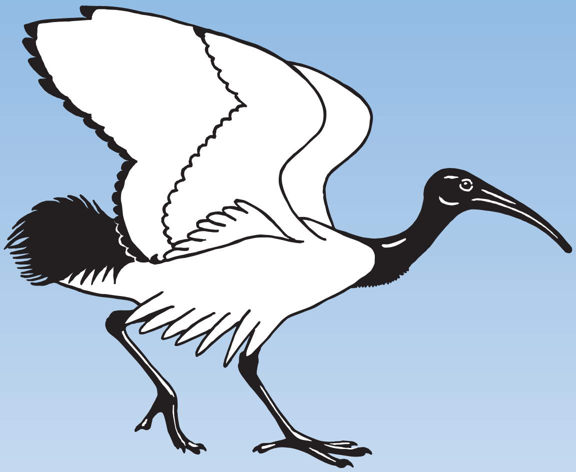
# Bulletin of the British Ornithologists' Club



Volume 137 No. 3 (Online)
September 2017

ISSN 2513-9894 (Online)

## 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 2017 evening meetings will 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 18 September 2017—6.30 pm—Dr Nigel Collar—***Preparing the Illustrated Checklist: value vs vanity.*

*Abstract*.—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. Has it been worth the effort?

*Biography*.—Nigel Collar has worked in international conservation for more than 40 years, 37 of them spent with BirdLife International.

---

**Monday 6 November 2017—6.30 pm—Dr Claire Spottiswoode—***Cuckoos vs. hosts: an African perspective.*

*Abstract*.—This talk will discuss the co-evolutionary arms races that arise between brood parasites and the hosts they exploit to raise their young, focusing on various African bird species that I study in the field in Zambia: cuckoos, honeyguides and parasitic finches (especially Cuckoo-finch *Anomalospiza imberbis*). In particular I will ask, first, how coevolution can escalate to shape sophisticated signals of identity, leading to a race between host egg 'signatures' and parasitic egg 'forgeries'. Second, how can co-evolution shape ancient genetic specialisation within a single species, allowing the evolution of parasitic 'gentes'? The research I will describe comes from a mixture of field experiments facilitated by a large team of wonderful Zambian nest-finders, and museum work enabled by the remarkable egg collection of the late Major John Colebrook-Robjent.

*Biography*.—Claire works jointly at the University of Cambridge, where she is Hans Gadow Lecturer and a BBSRC David Phillips Research Fellow, and at the University of Cape Town in her home country of South Africa, where she is Pola Pasvolsky Chair in Conservation Biology. She did her B.Sc. (Hons.) at the University of Cape Town, before moving to the University of Cambridge as a Ph.D. student, supervised by Prof. Nick Davies. She has stayed there ever since with the kind support of a series of research fellowships, which have permitted her to spend the last 12 years or so carrying out field work on various evolutionary questions involving birds, primarily in Zambia working on brood parasitism, and also latterly in Mozambique working on honeyguide-human mutualism.

---

**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

Vol. 137 No. 3 Published 15 September 2017

# CLUB ANNOUNCEMENTS

## Chairman's Message

The talk by Dr Alex Bond (described below) was preceded by the Chairman's Review and the Trustees' Report and Accounts for 2016. Chris Storey reminded the meeting of the sequence of events leading up to the acceptance by the Charity Commissioners of the BOC's new status as a Charitable Incorporated Organisation (BOC CIO) with a revised Constitution and a newly appointed Board of Trustees. The CIO came into existence on 18 October 2016. During 2016 the Trustees had taken the decision to publish the Bulletin in electronic format alone: during 2017 the four issues of Vol. 137 would be issued as .pdfs on the BOC website and from the beginning of 2018 the next volume, Vol. 138, would be published on the website of the American online academic publisher, BioOne. BOC had signed a three-year agreement with BioOne and looks forward to working with them to optimise the accessibility and visibility of BBOC Online.

---

The 986th meeting of the Club was held on Monday 12 June 2017 in the upstairs room at the Barley Mow, 104 Horseferry Road, Westminster, London SW11P 2EE. Twelve members (Friends) and five guests were recorded as present (but a considerable additional number in attendance alas went unrecorded).

Friends attending were: Cdr M. B. Casement, RN, Mr S. Chapman, Dr R. A. Cheke, Mr M. J. Earp, Mr D. Fisher, Mr R. Malin, Mr D. Montier, Dr R. Prŷs-Jones, Mr N. J. Redman, Mr S. A. H. Statham, Mr C. W. R. Storey (*Chairman*) and Mr A. Tye.

Guests attending included: Mrs B. Azvevo-Benitez, Dr A. Bond (*Speaker*), Mrs J. McDonald, Mrs M. Montier and Mr O. Prŷs-Jones.

Alex Bond gave a talk entitled *Gough Island: an unnatural history of mice and birds*. Taking the audience on the journey from Cape Town, South Africa, to Tristan da Cunha and then to Gough Island, Alex highlighted the plight of the seabirds on one of the world's most remote islands. House Mice *Mus musculus* were introduced in the 19th century, and now threaten the persistence of many of the island's endemic species, including the iconic Tristan Albatross *Diomedea dabbenena*, Atlantic Petrel *Pterodroma incerta*, MacGillivray's Prion *Pachyptila macgillivrayi* and Gough Finch *Rowettia goughensis*, and many, if not all, of the *c.*25 species of breeding birds on the island. Each year, nearly 1,000,000 seabird chicks that would have otherwise survived are predated by mice, a gruesome fate that was highlighted by a short film.

Thankfully, the eradication of introduced rodents has become a relatively common conservation intervention, and Alex highlighted plans by the Royal Society for the Protection of Birds (BirdLife in the UK) and Tristan da Cunha government to eliminate the rats through the use of cereal pellets with rodenticide broadcast by helicopter. While the challenges in an operation as complex as this on Gough are many, more than 15 years of research has gone into identifying the solutions to Gough's remoteness, cliffs and the potential for non-target mortality. Studies of captive husbandry and clinical pathology of the Gough Finch and Gough Moorhen *Gallinula comeri* have laid the groundwork for maintaining captive populations during the eradication operation, currently planned for the austral winter of 2019.

Finally, Alex discussed the current status of the island's three breeding albatrosses (Tristan Albatross, Sooty Albatross *Phoebetria fusca* and Atlantic Yellow-nosed Albatross *Thalassarche chlororhynchos*), showing the ongoing declines owing to bycatch in fisheries in the South Atlantic, but also highlighting the great strides that have taken place in reducing bycatch off southern Africa and South America. Working north, he ended the talk by previewing work done on Tristan and Nightingale islands to understand declines in Northern Rockhopper Penguins *Eudyptes moseleyi*, and the comparative populations of Nightingale Finch *Nesospiza questi*, which numbers 4000 pairs, and the sympatric Wilkins' Finch *Nesospiza wilkinsi*, numbering only 80 pairs.

Those interested in following the progress of the Gough Island Restoration Programme can visit the project's website: www.rspb.org.uk/GoughIsland.

# A new Peruvian locality for Scimitar-winged Piha *Lipaugus uropygialis*, with the first description of flight display and other natural history notes

*by Daniel F. Lane & Tatiana Pequeño*

*Received 8 February 2017; revised 24 June 2017; published 15 September 2017*

*http://zoobank.org/urn:lsid:zoobank.org:pub:9C8202FA-B891-4156-AF49-E6CD34C51820*

Summary.—While participating in a Rapid Biological Inventory (RBI) to the Santuario Nacional Megantoni, Cuzco department, Peru in May 2004, we encountered Scimitar-winged Pihas *Lipaugus uropygialis* in tall cloudforest at our high-elevation camp 'Tingkanari' (*c.*2,100–2,300 m; 12º16'S, 72º06'W). The species previously was known in Peru from only one site nearly on the Bolivian border *c.*400 km to the south-east: Abra de Maruncunca, in Puno department. Over two days, we observed the pihas several times and documented them with photographs and sound-recordings, including the first known observations of the species' display flight, in which it produces mechanical sound with its uniquely modified primaries. We also present information from the four Peruvian specimens of the species, and discuss various characters, including the voice, display, probable subadult plumage and modifications of the primaries, and their implications for taxonomic relationships between this species and other pihas. We suspect Scimitar-winged Piha is restricted to tall humid forest on ridgeline 'saddles' at 1,800–2,750 m. These sites probably represent desirable sites for human colonists to clear for pasture and agriculture, and thus are of conservation concern. However, with the potential size of the species' distribution nearly doubled by the discovery of a Cuzco locality, more of its habitat may be protected than previously thought.

Scimitar-winged Piha *Lipaugus uropygialis* has been shrouded in mystery since its description by Sclater & Salvin (1876); the species has remained seldom seen and its voice has only recently been described in detail (Bryce *et al*. 2005). What little is known of the species' natural history was summarised by Snow (2004), Bryce *et al*. (2005) and Kirwan & Green (2012). The bulk of its distribution has been thought to lie within Bolivia (Snow 1982, 2004, Fjeldså & Krabbe 1990, Ridgely & Tudor 1994, BirdLife International 2000, Bryce *et al*. 2005, Kirwan & Green 2012). However, two specimens taken in 1980 at Abra Maruncunca, Puno department, a site within 35 km of the Bolivian border, were the first documentation of the species in Peru (Remsen & Traylor 1989, Fjeldså & Krabbe 1990, Robbins *et al*. 2013). The species remained unknown further to the north and west in Peru despite fairly heavy ornithological coverage of the *yungas* (southern Andean humid montane forest) habitat along the Cuzco–Quincemil and Paucartambo–Pilcopata roads by field workers and birders (Walker *et al*. 2006). Thus it was with some surprise that we encountered this species while conducting avifaunal surveys in Santuario Nacional Megantoni (hereafter simply Megantoni), on the east side of the middle río Urubamba, Cuzco department (Lane & Pequeño 2004). This record extends the Scimitar-winged Piha's range more than 400 km to the north-west of Abra de Maruncunca (Fig. 1).

We located two different groups of *Lipaugus uropygialis* and documented them by sound-recordings and photographs. Another unknown sound led us to observe a lone bird performing its display flight, which includes mechanically produced sounds. To our

© 2017 The Authors; Journal compilation © 2017 British Ornithologists' Club ISSN-2513-9894 (Online)

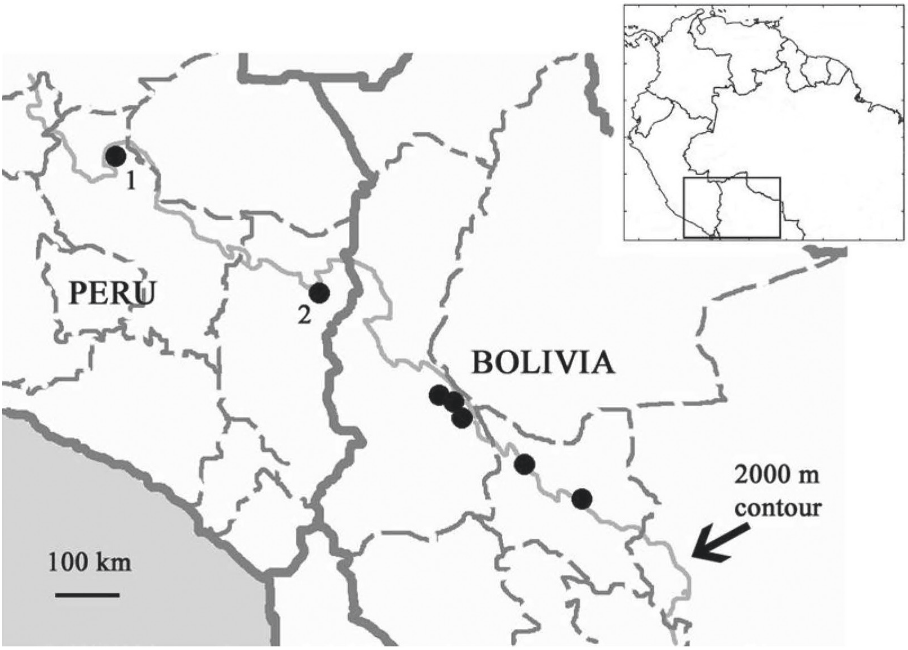


Figure 1. Map of localities where Scimitar-winged Piha *Lipaugus uropygialis* has been reported, largely based on Bryce *et al*. (2005), with the new locality at Megantoni, Cuzco, Peru, represented by point 1, and Abra Maruncunca, Puno, Peru, by point 2. The grey line represents the approximate 2,000 m contour line of the main Andes.

knowledge, this is the first time this display has been witnessed. Below, we augment the natural history information published by Bryce *et al*. (2005), describe the flight display in detail and compare it to that of the other two montane *Lipaugus*. We also provide information concerning the four Peruvian specimens of *L. uropygialis* and discuss the distribution and conservation status of the species in light of the Megantoni record.

## Locality and Methods

On 9–14 May 2004, we, as part of a Rapid Biological Inventory (RBI) team, established a campsite in Megantoni named 'Tinkanari'. The Tinkanari camp is in Cuzco department, Peru, on the east bank of the middle río Urubamba area, at 12º16'S, 72º06'W, *c*.2,100–2,300 m elevation (Fig. 1). A detailed description of the vegetation and fauna of Tinkanari is available in Vriesendorp *et al*. (2004). Our censusing methods and results were outlined in Lane & Pequeño (2004). We made recordings using a Sony TCM-5000 cassette recorder with a Sennheiser ME-66 microphone, and these recordings are deposited at the Macaulay Library (Cornell Lab of Ornithology, Ithaca, NY) and Xeno-canto (www.xeno-canto.org) sound collections.

## Observations

*Encounters*.—At *c*.11.10 h on 10 May 2004, we were alerted to the presence of two *Lipaugus uropygialis* by their loud vocalisations. These birds were near a group of Dusky-green Oropendolas *Psarocolius atrovirens* and Blue-banded Toucanets *Aulacorhynchus coeruleicinctis*, but the pihas appeared to be moving independently of the other species. They did not respond to playback of their vocalisations. We found another group of pihas (not accompanying other bird species) more than 1 km to the east around dawn (*c*.05.45 h) on 11 May, relocating these again at approximately 08.30 h, *c*.0.5 km to the south-east, on a fairly level ridgetop at the ecotone of tall and stunted subtropical forest. This group of three individuals moved more slowly, foraging in the mid- and subcanopy (*c*.7–15 m above the forest floor; canopy 12–15 m). They permitted rather close approach, and we tape-recorded and photographed these individuals extensively. More than 3 km to the north-west, at *c*.16.00 h on 11 May, we found another lone individual performing a song-flight display. Again, we made tape-recordings and took notes as we observed the display. We did not encounter the species again during the following three days that we spent at Tingkanari, although we spent most of that period on different trails.

*Behavior and habitat*.—We observed Scimitar-winged Pihas moving through the forest in small groups that were very vociferous, producing loud bursts of noise that carried quite a distance; our observations agree closely with Bryce *et al*. (2005). The second group of pihas responded strongly to playback of these calls, readily approaching to inspect the source; playback would induce them to vocalise immediately, overlapping their vocalisations with those being played back much as they did with one another's vocalisations. The birds remained in the midstorey and subcanopy (5–15 m) of moderate stature forest (canopy *c*.15 m) and switched perches frequently and noisily, their wings producing an audible 'swishing' sound, which we even captured on tape.

The pihas' normal perched attitude when active was hunched, with the tail held *c*.20º below horizontal and head jutting forward. When not foraging, they would perch more upright (Figs. 2–4). As they foraged, groups of pihas covered ground rapidly in the manner described by Bryce *et al*. (2005). We observed a single foraging attempt, when an individual was seen sallying *c*.2 m, out and slightly above horizontal, for a fruit or insect (the item was not clearly seen) from a cluster of leaves as it changed perches. On landing, the bird tossed the item in the air and swallowed it with no noticeable handling motion (e.g., bashing the item on its perch). Stomach contents and foraging observations (Remsen *et al*. 1982, Snow 1982, Bryce *et al*. 2005) indicate that the species is largely frugivorous but consumes some insects, and even the occasional vertebrate. The stomach contents of four Peruvian specimens (see below) contained insects, a large pit (undoubtedly of an already digested fruit) and even a small lizard, suggesting that the species is rather omnivorous and opportunistic.

All encounters with pihas were on broad ridgetop 'saddles' (between higher ridges) with tall forest (canopy *c*.12–25 m) or on very shallow-sloping mountainsides. We did not find pihas on steeper slopes, and conclude that they may remain largely on these flatter saddles, foraging along their length. Our most prolonged observation (*c*.30 minutes) was of a trio near the ecotone of taller forest and poor-soil stunted forest, but we noted that the group did not enter the stunted forest. The forest was heavily festooned with moss, with a notable presence of *Chusquea* bamboo, and a dense understorey including many tree ferns. In June 2007, DFL, A. M. Cuervo and K. Faust briefly observed another *L. uropygialis* at Abra Maruncunca, Puno department, in habitat very similar to that at Megantoni, but here the forest was taller: nearly 25 m (Robbins *et al*. 2013; Fig. 5). DFL has also encountered the species on several occasions at elevations of 1,800–2,400 m along the 'Old Coroico Road' in the Nor Yungas of La Paz department, Bolivia, in September 2009, September 2010, September 2011 and September 2016, while guiding tours. At this last site during the first three observations, 1–2 birds (those seen well were in subadult plumage, see below) were present along the road at a site where the slope was shallower, with fruiting trees amid second growth. In the 2016 observation, DFL and tour participants walked off the road on a track that led to taller primary forest along a saddle, where three adults responded

Figure 2. One of the Scimitar-winged Pihas *Lipaugus uropygialis* at Reserva Nacional Megantoni, Cuzco, Peru, 11 May 2004 (Daniel F. Lane)

Figure 3. A presumed subadult-plumaged Scimitar-winged Piha *Lipaugus uropygialis*, Alto Sacramento, Old Coroico Road, La Paz department, Bolivia, 25 September 2009 (Daniel F. Lane)

A different presumed subadult-plumaged Scimitar-winged Piha *Lipaugus uropygialis*, above Alto Sacramento, Old Coroico Road, La Paz department, Bolivia, 24 September 2011 (Daniel F. Lane)

almost immediately to playback once in appropriate habitat. These observations, and additional confirmation from S. K. Herzog (pers. comm.; Herzog *et al*. 2017) regarding recent Bolivian sightings, suggest that the species' preference for tall-forest saddles and shallow slopes is probably real.

*Vocalisations*.—Several authors have incorrectly attributed the song of Blue-winged Mountain Tanager *Anisognathus somptuosus flavinuchus* to *Lipaugus uropygialis* (Ridgely & Tudor 1994, 2009, Prum 2001, Snow 2004). The true voice of the piha was not published until Bryce *et al*. (2005).

Figure 5. Habitat at Abra Maruncunca, Puno, Peru, where a Scimitar-winged Piha *Lipaugus uropygialis* was encountered, 15 June 2007 (Daniel F. Lane)

As noted by Bryce *et al*. (2005), foraging groups of pihas are most easily detected by their loud bursts of calls. These explosive calls of *L. uropygialis*, which we term 'foraging calls', usually involved overlapping of the voices of several individuals. Scimitar-winged Pihas did not make exaggerated head movements in the manner of singing Screaming Piha *L. vociferans* when giving foraging calls. These calls were rather variable in structure: notes given usually were short and simple in structure, but some were much longer and more complex, particularly when given in a 'group burst' (Fig. 6a–b; from XC40334, available at www.xeno-canto.org/40334). Similar vocalisations are noted for the other two Andean *Lipaugus* (Cuervo *et al*. 2001; T. Mark recording XC7055).

The song given during the display flight is very different from foraging calls: it is a piercing, modulated whistle that rises terminally (Fig. 6c; from XC40335). Over the course of this whistle, there are three dull *fft* sounds, presumably produced mechanically by the wings.

*Display flight*.—In the evening (16.10–16.50 hours) of 11 May 2004, we observed a single *L. uropygialis*, presumably a male, performing a display flight. This display occurred at intervals of *c*.95 seconds and was initiated by the bird as it perched on the outermost branches of a canopy tree (often on bare, exposed branches, *c*.15 m above ground; Fig. 7). We observed just one individual, and whereas it would use several perches for the display, it seemed to prefer certain ones, although this may have been partially

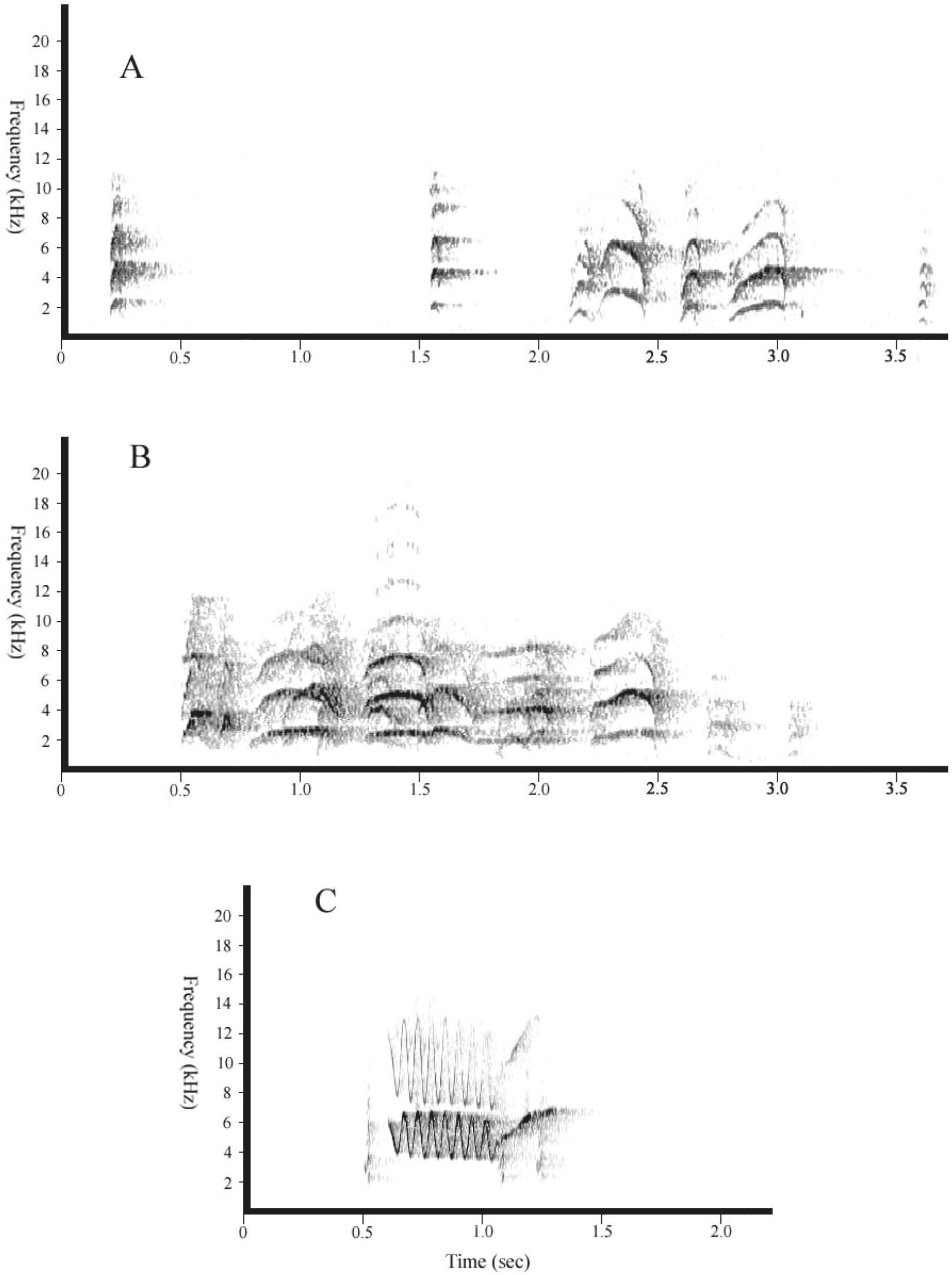


Figure 6. Sonograms of vocalizations of Scimitar-winged Piha *Lipaugus uropygialis*, all taken from recordings made by Daniel F. Lane at Megantoni, Cuzco, Peru, 11 May 2004. (A) Foraging calls from a single individual with shorter and longer calls (XC40334). (B) A burst of foraging calls with several birds' voices overlapping. (C) Sounds produced during flight display (XC40335). The long, modulated note with a rising tail is the piercing whistle given vocally, with three *fft* sounds (produced mechanically by the wings) at the start of the vocalisation, and twice more at the start and end of the rising tail of the whistle.

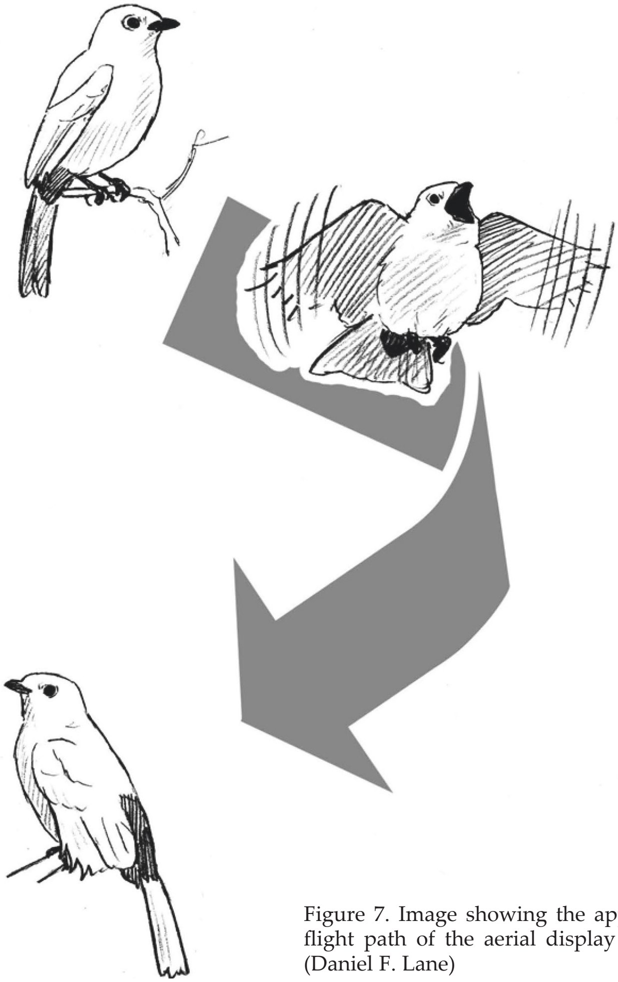


Figure 7. Image showing the approximate positions and flight path of the aerial display described in this paper (Daniel F. Lane)

determined by playback. After some time spent motionless, the bird launched from the branch and descended in a half-spiral (like a 'corkscrew') to a lower perch (*c.*7 m above ground; Fig. 7) while giving a high, piercing, whistled vocalisation in conjunction with three whirring sounds produced by the wings (Fig. 6c); only one such vocalisation was given per performance. As it descended, the bird appeared 'inflated', with body plumage exaggeratedly puffed out, and the bill open wide as it gave the vocal portion of its display. Our view of the display was partially obscured by tree-fern fronds, so we were unable to see details of the wing-flapping rate. However, we believe that the wings were sharply beaten at least three times during the vocalisation, resulting in airy *fft* sounds (Fig. 6c). During the long pauses between display flights, the bird never gave foraging calls; only in response to playback of the display vocalisation did it produce a foraging call. We did not see or hear another displaying individual at this site, indeed we did not detect any other individuals nearby at all, and so we have no evidence that the species has a lekking system of display.

## Specimens, morphology and comparisons to other Andean *Lipaugus*

*Peruvian specimens.*—We are aware of four specimens of *L. uropygialis* from Peru. Two are at Louisiana State University Museum of Natural Science, Baton Rouge (LSUMZ), both

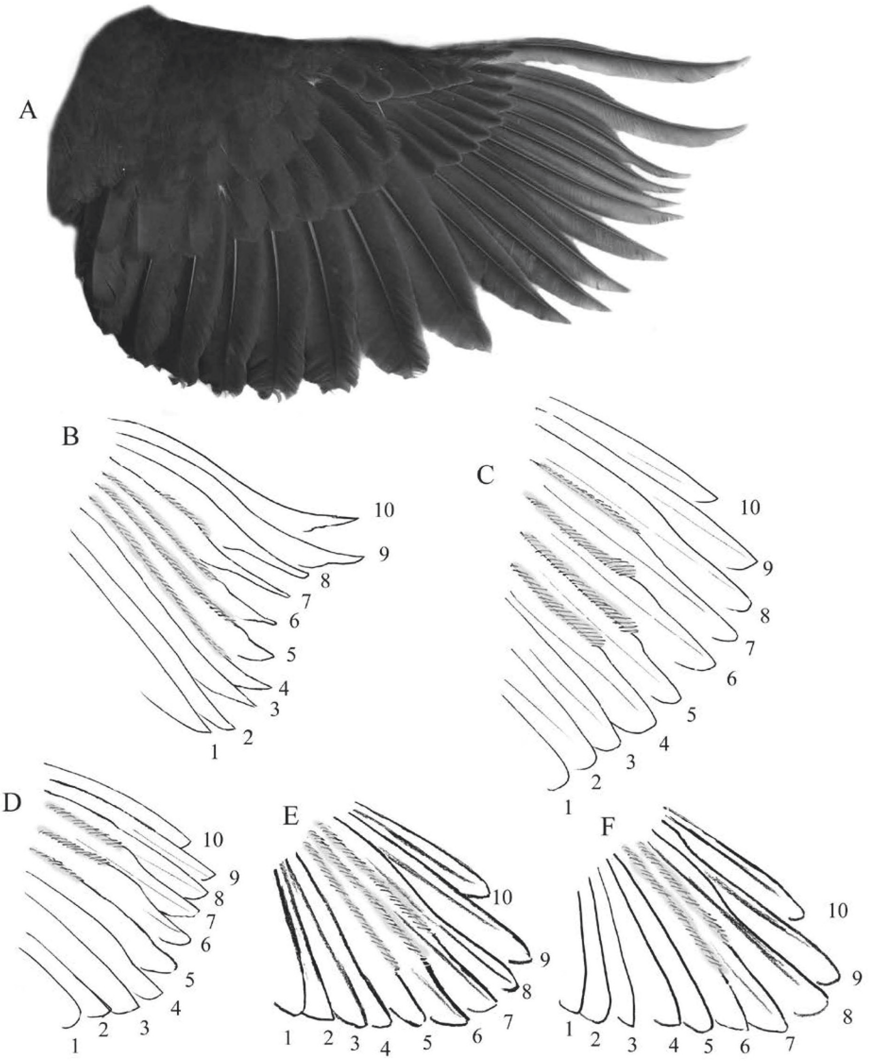


Figure 8. Images of the modified primaries of five species of piha (Daniel F. Lane). (A) The open wing of a male Scimitar-winged Piha *Lipaugus uropygialis* (CORBIDI-AV-011276), revealing the primary modifications. (B) Line diagram of primary modifications of *L. uropygialis* (based on AMNH 99212), with grey areas indicating the presence of stiffened outer webs lacking interlocking barbules. (C) Line diagram of primary modifications of Dusky Piha *L. fuscocinereus* (AMNH 183741). (D) Line diagram of primary modifications of Cinnamon-vented Piha *L. lanioides* (AMNH 494207). (E) Line diagram of primary modifications of Olivaceous Piha *Snowornis cryptolophus* (LSUMZ 171033). (F) Line diagram of primary modifications of Grey-tailed Piha *S. subalaris* (LSUMZ 88185).

females. Both specimens have pp10–4 (primaries numbered from innermost to outermost primaries) curved outward, lacking the degenerated outer webs and sharply attenuated tips of males. One (LSUMZ 98424) appears to have brown tips to the malar and breast feathers, as well as one brown lower scapular, suggesting that these may be retained from juvenile plumage, as such brownish feathering represents juvenile characters in the better-known *L. vociferans* (see description of first basic plumage below). However, of the two specimens, LSUMZ 98424 has a completely ossified skull and, additionally, lacks rufous tips to the rectrices.

LSUMZ 98424: collected and prepared by L. C. Binford, 15 November 1980. Peru: dpto. Puno; Abra de Maruncunca, 10 km south-west of San Juan de Oro, 2,000 m. Female, 131 g. Little fat. Heavy body moult. Ovary 8 × 4 mm, ova minute. Skull ossified. Stomach: huge seed and one small lizard. Bill: black, mandibular rami and basal half of gonys dark bluish grey. Feet darker bluish grey (slate). Iris: dark reddish brown.

LSUMZ 98425: collected and prepared by L. C. Binford, 25 November 1980 (locality same as previous). Female, 135 g. Little fat. Ovary 10 × 7 mm, largest ovum 1 mm. Skull not completely ossified. Mandible dark grey. Feet dark grey.

In addition, the Museo de Historia Natural de la Universidad Mayor de San Marcos (MUSM) and Centro de Ornitologia y Biodiversidad (CORBIDI) collections in Lima, Peru, house an additional male specimen each. The wings of the MUSM individual, collected in January, are in heavy moult: the outermost primaries are largely sheathed, although their modified tips are already apparent. By comparison, the CORBIDI specimen, collected in June, shows very limited moult, this being restricted to the body.

MUSM 24135: collected and prepared by T. Valqui, 7 January 2001. Peru: dpto. Puno; between Sandia and San Juan de Oro, Abra Maruncunca, 2,170 m. Male, 128 g. Little fat. Heavy wing, tail and body moult. Left testis 5 × 3 mm. No bursa found. Stomach: insects. Skull 100% ossified. Iris: reddish brown. Legs: greyish black, soles yellowish. Bill: dark grey. Collected in humid montane forest about 8 m above the ground.

CORBIDI-AV-011276: collected and prepared by A. M. Cuervo [pers. catalogue no. 826], 15 June 2007. Peru: dpto. Puno; Abra de Maruncunca, 14º12’S, 69 º13’W, *c.*2,150 m. Male, 131 g. Wingspan 462 mm. Heavy fat. Left testis 5 × 3 mm. Stomach: two seeds and violet fruit pulp. No bursa. Skull 100% ossified. No wing, tail moult; trace body moult. Irides dark reddish brown. Maxilla slate-black, mandible dark grey, horn towards base. Legs grey, orangey soles. Shot at 10 m height in the midstorey of tall montane wet forest in an area of large trees, open understorey, flat terrain.

*Subadult plumage.*—While leading tours in La Paz department, Bolivia, on 25 September 2009 and 24 September 2011, DFL photographed *L. uropygialis* (Figs. 3–4) that showed narrow, somewhat pointed rectrices with cinnamon tips and similar cinnamon tips to the secondaries. Specimens of *L. vociferans* at LSUMZ show these characters to be indicative of a subadult plumage in that species, so we infer that the same is true for *L. uropygialis*. We believe this to be the first evidence of a distinct age-related plumage class in *L. uropygialis* (Kirwan & Green 2012).

*Wing structure.*—As its English name implies, Scimitar-winged Piha has unusual wing feathers. Males (particularly) have unique modifications (Fig. 8) to the primaries, which led Sclater & Salvin (1876) to place the species in the subgenus *Chirocylla*, a name recognised at genus level occasionally since (e.g., Snow 1982). Following Remsen *et al*. (1982), more recent treatments (e.g., Fjeldså & Krabbe 1990, Ridgely & Tudor 1994, 2009, Prum 2001, Snow 2004, Bryce *et al*. 2005, Kirwan & Green 2012) have merged *Chirocylla* into *Lipaugus*, suggesting that *uropygialis* is sister to Dusky Piha *L. fuscocinereus*, which relationship was confirmed by Berv & Prum (2014). Two other montane *Lipaugus*, *L. fuscocinereus* and the recently described Chestnut-capped Piha *L. weberi*, share some of the primary feather modifications with *L. uropygialis*, and these species produce mechanical noise in flight displays (López-Lanús 2000, Cuervo *et al*. 2001, Snow 2004, Kirwan & Green 2012). We can find no evidence that lowland pihas possess any flight displays (Kirwan & Green 2012).

Fig. 8 shows the primary structure of a male *L. uropygialis*. Unique among all *Lipaugus* are the recurved (outward-bowed), finely pointed primaries. These can be seen in the field even on the closed wing. Additionally, as noted above, females also have recurved primaries. The stunted pp5–8 are also peculiar to *L. uropygialis*. Having surveyed male specimens from all genera (and nearly all species) of cotingas, only males of the two species of *Phoenicircus* red cotingas have recurved, narrow-tipped, similarly stunted primaries, which produce a bell-like tinkling in flight (pers. obs.). Among the pihas, *L. uropygialis* share stiffened outer webs, lacking interlocking barbules, of certain middle primaries with *L. weberi*, *L. fuscocinereus*, Cinnamon-vented Piha *L. lanioides*, and the two members of *Snowornis* (Cuervo *et al*. 2001). Which primaries possess these webs is species-dependent: in *L. uropygialis*, the stiffened vanes are present on pp4–7; *L. weberi* has them on pp6–7, *L. fuscocinereus* on pp4–7, *L. lanioides* on pp5–7, Olivaceous Piha *Snowornis cryptolophus* on pp5–7 and Grey-tailed Piha *S. subalaris* on pp6–7 (Fig. 8). We cannot find any other cotingids that share similar modifications to the outer vanes of the primaries in adult male plumages.

Similar, though not as extensive, structures appear on the middle primaries of the two species of the tyrant-flycatcher genus *Cnipodectes* (Lane *et al*. 2007). These feather modifications are thought to be used in the production of mechanical sounds in flight display as well. We expect that the mechanical sound produced in the display flight of Scimitar-winged Piha is made by a combination of the stiffened vanes and the finely pointed, recurved primaries; the precise mechanism requires more study. Of course, the acquisition of these characters by such unrelated clades as the two groups of pihas and the twistwings can be viewed only as convergence (Ohlson *et al*. 2007, Tello & Bates 2007, Berv & Prum 2014).

Compared to display noises recorded for the other two Andean *Lipaugus*, *L. uropygialis* includes fewer wing-produced 'swishing' sounds (just three vs. 12 by *L. fuscocinereus* and five in *L. weberi*), but sample sizes for each species are very small and there may be more variation within each species. In the published descriptions of flight displays of *L. fuscocinereus* and *L. weberi*, it appears that neither species has a vocal component to the flight display. López-Lanús (2000) suggested that the vocalisations on his sonogram may have emanated from a source or sources other than the displaying bird, and indeed, the overlap of two whistled phrases suggests that they stem from at least two sources, neither of which may have been the displaying bird. Although not explicitly stated in Cuervo *et al*. (2001), *L. weberi* also lacks a flight display vocalisation (A. M. Cuervo pers. comm.). The 'foraging call' vocalisations of *L. weberi* appear similar to those of *L. uropygialis* (Cuervo *et al*. 2001) and apparent 'foraging calls' of *L. fuscocinereus* suggest that it too has similar vocalisations (T. Mark recording XC7055).

## Discussion

*Evolutionary relationships*.—As discussed above, Cuervo *et al*. (2001) noted similarities in the structure of certain primary feather modifications among *L. uropygialis*, *L. fuscocinereus*, *L. lanioides*, *Snowornis cryptolophus* and *S. subalaris*. In particular, the barbule-less, stiffened outer webs of several middle primaries appear to be a shared character among all of these species. Conversely, the recurved primaries and (in the male) narrow-tipped outer primaries are autapomophic characters restricted to *L. uropygialis*. Additionally, the primaries of *L. uropygialis* do not extend beyond the longest secondaries on the folded wing (in either sex), a unique feature among *Lipaugus*; it appears this is due to the shorter, modified outermost primaries. Despite widely overlapping body masses, wing length of *L. uropygialis* is considerably shorter than in *L. fuscocinereus* (Snow 1982, 2004). The existence of similar flight displays among *L. uropygialis*, *L. fuscocinereus* and *L. weberi*, as well as their allopatric distributions at similar elevations, and their shared primary modifications, suggest that these species probably form a monophyletic clade, and at least a sister relationship between the former two was confirmed by Berv & Prum (2014). The same authors' phylogenetic tree suggested that *L. lanioides* is not part of this clade, but rather is sister to Black-andgold Cotinga *Tijuca atra* (Berv & Prum 2014). We have not located any information on the presence or absence of flight displays in *L. lanioides*; by voice, it appears to be more similar to lowland Rufous Piha *L. unirufus* and *L. vociferans* than to any of the Andean species. With several phylogenetic datasets supporting the distant relationship of *Snowornis* to *Lipaugus*, we must conclude that the similar wing structures are the result of convergence (Prum *et al*. 2000, Prum 2001, Ohlson *et al*. 2007, Berv & Prum 2014). We note that no flight displays have been reported for the two *Snowornis*, although sounds recorded from *S. cryptolophus*, and reported as vocalisations (Kirwan & Green 2012), probably refer to mechanically-produced sounds (XC9860).

*Conservation status*.—Given that Scimitar-winged Piha appears to exist at low densities along tall-forest ridges between 1,800 and 2,750 m (Snow 2004, Kirwan & Green 2012), it does seem prudent to consider its threat status as Vulnerable (BirdLife International 2000). That said, we strongly disagree with Bryce *et al*. (2005), who used frequency of specimen collection as a means to assess population change over time. Their statement that they 'believe that the lack of 20th-century specimens may represent evidence for a population decline, a conclusion supported by the fewer field observations in recent years' (Bryce *et al*. 2005: 105) is unfounded; indeed, the table of observations they presented showed an increase in sight records as specimen evidence tailed off. Prior to the use of tools such as playback and mist-nets, collection was an opportunistic activity, and hardly a means to ascertain abundance.

We expect pristine Scimitar-winged Piha habitat to decline as habitat alteration by encroaching colonists continues in the humid *yungas* of south-east Peru and western Bolivia. This may be especially true if taller forest on level-ground 'saddles' is the preferred habitat of the species and, simultaneously, favoured agricultural terrain; indeed, when revisiting Abra Maruncunca in July 2017, the locality where the 2007 bird was found had been cleared for pasture (DFL pers. obs.)! However, with the discovery of the piha in Megantoni, the potential size of the species' range has effectively doubled, and it seems likely that other populations within the Peruvian portion of its range are safeguarded by the large blocks of *yungas* habitat encompassed by two large and pristine national reserves: Santuario Nacional Megantoni (Vriesendorp *et al*. 2004) and probably Parque Nacional Manu. Lack of records on the Kosñipata and Marcapata roads may be due to their lack of intersection with flatter saddles (certainly true on the Kosñipata road: DFL pers. obs.), or where they do, forest cover was cleared by colonists too early for ornithologists to detect the piha. In addition, Bolivian populations are known within Parque Nacional Cotapata and Parque Nacional Carrasco (Bryce *et al*. 2005), and probably occur in Parque Nacional Madidi, suggesting that extensive pristine habitat is available to the species in that country. Of great concern, however, is the current squatting and clearance of land within Bolivian national parks, apparently unimpeded (indeed, it is supported) by the Movimiento al Socialismo, the political party currently in control of the government. Efforts should be made to avoid extensive forest clearance, especially where tall 'saddle forest' exists at 1,900–2,750 m, to maintain viable populations of Scimitar-winged Piha in that country.

## Acknowledgements

We thank the Field Museum for inviting us to join the Megantoni rapid inventory team. DFL made additional observations at Abra Maruncunca while accompanied by Andrés Cuervo, Katie Faust and Jano Nuñez; both expeditions were made possible with permits graciously granted by the Instituto de Recursos Naturales of Peru (INRENA). DFL's observations in Bolivia were made while leading Field Guides Inc. tours. The curators and staff of American Museum of Natural History, New York (George Barrowclough, Paul Sweet, Peter Capaniolo and Shannon Kenny), CORBIDI (Thomas Valqui) and MUSM (Irma Franke) permitted access to their collections. Sebastian Herzog, Sjoerd Mayer and Ross MacLeod made information and recordings available from observations in Bolivia. Todd Mark provided useful recordings of *Lipaugus fuscocinereus*. The paper was improved by comments from Andrés Cuervo, J. V. Remsen, Tom Schulenberg, Bret Whitney and several anonymous reviewers.

References:

Berv, J. S. & Prum, R. O. 2014. A comprehensive multilocus phylogeny of the Neotropical cotingas (Cotingidae, Aves) with a comparative evolutionary analysis of breeding system and plumage dimorphism and a revised phylogenetic classification. *Mol. Phyl. & Evol*. 81: 120–136.

BirdLife International. 2000. *Threatened birds of the world*. Lynx Edicions, Barcelona & BirdLife International, Cambridge, UK.

Bryce, R., Hennessey, A. B., MacLeod, R., Evans, K., Ewing, S. R., Herzog, S. K., Maccormick, A. & Gomez, M. I. 2005. First sound recordings, new behavioural and distributional records, and a review of the status of Scimitar-winged Piha *Lipaugus uropygialis*. *Cotinga* 24: 102–106.

Cuervo, A. M., Salaman, P. G. W., Donegan, T. M. & Ochoa, J. M. 2001. A new species of piha (Cotingidae: *Lipaugus*) from the Cordillera Central of Colombia. *Ibis* 143: 353–368.

Fjeldså, J. & Krabbe, N. 1990. *Birds of the high Andes*. Zool. Mus., Univ. of Copenhagen & Apollo Books, Svendborg.

Hennessey, A. B., Herzog, S. K. & Sagot, F. 2003. *Lista anotada de las aves de Bolivia*. Fifth edn. Asociación Armonía / BirdLife International, Santa Cruz de la Sierra.

Herzog, S. K., Terrill, R. S., Jahn, A. E., Remsen, J. V., Maillard Z., O., García-Solíz, V. H., MacLeod, R., Maccormick, A. & Vidoz, J. Q. 2017. *Birds of Bolivia*. Asociación Armonía, Santa Cruz de la Sierra.

Kirwan, G. M. & Green, G. 2012. *Cotingas and manakins*. Princeton Univ. Press.

Lane, D. F. & Pequeño, T. 2004. Birds. Pp. 204–214 *in* Vriesendorp, C., Chávez, L. R., Moskovits, D. & Shopland, J. (eds.) 2004. *Perú: Megantoni*. Rapid Biological Inventories 15. Field Museum of Natural History, Chicago.

Lane, D. F., Servat, G. P., Valqui, T. & Lambert, F. R. 2007. A distinctive new species of *Cnipodectes* tyrant flycatcher (Passeriformes, Tyrannidae) from southeastern Peru. *Auk* 124: 762–772.

López-Lanús, B. 2000. Display and mechanical sound in Dusky Piha *Lipaugus fuscocinereus*. *Cotinga* 13: 44–45.

Ohlson, J., Prum, R. O. & Ericson, P. G. P. 2007. A molecular phylogeny of the cotingas (Aves: Cotingidae). *Mol. Phyl. & Evol*. 42: 25–37.

Prum, R. O. 2001. A new genus for the Andean green pihas (Cotingidae). *Ibis* 143: 307–309.

Prum, R. O., Rice, N. H., Mobley, J. A. & Dimmick, W. W. 2000. A preliminary phylogenetic hypothesis for the cotingas (Cotingidae) based on mitochondrial DNA. *Auk* 117: 236-241.

Remsen, J. V. & Traylor, M. A. 1989. *An annotated list of the birds of Bolivia*. Buteo Books, Vermillion, SD.

Remsen, J. V., Parker, T. A. & Ridgely, R. S. 1982. Natural history notes on some poorly known Bolivian birds. *Gerfaut* 72: 77–87.

Ridgely, R. S. & Tudor, G. 1994. *The birds of South America*. Univ. of Texas Press, Austin.

Ridgely, R. S. & Tudor, G. 2009. *Field guide to the songbirds of South America: the passerines*. Univ. of Texas Press, Austin.

Robbins, M. B., Schulenberg, T. S., Lane, D. F., Cuervo, A. M., Binford, L. C., Nyári, Á. S., Combe, M., Arbeláez-Cortés, E., Wehtje, W. & Lira-Noriega, A. 2013. Abra Maruncunca, dpto. Puno, Peru, revisited: vegetation cover and avifauna changes over a 30-year period. *Bull. Brit. Orn. Cl*. 133: 31–51.

Sclater, P. L. & Salvin, O. 1876. On new species of Bolivian birds. *Proc. Zool. Soc. Lond*. 1876: 352–358.

Snow, D. W. 1979. Family Cotingidae. Pp. 281–308 *in* Traylor, M. A. (ed.) *Check-list of birds of the world*, vol. 8. Mus. Comp. Zool., Cambridge, MA.

Snow, D. W. 1982. *The cotingas*. Cornell Univ. Press, Ithaca, NY.

Snow, D. W. 2004. Family Cotingidae (cotingas). Pp. 32–108 *in* del Hoyo, J., Elliott, A. & Christie, D. A. (eds.) *Handbook of the birds of the world*, vol. 9. Lynx Edicions, Barcelona.

Tello, J. G. & Bates, J. M. 2007. Molecular phylogenetics of the tody-tyrant and flatbill assemblage of tyrant flycatchers (Tyrannidae). *Auk* 124: 134–154.

Vriesendorp, C., Chávez, L. R., Moskovits, D. & Shopland, J. (eds.) 2004. *Perú: Megantoni*. Rapid Biological Inventories 15. Field Museum of Natural History, Chicago.

Walker, B., Stotz, D. F., Pequeño, T. & Fitzpatrick, J. W. 2006. Birds of the Manu Biosphere Reserve. Pp. 23–49 *in* Patterson, B. D., Stotz, D. F. & Solari, S. (eds.) Mammals and birds of the Manu Biosphere Reserve, Peru. *Fieldiana Zool*. 110.

*Addresses*: Daniel F. Lane, Louisiana State University Museum of Natural Science, 119 Foster Hall, Baton Rouge, LA 70803-3216, USA, e-mail: barbetboy@yahoo.com. Tatiana Pequeño, Calle Federico Gerdes 141, San Miguel, Lima, Peru.

# Breeding biology during the nestling period at a Black-crowned Pitta *Erythropitta ussheri* nest

*by Eric R. Gulson-Castillo, R. Andrew Dreelin, Facundo Fernandez-Duque, Emma I. Greig, Justin M. Hite, Sophia C. Orzechowski, Lauren K. Smith, Rachel T. Wallace & David W. Winkler*

*Received 30 March 2017; revised 3 July 2017; published 15 September 2017*

*http://zoobank.org/urn:lsid:zoobank.org:pub:8F5C236B-0C84-402A-8F73-A56090F59F56*

Summary.—The natural history of most Pittidae is understudied, but the breeding biology of the genus *Erythropitta*, a recently recognised grouping of red-bellied pittas, is especially poorly known. We monitored and video-recorded a Black-crowned Pitta *E. ussheri* nest in Sabah, Malaysian Borneo, during the nestling period and found that the male had a higher visitation rate and the female was the sole adult that brooded. We clarify this species' nestling development and describe two vocalisations: (1) the first instance of a fledgling-specific song in Pittidae and (2) a soft grunt-like sound given by adults arriving at the nest early in the nestling period. We analysed the structure of each visit, finding that the longest segment of most parental visits was the period between food delivery and parental departure. We hypothesise that adults linger to await the production of faecal sacs and aid nestlings to process food.

The pittas (Pittidae) are a colourful group of Old World understorey birds that were recently split into three genera: *Pitta*, *Hydrornis* and *Erythropitta* (Irestedt *et al*. 2006). This classification is supported by morphology and occurrence of sexual dimorphism (Irestedt *et al*. 2006), but further comparisons are difficult because data on much of the pittas' natural history are lacking. Only the breeding biology of Gurney's *Hydrornis gurneyi*, Giant *H. caerulea*, Rainbow *Pitta iris* and Fairy Pittas *P. nympha* have been fully documented (Round & Treesucon 1986, Round *et al*. 1989, Gretton 1988 *in* Lambert & Woodcock 1996, Zimmermann & Noske 2003, Lin *et al*. 2007b, Donald *et al*. 2009, Kim *et al*. 2012), while sporadic quantitative data have been reported for a handful of other species (Lambert & Woodcock 1996, Erritzoe & Erritzoe 1998). The nests and clutch sizes of most *Erythropitta* are known, but virtually no detailed observations have been made on the nesting behaviour of any species in this genus.

Black-crowned Pitta *Erythropitta ussheri* is endemic to northern Borneo. There are eight published breeding records (Gibson-Hill 1950; summarised in Lambert & Woodcock 1996, Mann 2008; excluding one with a 'yellow chick', see Discussion), which show that—like many other Bornean birds—the species usually nests just after the north-east monsoon (February–July; Fogden 1972). Its nest is a domed structure of sticks, bark, fine roots and leaves, and it lays two white eggs with dark red and black spots forming a ring at the broader end (Lambert & Woodcock 1996). This taxon is sometimes treated as a subspecies of Garnet Pitta *E. granatina* due to certain plumage similarities and 1–2 apparently hybrid specimens (the number varies according to the authority; Stresemann 1938 *in* Voous 1961, Erritzoe & Erritzoe 1998). Regardless, detailed observations on the nests of either taxon would be novel (Lambert & Woodcock 1996).

Based on a nest of Black-crowned Pitta, we present the first detailed documentation of the nestling period in an *Erythropitta* species. We partitioned each provisioning visit into

© 2017 The Authors; Journal compilation © 2017 British Ornithologists' Club

time periods around the beginning and end of feedings, and present hypotheses as to the selection factors affecting the length of each visit segment and visit duration as a whole.

## Methods

***Study area***.—The study took place in Tawau Hills Park (04.399°N, 117.889°E), a reserve managed by the state agency, Sabah Parks, in southern Sabah, Malaysia, in northern Borneo. The park is *c*.72 km from the border with Kalimantan, Indonesia, and protects 280 km$^2$ of lowland dipterocarp forest, lower montane forest and patches of other habitat (Omar & Nais 1995). We concentrated our efforts in the lowlands, surveying our study site near the park headquarters daily for pitta activity between 26 February and 20 May 2013, covering an area of *c*.1.5 km$^2$. We regularly scouted ridges and swamps near the Tawau River, monitoring pitta territories and nesting activities.

***Nest observations***.—The Black-crowned Pitta nest was found midday on 2 March 2013, when three of us (JMH, DWW, SCO) following the base of a gully inadvertently stepped on a log adjacent to the nest, causing the bird to flush. Prior to this, the same observers had been performing Black-crowned Pitta playback nearby at half-hour intervals with no vocal response. At the time of discovery, the nest was complete and held two eggs. We did not visit again until 4 March, when we erected a hide *c*.7 m from the nest, opposite the stream running through the gully. The hide was sited behind the intersection of a fallen log and a large buttressed stump, and consisted of two curtains of camouflage cloth hung over parallel lines of parachute-cord, so that a lens could be placed between the two curtains and a person could sit comfortably behind the log. The fallen log concealed us from the nest as we entered the hide. We monitored the nest using our cameras and continually recorded events around it. Videos were made using Canon 5D Mark II, 5D Mark III or 7D camera bodies with 70–200 mm, 400 mm or 500 mm lenses, often with 1.4× or 2× teleconverters. A subset of our videos is archived at the Macaulay Library of Natural Sounds, Cornell University (www.macaulaylibrary.org) and are referred to here using their ML catalogue numbers.

Our initial nest watch lasted 154 minutes on 4 March. We then did not visit the nest until 6 March, allowing the birds to acclimatise to disturbance before we began a nest-watching routine that spanned, maximally, 07.00–18.00 h daily. Over the 15-day nestling period, we summed on average 8.67 observation hours per day and completed five full-day nest watches. Our videos from 6 March showed the mostly obscured bird on the nest consuming both eggshells (ML 479789), indicating the nestlings hatched that day. We numbered days thereafter using this date as day 0.

On 16 March (day 10) at 13.20 h we extracted the chicks while wearing nitrile gloves to prevent predator-attracting scents and took them 50 m away to be banded, measured and photographed. During this time, SCO remained near the nest to ensure that the birds did not return before the nestlings had been replaced. We excluded post-banding events in our behavioural analysis for 16 March. On 18 March at 12.00 h we set mist-nets around the gully, blocking flyways to the nest. The mist-nets were 3–8 m long and 3–5 trammels tall, with 30 mm mesh. We kept them open during our watches until we had caught both adults, the female on 19 March and the male on 20 March. We excluded these 2.5 days from our analysis of parental care. We collected *c*.70 μl of blood using brachial venipuncture from all four birds (adults and nestlings) that we later used for DNA sexing. The birds were released without harm. We placed bands in unique combinations on the birds' legs and covered the bands with thin pieces of coloured electric tape, replicating colour bands, to ease identification of individuals in the field (Table 1).

The chicks fledged on 21 March (day 15) with the nest still intact. However, when we returned to collect the nest five days later, it had been dismantled, apparently by a predator.

TABLE 1
Individual measurements with their colour band combinations.

| **Bird** | **Band colour (leg)** | **Mass (g)** | **Flat wing (mm)** | **Tarsus (mm)** | **Tail (mm)** | **Culmen (mm)** | **Bill depth (mm)** | **Bill width (mm)** | **Head + bill (mm)** |
|---|---|---|---|---|---|---|---|---|---|
| Nestling, day 10 | Blue (L), yellow (L) | 44.0 | 61.0 | 39.0 | 11.0 | 7.1 | 4.2 | 4.3 | 36.8 |
| Nestling, day 10 | Red (R), blue (R) | 40.2 | 59.0 | 38.0 | 11.0 | 7.0 | 4.1 | 5.1 | 35.2 |
| Female | Orange (R), yellow (L) | 59.5 | 90.0 | 39.9 | 38.7 | 14.3 | 8.0 | 6.8 | 48.8 |
| Male | Yellow (R) | 58.5 | 93.0 | 42.75 | 36.1 | 15.15 | 7.85 | 6.3 | 51.5 |

This prevented direct measurements of nest dimensions in the field, but we reconstructed these measurements from photographs. We collected and photographed the nest material, sorted by size and type.

***Video analysis***.—We took the following data for each nest visit recorded on video: sex of the visiting adult, time of arrival, time when the adult started feeding (a 'feeding' occurred when food was visibly placed or manipulated inside a nestling's gape, which could be recognised at a distance by the quick bobbing or shaking of the adult's head), time when the adult gave the last 'feed', number of feeds per visit, time of departure, extraction of faecal sacs, and exit direction from the nest. Arrival and departure times were based on the moment an adult's feet touched or left the nest entrance and were used to calculate visit duration, feeding latency (time between arrival and the first feed; *sensu* Pugesek 1990, Siegel *et al*. 1990) and departure latency (time between the last feed and departure). Time spent feeding was the period between the first and last feeds. We counted the number of times the birds fed nestlings as a proxy for the amount and / or handling time of the food delivered. Direct measurements of food quantity from videos were impossible because of variable image quality. Brooding visits were easily recognised, as they involved an adult entering the nest and remaining there for at least an hour and often much longer.

***Sexing the adults***.—From observations of the adults in the field and in the hand, we determined that they differed slightly but reliably in plumage, with the male being generally subtly brighter than the female. This dimorphism enabled us to identify them in the videos. Although lighting could influence field marks, the most reliable separator was the shade and extent of blue on the wing-coverts (Fig. 1A–B), bright sky-blue in the male, while the female had desaturated darker blue coverts. However, in poor light the lesser extent of blue on the female's coverts was a better indicator because she showed a broader area of grey between the two rows of blue feathers. While the following marks were less consistent, we used them as supporting evidence: the male had a shaggier and more distinct supercilium, a brighter purple mantle, and a darker black head than the female. On visits for which we lacked video, we designated the visiting adult's sex as 'unknown' due to the difficulty of reliably sexing birds in the field without a video record.

We later confirmed adult sex by amplification of W- and Z-specific alleles using the 2550F/2718R sexing protocol (Fridolfsson & Ellegren 1999). In our amplification of the W- and Z-specific alleles, we used as a reference the DNA of a Black-crowned Pitta specimen, which we collected during the same expedition (CUMV 55593). We stained this specimen with a 1% Lugol's (IKI) solution (Metscher 2009) and inspected a 50 µm CT scan obtained on an GE eXplore CT-120 micro CT (General Electric, Fairfield, CT) taken at the Cornell Imaging Facility (http://www.biotech.cornell.edu/brc/imaging-facility). The specimen showed ova in its ovary, so we definitively sexed the reference pitta as female. Molecular sexing confirmed our visual identifications of the video records.

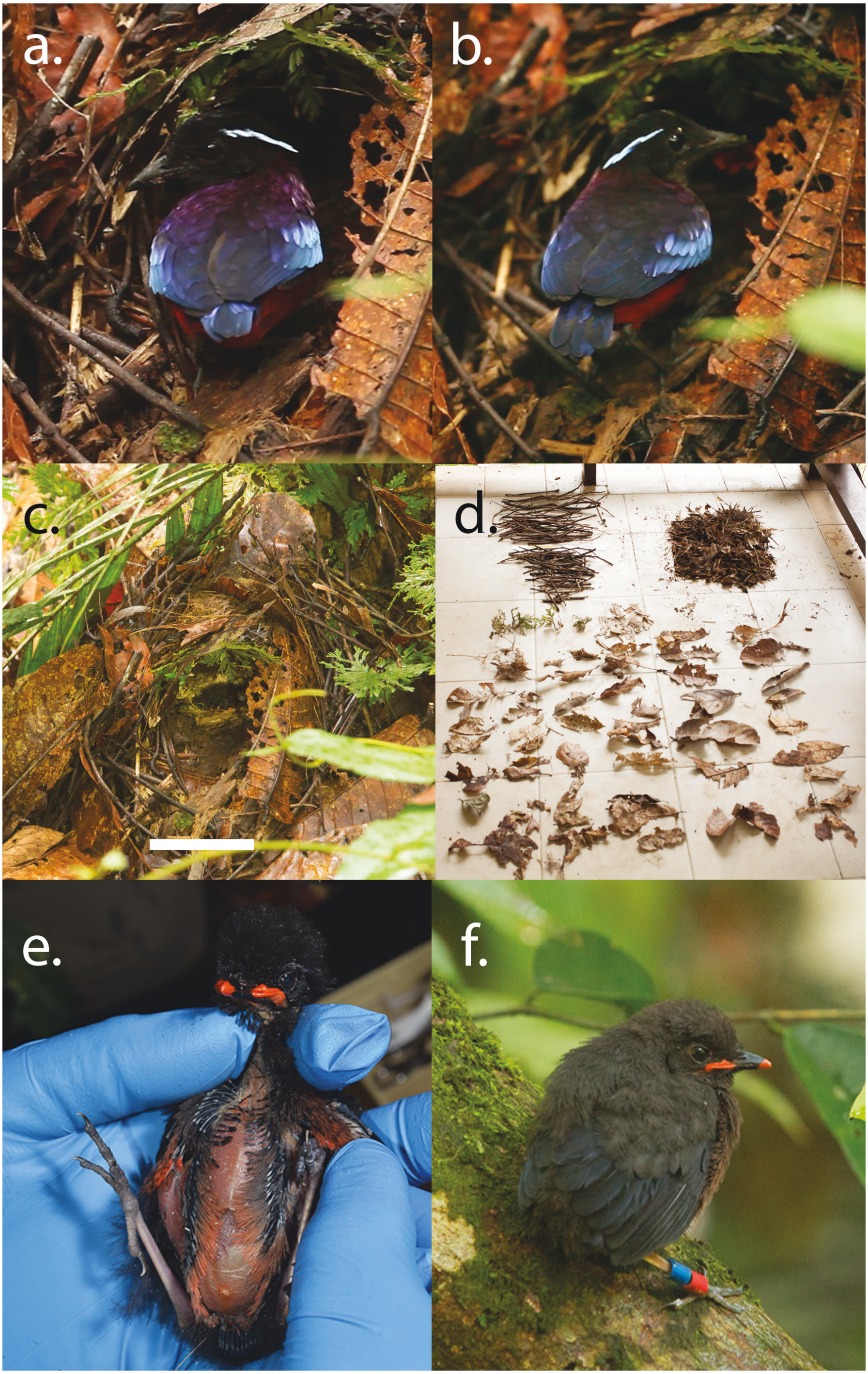


Figure 1. Various aspects of the nesting biology of Black-crowned Pitta *Erythropitta ussheri*. (A) Adult male at the nest entrance (Justin M. Hite). (B) Adult female showing duller wing-coverts and mantle coloration, plus greyer face (Emma I. Grieg). (C) The intact nest and immediate surroundings, with orange bill tips of the nestlings just visible in the nest; the white bar measures *c*.10 cm (David W. Winkler). (D) The nest components disassembled. (E) A nestling on day 10 (© J. Ryan Shipley). (F) A juvenile an hour after fledging on Day 15 (Sophia C. Orzechowski).

© 2017 The Authors; Journal compilation © 2017 British Ornithologists' Club

***Linear measurements***.—We used ImageJ 1.49 (Schneider *et al*. 2012) to measure nest dimensions, nest components, and faecal sacs from photographs and video screenshots. We aligned nest components next to a ruler so that we could convert measured pixels into mm. We excluded sticks not entirely visible in the photographs. We measured the nest's general dimensions (e.g. height and width) by taking a video screenshot when an adult had its bill perpendicular to the camera so that we could use bill length as a scale. Similarly, we used screenshots of the birds holding faecal sacs to calculate sac width and length using known bill dimensions (see Table 1).

***Sound analysis***.—We used Raven Pro 1.4 (Bioacoustics Research Program 2011) for all acoustic measurements. When measuring upper and lower frequencies of a vocalisation, we used the functions Frequency 95% and Frequency 5%, which give intervals containing 90% of the energy of a selection. This helped maintain consistency across measurements.

***Statistical analysis***.—We performed all statistical analyses in R version 3.1.0 (R Core Team 2014). We used linear models (function 'lm') to understand which factors affected aspects of visit length or visitation rate. In all cases, we tested for behavioural differences between the sexes and for trends across the nestling season by date. Dependent variables are listed in Table 2. Sex and date are predictors for all models; other predictors (explained below) are context-specific and attempt to explain variation in our measurements and their effects on visit structure. We used hour of the day to test for circadian patterns in visitation rate. We noticed that feeding latency decreased rapidly during the first three days of observation, so we included both date squared and a dichotomous variable indicating whether or not the nestlings were being brooded (because the male often visited to feed while the female was brooding and the female sometimes fed nestlings before entering the

TABLE 2

Linear model (function 'lm') outputs for tests of the strength of the relationship between each dependent variable and the listed independent variables. (*) indicates statistical significance at $P = 0.05$.

| **Dependent variable** | **Independent variables** | **Estimate** | **Standard error** | ***t* value** | ***P* value** |
|---|---|---|---|---|---|
| (a) visitation rate | (Intercept)* | 11.82 | 2.36 | 5.02 | <0.001* |
| | date* | -0.15 | 0.03 | -4.48 | <0.001* |
| | sex—female* | -13.07 | 4.56 | -2.87 | 0.005* |
| | hour of day | 0.002 | 0.03 | 0.06 | 0.95 |
| | date:sex—female* | 0.17 | 0.06 | 2.71 | 0.008* |
| (b) visit duration | (Intercept) | 4.59 | 38.09 | 0.12 | 0.90 |
| | date | 0.37 | 0.55 | 0.66 | 0.51 |
| | sex—female | -4.97 | 4.80 | -1.04 | 0.30 |
| | sex—unknown | -1.95 | 21.39 | -0.09 | 0.93 |
| (c) feeding latency | (Intercept) | 400.71 | 263.71 | 1.52 | 0.13 |
| | sex—female | 1.05 | 0.99 | 1.06 | 0.29 |
| | date | -9.13 | 7.76 | -1.18 | 0.24 |
| | I(date^2) | 0.04 | 0.06 | 0.85 | 0.40 |
| | brooding - no* | -139.87 | 39.39 | -3.55 | <0.001* |
| | date:brooding - no* | 2.01 | 0.58 | 3.48 | 0.001* |
| (d) log (feeding duration) | (Intercept)* | 3.43 | 1.19 | 2.89 | 0.005* |
| | sex—female | -0.16 | 0.14 | -1.18 | 0.24 |
| | date* | -0.05 | 0.02 | -3.06 | 0.003* |
| | no. of feeds* | 0.68 | 0.04 | 18.49 | <0.001* |
| (e) departure latency | (Intercept)* | 62.90 | 22.21 | 2.83 | 0.005* |
| | date | -0.63 | 0.32 | -1.95 | 0.05 |
| | faecal sac—yes* | 8.96 | 2.77 | 3.23 | 0.002* |
| | sex—female | 1.30 | 2.56 | 0.51 | 0.61 |

nest to brood) as a predictor for the feeding latency of each visit. To evaluate the relationship between feeding duration and the amount of food delivered, we used number of feeds as a predictor for feeding duration. We also included a dichotomous variable testing the effect of faecal sac removal on the departure latency. All models are summarised in Table 2.

Finally, we used a Fisher's exact test (function 'fisher.test') for count data to determine: (1) if there was a statistical relationship in exit direction from the nest with or without a faecal sac (excluding the 9.8% of visits for which exit direction could not be determined), and (2) if the difference between the number of faecal sacs extracted by each sex was due to a difference in the number of visits to the nest by each parent.

## Results

***The nest and its environs.***—The small gully harbouring the nest was carved into the steep and densely vegetated lower slopes of a ridge. A trickling stream along its bottom widened into larger puddles immediately before emptying into a swamp in the flat lowland below the ridge. The nest was constructed *c.*0.5 m above the stream on the side of the gully. It was dome-shaped and consisted largely of dead leaves, leaf skeletons and small twigs, plus several small spike mosses (*Selaginella* sp.; Fig. 1C–D; Table 3). Its entrance had a layer of rotting wood chips that the adults landed on when visiting the nest. The entire nest was 24 cm wide and 22 cm tall, and the entrance was 10 × 11 cm. The birds integrated surrounding vegetation into the nest, including some *Selaginella* and the lower end of a rattan (*Calamus* sp.) frond. The birds bent the rattan so that its leaves were woven into the back of the dome and the frond shaded the nest from above. The frond sprang back up when we collected the nest.

***Activity at the nest.***—On 4 March, our only nest watch during incubation, we observed the male bring a stick to the nest and arrange it inside the main cavity at 06.14 h. He was still inside the nest when the watch ended 2.25 hours later. There was no sign of other birds in this period.

During the nestling period, we observed a total of 241 nest visits over 114.8 hours of observation and recorded 174 of these visits on video. More than half of the total visits were made by the male (64%; 155 visits) and 20% (48 visits) were made by the female, with 16% (38 visits) by an adult we were unable to sex. Excluding hours associated with prolonged human disturbance at the nest, we remain with 209 visits made over 96.2 hours of observation, with a mean 2.17 visits/hour. When calculating sex-specific visitation rates, we further excluded hours in which we observed the nest for <0.8 hours and during which the adult could not be sexed, as when there was no camera recording. This left 154 visits over 74.3 hours, of which the male made 127 (82%). The male visited the nest more frequently but his visitation rate declined steadily over the course of the nestling period (Fig. 2, Table 2). The female progressively increased her visitation rate throughout the season, with her visitation rate converging with that of the male by the end of the season. Time of day did not affect visitation patterns for either sex. Over the nestling period, the male made a mean

TABLE 3
Summary of nest component dimensions by type.

| Component type | Mean length | Mean width | Max. length | Max. width | % composition |
|---|---|---|---|---|---|
| Stick ($n$ = 71) | 205 mm | 5 mm | 663 mm | 9 mm | 57% |
| Leaf ($n$ = 51) | 117 mm | 41 mm | 267 mm | 89 mm | 41% |
| *Selaginella* sp. ($n$ = 3) | 108 mm | 85 mm | 161 mm | 157 mm | 2% |

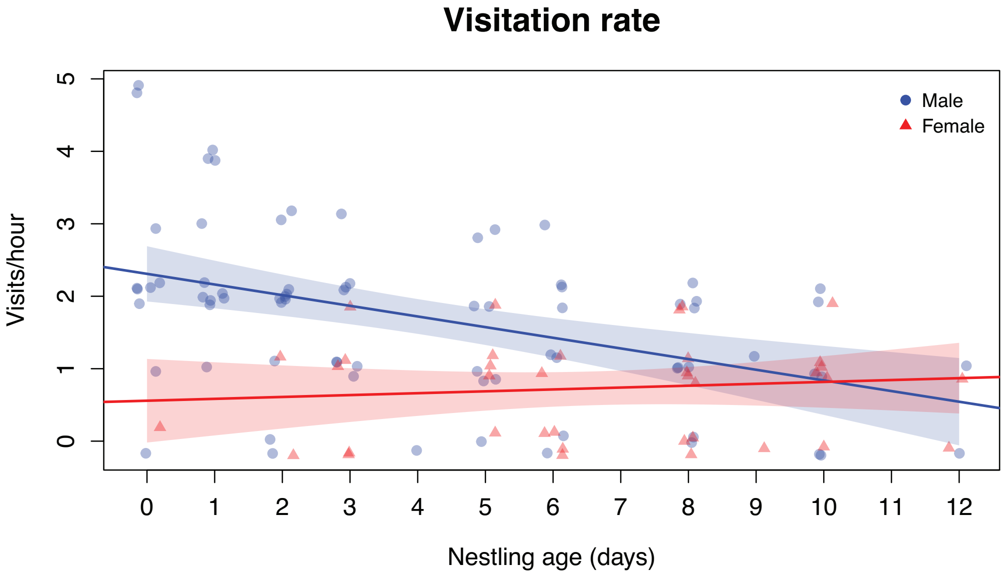


Figure 2. Visitation rate by sex throughout the nestling season. Day 0 = the day the nestlings hatched. Each point represents the number of visits that we witnessed over the course of an hour by sex—the axis ends on day 12 because we excluded all hours in which we caused disturbances or did not observe the nest for ≥0.8 hours (including days 13–15). This excludes visits for which the sex of the bird was unclear. There are few female visits or absences during the first three days because she was brooding. Red triangles = female visits, blue circles = male visits. The lines are linear regressions representing the interaction value on our linear model (see Table 2).

1.69 visits / hour and the female 0.72 visits / hour. Day 1 witnessed the highest visitation rates, when the male made a mean 2.55 visits / hour (the female spent the day brooding). The most visits in an hour we witnessed were five, associated with the rejection of food by the female (see Brooding).

A typical visit began with the adult approaching the nest from the opposite side of the gully (ML 479313) or the bottom of the gully (ML 479977), sometimes perching *c*.3 m away for several seconds before moving to the nest. It then would fly directly to the entrance, land on it, and sometimes look around or in the nest. Then stepping onto the edge of the cup, it would stretch to shove its bill into the begging mouths, shaking its head as it relinquished food. The bird then waited for several seconds before leaving, sometimes departing with a faecal sac (ML 484393). Visits lasted a mean 28.9 seconds, with no effect of sex or date on visit duration (Table 2).

***Brooding***.—Only the female was observed brooding and we noted eight brooding periods. In counting these bouts, we assumed that a female that was in the nest when we left in the evening and there when we returned next morning, had spent the night brooding (Fig. 3). The female spent almost the entirety of days 0 and 1 brooding, but she gradually brooded less, departing around 10.00 until day 6, when she left the nest at 08.01. We did not record any more instances of brooding and do not know if the female continued roosting in the nest after the evening of day 5. The hours during which the female brooded did not factor into calculating her visitation rate, but the decrease in brooding activity correlated with an increase in provisioning rates.

When arriving at the nest to commence brooding, the female would pause and look around as during a typical provisioning visit. She would then enter, and settle down out of sight except for her red underparts, visible in the dome's shadows (ML 487400). We

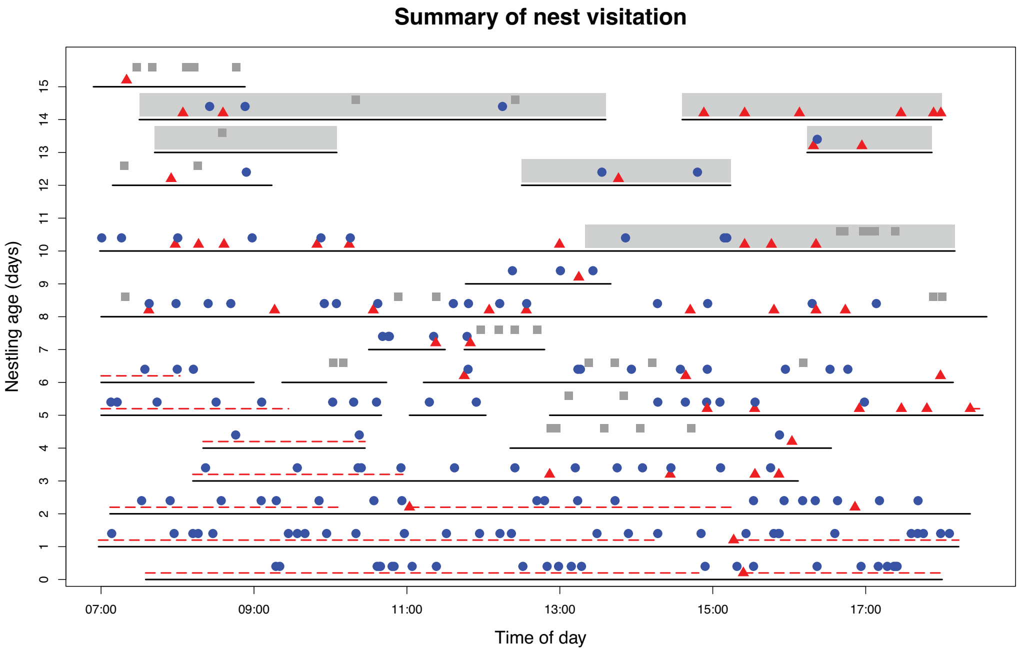


Figure 3. Graphical representation of the visits we witnessed at the nest. Red triangles = female activity, blue circles = male activity, and pale grey squares = visits we could not attribute to either sex, usually because they were not captured on video. Dashed red lines = periods during which the female was brooding, and the female was already on the nest when they do not begin with a point. Solid black lines = our presence at the hide, i.e. sampled period. Periods during which mist-nets were set around the nest and those following an anthropogenic disturbance (either mist-netting or banding of nestlings) are shaded pale grey; we excluded data collected during those periods from most analyses because the disturbances probably affected the birds' behaviour.

recorded her feeding the nestlings before entering the nest twice, but on her first brooding visit she carried the food into the nest with her. When departing, she walked to the edge of the nest head-first and flew away immediately, without pausing (ML 487402).

The male visited the nest during each of the female's diurnal brooding bouts. Early in the season, the male would wait for her to move sideways in the nest chamber, the nestlings would beg, and the male fed them directly. Subsequently, the female brooded so that the nestlings' bills were already visible when the male arrived. The male fed the female at least once, but in most circumstances there was insufficient light to determine if this was a regular occurrence. The feeding latencies for both adults, especially the male, were particularly long on days 0–2 but decreased rapidly with time. The model that best fits these data suggested that the female's presence at the nest caused the male to delay food delivery early in the season, but the interaction between date and the female's brooding behaviour reveals that feeding latency was never very long when the female was not brooding (Fig. 4, Table 2). Mean feeding latency during a visit associated with brooding was 7.8 seconds and that without brooding 1.4 seconds; sex was not a significant predictor in the model (Table 2) probably because the female fed the nestlings from outside the nest before entering it to brood on a couple of occasions meaning that there was still a feeding latency attached to her visits to brood.

Occasionally on days 0–1, the female did not respond to the arrival of the male while she was brooding and the male would depart the nest still carrying the food it had brought. This included the first five visits the male made on day 0, despite these being spread over

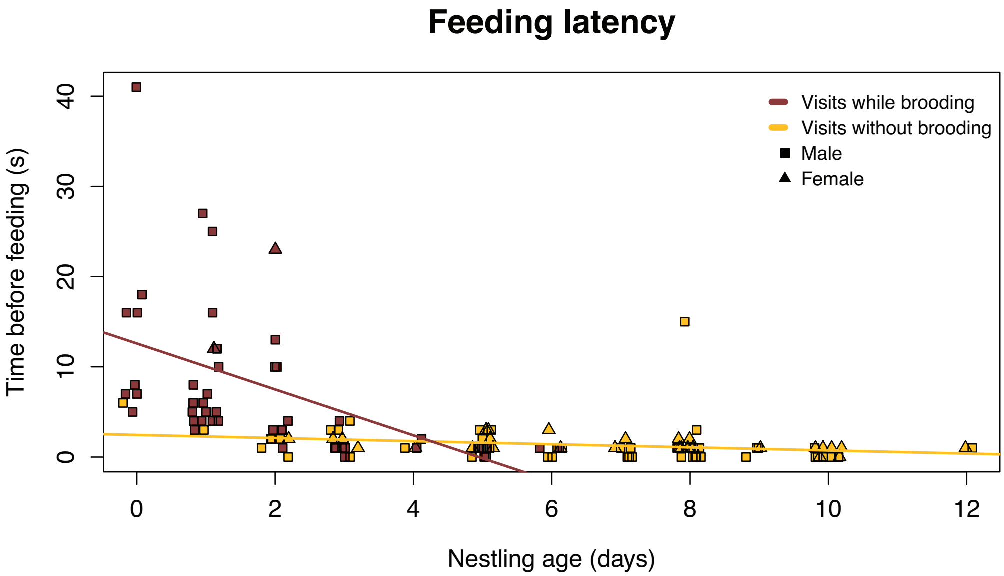


Figure 4. Time between arrival and feeding (feeding latency) declined sharply during the first three days of observation. Feeding latency was longest when the female arrived to brood or the male arrived while the female was brooding. Squares = male visits, triangles = female visits, red points = the female was brooding during the visit, and yellow points = visits when the female was not brooding. The lines are linear regressions representing the interaction value on our linear model (see Table 2).

1.5 hours. On five occasions, the male made up to four consecutive visits before being able to feed the nestlings (e.g. ML 484392). During one of these series of repeated visits, JMH noticed that the male was perched at the edge of the fallen log at the base of the gully, waiting before flying back to the nest again. These repeated visits may have influenced the overall high visitation rates we recorded during these two days (Figs. 2–3).

Additionally, the male hopped by the nest twice without going onto the nest entrance early on day 0 at 07.45 h and 08.52 h. The second time, he perched upright and flicked his wings several times before departing. This latter occasion occurred 30 minutes before we noticed the female eating the eggshells.

***Nestling diet and feeding.***—The quality of video was generally insufficient to identify the items the adults brought to the nestlings, but it was possible to identify a large diversity of invertebrates, such as orthopterans, lepidopterans (both adults and caterpillars), arachnids, annelids and grubs. We also saw them bring what appeared to be a small colubrid snake (*sensu lato*). When we caught the female in a mist-net coming to the nest, she was carrying a large spider. When we caught the male a day later, he was bringing a 2–3 cm caterpillar and a 2–3 cm cricket. On 26 March, we also saw an adult in the neighbouring territory bring a large spider to its fledgling.

Adults did not differ in the amount of time they spent feeding the nestlings during each provisioning visit; this was correlated with the number of times the bird inserted its head in the nest to feed or move food items ('feeds') during each visit (Fig. 5, Table 2). The male stayed at the nest longest when bringing the small snake, repositioning the prey several times. The mean time the adults spent feeding the nestlings within provisioning visits was 7.0 seconds.

***Faecal sacs.***—The adults routinely removed faecal sacs from day 2 until the nestlings fledged on day 15. Faecal sacs were large and white, except a clump of dark material at one end (Fig. 6A). When ejecting a faecal sac, a nestling would turn its vent toward the nest

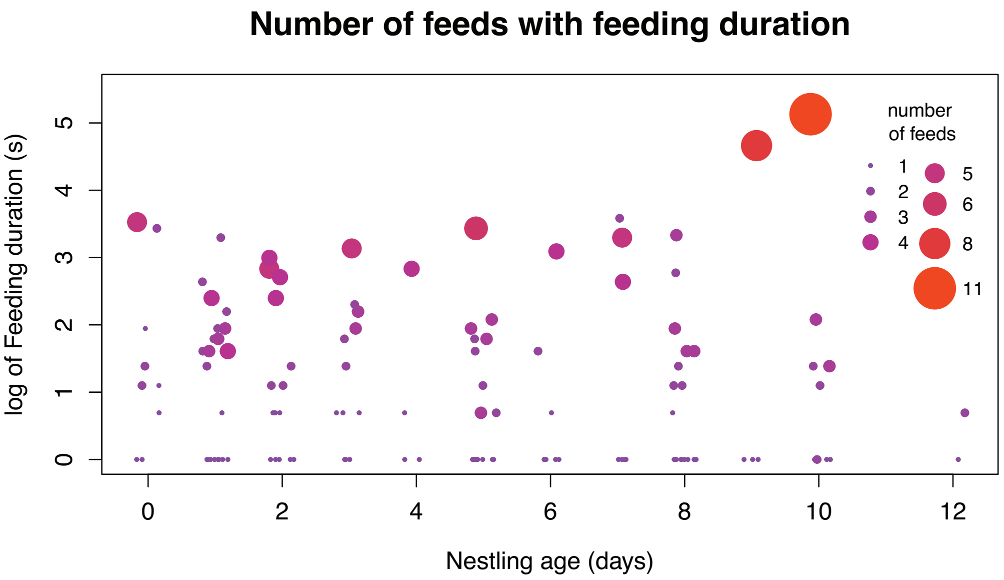


Figure 5. Feeding duration declined somewhat with time but increased noticeably with the number of 'feeds', i.e. the number of times an adult inserted food into the nestlings' mouths. Number of feedings is a proxy for number of food items and effort spent feeding, as we could not distinguish between either possibility on video.

Figure 6A. Adult male Black-crowned Pitta *Erythropitta ussheri* exiting the nest with a faecal sac; the clump of darker matter is visible at the end of the faecal sac furthest from the bird (Emma I. Greig). B. Male looking out of the nest during the departure latency (Justin M. Hite).

entrance and permit an adult to take the sac directly from the cloaca—when the nestlings were older this occurred while its sibling continued to beg. The adults almost always

© 2017 The Authors; Journal compilation © 2017 British Ornithologists' Club ISSN-2513-9894 (Online)

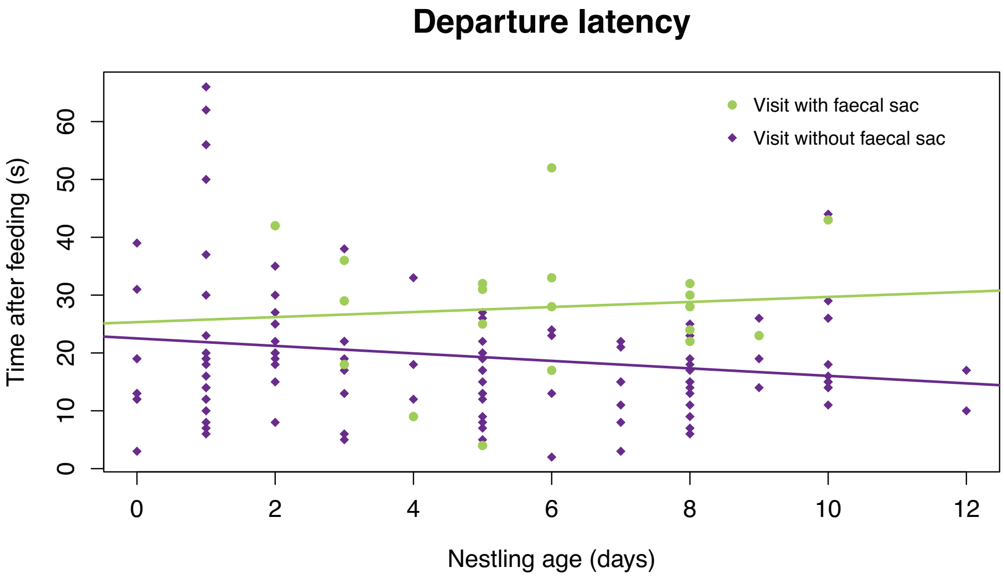


Figure 7. Time spent at the nest after feeding but before departing (departure latency) tended to be longer when an adult extracted a faecal sac. Purple diamonds = visits in which adults did not extract a faecal sac and green diamonds = visits in which they did extract a faecal sac. The lines are linear regressions representing the interaction value on our linear model (see Table 2).

stayed at the nest after they finished feeding the chicks—the departure latency—and the production of faecal sacs significantly increased this length of time (Fig. 7, Table 2) from a mean 19.3 seconds to one of 27.9 seconds. The adults never lingered after receiving a faecal sac, and once when a chick had left a faecal sac on the nest edge without an adult present, the adult promptly removed the sac after feeding the nestlings and its departure latency was only four seconds.

Birds exiting the nest with a faecal sac tended to fly downstream along the gully (92% of visits with a faecal sac, in the remaining 8% exit direction could not be determined from the videos and were excluded from analysis). The birds occasionally dropped faecal sacs in a small pool in the gully, 15–20 m from the nest. With a Fisher's exact test, we found that the adults were significantly more likely to fly upstream or across the gully, to nearby cover, when they left without a faecal sac (72% of visits without a faecal sac, $P < 0.001$).

We observed the pittas remove 35 faecal sacs over the course of the nestling period. Of those that we could measure digitally, mean faecal sac length was 30.3 mm and mean width 22.6 mm ($n = 18$). Unfortunately, the measurements we took were insufficiently precise to detect changes in faecal sac size over time. Excluding the first two days with no faecal sacs, the adults removed a mean 0.40 sacs / observation hour, or one sac about every 2.5 hours. The male removed more faecal sacs than the female, 16 vs. nine, but a Fisher's exact test showed that this was driven by his higher visitation rate, not a difference in the rate of faecal sac removal by sex per visit ($P = 0.31$).

***Visit structure***.—To compare the relative length and importance of each visit segment across the nestling period, we plotted them as a proportion of their corresponding visit (Fig. 8). Feeding latency represented a large proportion of each visit during the first three days, but subsequently was consistently short. Feeding duration tended to be short, but showed more variation throughout the season. Otherwise, departure latency consistently comprised the bulk of each visit: the adults spent most of their time on the nest after they had finished feeding the nestlings.

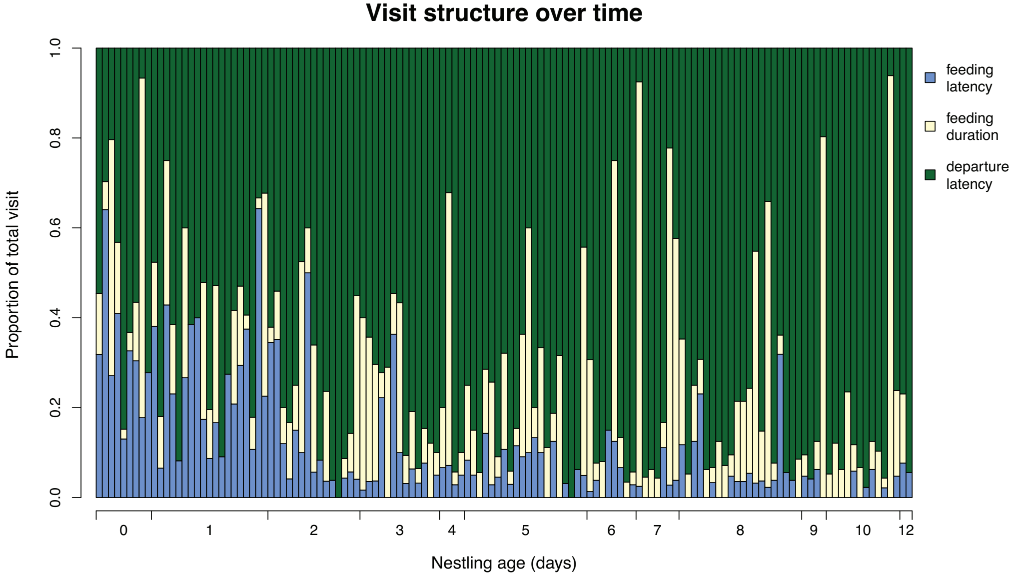


Figure 8. The proportion of a visit taken by each visit segment: pale blue segments = feeding latency, yellow segments = time spent feeding, and dark green segments = departure latency. Note the predominance of departure latency on most visits. All visits plotted included all three visit segments, but if any visit segment duration was <1 second it does not appear on this plot. Therefore, it appears as if certain visit segments are missing from some of these visits.

***Vocalisations at the nest.***—The birds seldom vocalised during the incubation and nestling periods, making it almost impossible to locate them away from the nest. They failed to respond to playback and only gave their principal song, a plaintive whistle, sporadically while we were in the hide. We heard this vocalisation no more than five times per day and did not hear it after day 10.

We observed two undescribed vocalisations associated with nesting. The vocalisation given by a fledgling is discussed below (see Nestling development and fledging). The other vocalisation was heard regularly only until day 2, although we heard it once each on days 3 and 4. This was a soft grunt- or cluck-like noise accompanied by a quick deflation of the body cavity and a downward pulse of the tail (ML 484302; Fig. 9). Calls were almost always given in short series; the longest series was 31 calls and the mean 5.1 calls. The male generally gave this call at the nest before feeding the nestlings while the female was brooding. Once, the male gave a call between feeds, while holding food in his bill. We heard the male give this call on 21 of 43 visits while the female was brooding and calls could be detected. We could not hear the call when conditions were unfavourable (such as when many cicadas were singing or during heavy rain). The male only gave this call once when the female was absent from the nest, on day 2. The female gave it once when she was returning to brood on days 1 and 2, and once before flying to the nest during a provisioning visit on day 3. The female's call was higher in pitch (ML 487400–401; Fig. 9).

The vocalisation we heard most frequently around the nest was the Blue-headed Pitta *Hydrornis baudii*-like call described by Pegan *et al.* (2013), which we transcribed as a slurred *hyiaaar* (ML 212068). We heard this twice for the first time on day 2, again on day 6 and regularly afterwards, with daily occurrences except on days with fewer than two hours of observation. On many occasions, the circumstances prompting the call were not apparent to us—the birds sometimes uttered the call 2–4 times and were then silent, but

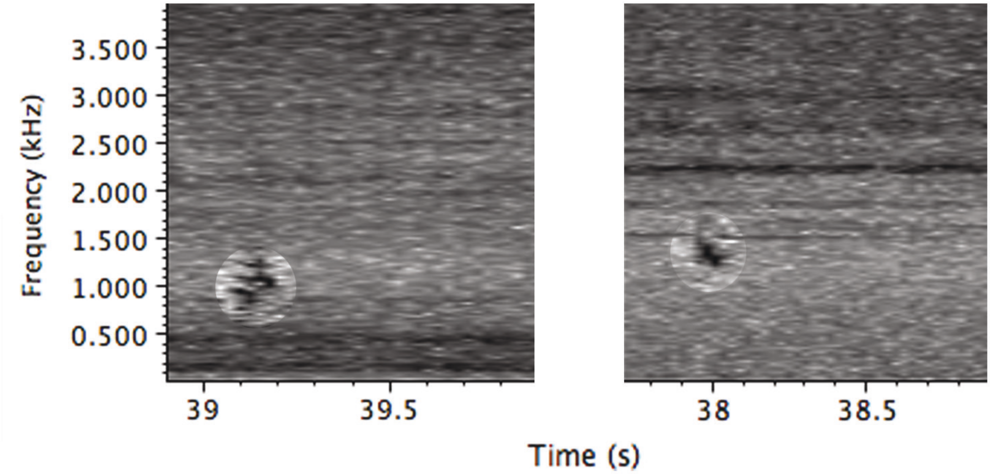


Figure 9. Sonograms of male (left) and female (right) grunt-like sounds given at the nest entrance. Mean low frequency of male grunt vocalisations was 0.865 kHz and mean high frequency 1.180 kHz. Mean duration of the call was 0.13 seconds (*n* = 8 vocalisations). Mean low frequency of female vocalisations was 1.207 kHz and mean high frequency 1.417 kHz. Mean duration of the call was 0.08 seconds (*n* = 3). Circles were artificially enhanced using Photoshop to make the vocalisations obvious. Sonogram parameters: Hann type, window size of 2,561 samples, hop size of 1,281 samples, overlap of 50%, DFT of 4,096 samples.

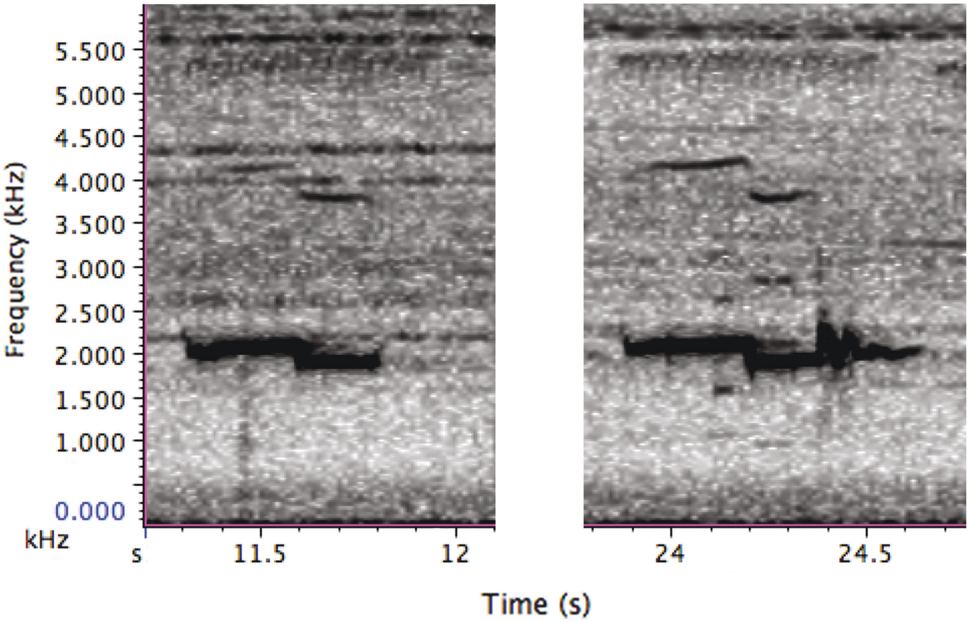


Figure 10. Two variants of the fledgling-specific vocalisation. Mean low frequency was 1.870 kHz and mean high frequency 2.095 kHz. Mean duration of the call was 0.59 seconds (*n* = 10 vocalisations). Both main notes have a harmonic with a frequency between 3.800 and 4.200 kHz. Sonogram parameters as Fig. 9.

on days 6 and 8 they repeated it >80 times over 15 minutes. However, there were instances in which the birds appeared to call in response to activity at the nest. One bird called >10 times as SCO placed a microphone in front of the hide on day 8. On day 10, the birds gave this call four times just before a White-crowned Hornbill *Berenicornis comatus*—a known nest predator that had been calling *c*.10 minutes earlier—flew low through the midstorey. Other birds began alarm-calling as soon as the hornbill came into view. Later on day 10, the birds gave this call in conjunction with a flurry of calls from a Scaly-crowned Babbler *Malacopteron cinereum*, 1.5 hours before a small monitor (Varanidae) crawled into the gully in the direction of their calls. The male gave this call once from the nest on day 12, while facing the hide, two days after we banded the chicks—this was also the only occasion we witnessed the adults give a loud vocalisation from the nest. One bird gave this call just after hitting, and before escaping from, a mist-net near the nest on day 13.

Two other instances during which the birds used the *hyiaaar* call were particularly noteworthy: (1) while we banded the nestlings and (2) when the nestlings fledged. (1) SCO heard the birds calling the entire time she was in front of the nest while we banded the nestlings on day 10, starting just after she arrived and ceasing just after the nestlings had been replaced, 23 minutes later, and she had returned to the hide. (2) On day 15, two hours before the nestlings fledged, the parents made *c*.13 calls per minute for 24 minutes, amounting to 250–350 renditions of the call. They then gave the call five times from behind the hide, the last time a mere six minutes before the chicks fledged. Afterwards, the adults called continuously while we located the fledglings and filmed them; the adults stopped calling when we left the vicinity (see Nestling development and fledging).

Throughout our nest-watch period, the birds in a nearby territory to the north-east where we had searched unsuccessfully for a nest were also silent. This territory was separated from our focal nest by *c*.140 m in which we never saw or heard pittas. However, on 26 March, both neighbouring adults started vocalising, one singing and one giving *hyiaaar* calls, in a gully on a ridge slope (ML 177987). They eventually led us to a fledgling. After the high calling activity of the fledging day, the birds in both territories behaved differently. Our focal birds remained silent and went unrecorded between 21 March and 26 April, when we finally heard and saw the colour-banded male singing again. The adults in the neighbouring territory never stopped singing regularly after we found their fledgling.

***Nestling development and fledging***.—The nestlings were not visible on days 0 and 1, mostly because the female spent most of the day brooding. On day 2 they began to lean their heads forward to receive food and, over the next few days, gradually begged more vigorously. After day 2, the nestlings started to vocalise as soon as they could see an adult perched on the other side of the gully. Their begging was a frantic, rapid twittering repeated by both nestlings continually (unless they had just received food, in which case they resumed begging soon afterwards). Earlier in the season their begging had subsided by the time the adult departed (e.g. ML 484319), but from day 8 the begging continued until the adult had disappeared (e.g. ML 484393).

Nestlings were similarly sized when we banded them on day 10 (Table 1) and had comparable feather growth (Fig. 1E). Their contour feathers were partially in sheath and did not fully cover their underparts or the neck-sides. The barbs of even the fully emerged feathers were loosely attached to each other, affording the feathers a fluffy appearance. The feathers of the upperparts were dark grey but had hints of brown in natural lighting when the birds fledged. The base of the bill and the tip were red-orange; the rest, including the culmen, was black. The throat feathers were mostly still in sheath. The flight feathers were a somewhat darker grey than the upperparts and only one-quarter emerged from their sheaths; the greater coverts looked similar but were only about one-eighth emerged. All of their breast and belly feathers were about half to two-thirds emerged from their sheaths. The breast feathers ranged from dark grey to a paler and warmer brownish grey. The belly feathers were pale carmine with grey bases. The upper flanks were grey quickly transitioning to bright orange-red on the lower flanks. Feathers covered only about half of the breast and belly. The tail feathers had only just broken the sheath and were still only 10% emerged. The upper leg was sparsely covered by pin-feathers. The tarsus was pale horn and the toes pale grey.

The nestlings fledged on day 15 at 08.53 h. At this time, the adults seemed particularly wary of the hide, looking at it repeatedly on every visit while the nestlings appeared to move closer to the edge of the nest. Eventually, both nestlings left the nest, one after the other, flying across the gully with no obvious hesitation. We re-found one at 09.22 h, perched 1 m high on a branch *c.*15 m from the nest (ML 479335, Fig. 1F). It was uttering an undescribed vocalisation that we only heard that day. The call was a high-pitched and clearly whistled *whee-ooo* that ended abruptly and had a slightly buzzy ring to the second note (ML 181706; Fig. 10). Unlike the *hyiaaar* call the adults uttered, the fledgling's call comprised two clearly defined notes of similar length. The adults were out of sight as we recorded the fledgling but gave the *hyiaaar* call repeatedly. As soon as we left the area and returned to the hide, the adult calls ceased but not those of the nestling. A few minutes later all birds fell silent. Soon afterwards, we spotted the adult hopping away, followed closely by the fledgling.

The fledgling in the neighbouring territory did not make the novel 'fledgling' sound the day we saw it. It was silent and allowed ERGC to unknowingly set a tripod 2 m away before an adult came to feed it. All three fledglings from both nests were superficially very similar and were probably similarly aged. They retained the orange bill tip and base observed when they were ten-day-old nestlings. The entire body was uniformly covered in contour feathers that still had the ragged or fluffy appearance of day 10. The flight feathers were dark grey, the secondaries tinged blue, and the tail was still only just visible. The grey breast feathers transitioned to red-tinged flank and belly feathers. The tarsi were still dull horn and feet grey. The fledglings probably appeared greyer than they did on day 10 in part due to the morning light. They looked smaller than the adults, as was obvious when they hopped after their parents.

Beyond the two territories discussed above, we detected birds in juvenile plumage twice in two separate territories: on 19 March and 28 April. The former was around adult size but was still in dusky-brown plumage and had an orange bill tip. The latter was accompanied by an adult giving the *hyiaaar* call.

## Discussion

This study revealed many important details concerning the breeding biology of Black-crowned Pitta. Below, we discuss these in the same sequence used in the Results.

***Distinguishing the sexes, nest placement and incubation.***—Black-crowned Pitta is generally considered to be sexually monochromatic (Lambert & Woodcock 1996), although Erritzoe & Erritzoe (1998) suggested that the red belly of females of the closely related Garnet Pitta might be paler than in males. During our nest observations, the underparts were usually not visible but we found the upperparts useful in distinguishing the sexes. Sexual differences in colour intensity have been previously reported for other monochromatic pittas including Hooded *Pitta sordida*, Rainbow, Noisy *P. versicolor*, Superb *P. superba*, Whiskered *Erythropitta kochi* and members of the recently split Red-bellied Pitta complex *E. erythrogaster* (Rothschild & Hartert 1914, Coates 1990, Taylor & Taylor 1995, Erritzoe & Erritzoe 1998, Zimmermann & Noske 2003). It seems probable that this could be true for other apparently monochromatic pitta species. Such detailed colour distinctions should be made with caution and be supported at least by photographs or video. Low *et al.* (2016) appears to be the only other relevant study that used video equipment for this purpose, although they used supercilium shape rather than colour intensity to distinguish the sex of Blue-winged Pittas *P. moluccensis* (the difference in white wing patch size reported by Wells 2007 may not have been visible in their video recordings).

The nest, its placement on the ground and the clutch of two eggs are consistent with previous descriptions for Black-crowned Pitta and all other *Erythropitta* species, except some members of the Red-bellied Pitta complex (Lambert & Woodcock 1996, Rosell & Ceriban 2012). By using sticks to anchor the rattan frond to the nest dome, the Black-crowned Pittas modified their environment to cover their nest. Other pittas have shown resourcefulness when building their nests or making them cryptic: digging holes in riverbanks (Meyer & Wiglesworth 1989), using soft mud to bind the nest lining (J. Howes *in litt. in* Lambert & Woodcock 1996, Low *et al*. 2016), covering their nest with a layer of moss (Coates 1990) and building their nest such that a palm (*Licuala* sp.) grew through it (Eames 1996).

We can make limited statements concerning the incubation period at our Black-crowned Pitta nest. That the male brought a stick to the nest suggests that he participated in nestbuilding (*cf*. Lambert & Woodcock 1996). Furthermore, the addition of a stick two days before the nestlings hatched shows that the species continues construction well into the incubation period. Tarboton *et al*. (2011) also recorded an African Pitta *P. angolensis* bringing nest material during incubation, although the clutch was incomplete. Taylor & Taylor (1995) reported that Noisy Pittas brought soft material to the nest at almost every changeover during incubation. It is impossible to ascertain if the female Black-crowned Pitta also incubated based on our short observation, but those made at a nest in Lambert & Woodcock (1996) and her prominent role in brooding suggest that she probably did.

We discovered this nest by inadvertently flushing an incubating adult. Pittas vary in how resistant they are to flushing from the nest, but several sit tight enough to be caught, including Blue-naped *Hydrornis nipalensis*, New Britain *Erythropitta gazellae* and Papuan Pittas *E. macklotii* (Dahl 1899 *in* Erritzoe & Erritzoe 1998, Gilliard & LeCroy 1967, Erritzoe & Erritzoe 1998). Hooded Pittas appear more willing to flush during incubation but sit tight during brooding (Coates 1990). Our observations and those by Sheldon (in prep. *in* Lambert & Woodcock 1996), who observed an adult remain on its eggs until it was almost touched, suggest that Black-crowned Pittas are typical in their reluctance to leave the nest. During the nestling period, we once stood *c*.5 m from the nest and the brooding female did not flush, but we never moved closer.

***Parental provisioning, effort and brooding***.—The male and female exhibited differential parental investment: the male provisioned the nestlings more extensively over the course of the nestling season, while the female was the sole bird we recorded brooding. Other species of pitta show various trends in parental division of labour. In Rainbow and Blue-winged Pittas, both sexes appear to contribute almost equally to nestling provisioning (Zimmermann & Noske 2003, Hutchinson & Mears 2006). Male Giant and Hooded Pittas visit the nest somewhat more frequently than females, making *c*.55% of visits (Round *et al*. 1989, Coates 1990). Similar to Black-crowned Pitta, the male Gurney's Pitta at two nests made more visits than the female and at one nest female visitation increased in the second week (Round & Treesucon 1986, Gretton 1988 *in* Lambert & Woodcock 1996). That said, our results show that the relative contributions of each sex changed during the nestling season. Therefore, the results of other studies cannot validly be compared to ours, unless they properly sampled throughout the nestling season. In the studies mentioned above, those of Hooded and Blue-winged Pittas did not span the entire nestling period (although the extent to which this is true is unspecified in the latter; Coates 1990, Hutchinson & Mears 2006). The same was true at one Gurney's Pitta nest (Round & Treesucon 1996). However, the observations at Rainbow, Giant and the other Gurney's Pitta nests all provide a benchmark by which to compare the relative efforts of male and female pittas (Round *et al.* 1989, Zimmermann & Noske 2003; A. Gretton pers. comm.).

Compared to all other relatively well-studied pittas, Black-crowned Pitta had a much lower mean visitation rate—only 2.17 visits / hour and at most averaging 2.55 visits / hour in a day. Gurney's, Hooded and Rainbow Pitta visitation rates range from 6.73 to 9.3 visits / hour (Gretton 1988 *in* Lambert & Woodcock 1996, Coates 1990, Zimmermann & Noske 2003), while those at a Fairy Pitta nest increased from 2.2 to 6.2 visits / hour over the first seven days of the nestling period (Lin *et al*. 2007b). Pairs of Giant and Bar-bellied Pittas *Hydrornis elliotii* made *c*.3.2 visits / hour each (Round *et al*. 1989, Eames 1996), which is more similar to Black-crowned Pitta, albeit still a higher visitation rate. Visitation rates for species for which few observations exist (Hooded and Bar-bellied Pittas) may not be directly comparable to our nest, but it is otherwise clear that the Black-crowned Pittas at this nest had a notably low visitation rate.

Multiple factors could lead to a lower visitation rate but data to discriminate among them are scarce. Compared to the species that occur further north, Black-crowned Pitta has a smaller clutch size (two vs. 3–5) and therefore may require less activity around the nest (Skutch 1949)—the exceptions are Giant and Bar-bellied Pittas, which also lay two eggs (the nest of the latter that Eames 1996 observed had two eggs, but the species can lay 2–4 eggs) and had lower visitation rates. Black-crowned Pitta nestlings might require less food if they receive a higher quality diet (Twining *et al*. 2016) or have a longer nestling period (but see Nestling development and fledging). Our observations of nestling diet appear typical of many pittas (Round *et al*. 1989, Lin *et al*. 2007b, Donald *et al*. 2009, Kim *et al*. 2012). This is not necessarily indicative of nutritional content, though, especially because we have no measure of how prominently earthworms figured in diet relative to other invertebrates.

Data concerning brooding in other pittas is relatively scarce, partially because it can be unclear if observers include brooding under the term 'incubation'. It appears that males have occasionally been observed brooding in Gurney's Pitta (Gretton 1988 *in* Lambert & Woodcock 1996), but in Giant, Blue-rumped *Hydrornis soror* and Noisy Pittas females alone have been noted brooding, as at the Black-crowned Pitta nest we studied (Round *et al*. 1989, Lambert *et al*. 1995, Taylor & Taylor 1995). Interestingly, both sexes at a Black-crowned Pitta nest in Danum Valley, Sabah, incubated the nestlings (Lambert & Woodcock 1996); although the extent to which the male brooded is unclear, this indicates there is some variation to be explored by future studies with larger samples, assuming sexes were always correctly identified. Like Gurney's and Giant Pittas, the Black-crowned Pitta female we observed brooded at night at least until the evening of day 5, although Giant Pittas continue brooding until their nestlings are near fledging (Round *et al*. 1989). We have no direct evidence that the Black-crowned Pitta did not continue brooding at night after day 5, but she began visiting the nest earlier in the morning and was not seen arriving as dusk approached thereafter. Her brooding patterns overall resembled those of a Gurney's Pitta (Gretton 1988 *in* Lambert & Woodcock 1996): early on, she brooded nearly all day and she gradually decreased the number of hours spent at the nest.

***Correlations with visit segment durations and visit function*.**—We found that the pittas spent most of their time on the nest after feeding the nestlings, in the departure latency period. This is initially counter-intuitive because the older nestling begged continually during this period, which increases nest detectability and might attract predators (Haff & Magrath 2011, Ibáñez-Álamo *et al*. 2012), and the adults' presence often seems to serve no parental purpose. We found longer departure latencies associated with visits in which the adults removed faecal sacs. Once a faecal sac was produced the adults departed immediately. One exception to the tendency of longer departure latencies was the single time a faecal sac was waiting at the nest entrance when an adult arrived with food. The bird removed the sac immediately after food delivery, resulting in an especially short departure latency. This is similar in Blue-winged Pittas—longer visits are associated with the extraction of faecal sacs (Low *et al*. 2016). This made us suspect that the adults could anticipate the production of a faecal sac and waited for it before departing the nest. A recent study of Red-whiskered Bulbul *Pycnonotus jocosus* reached the same conclusion after experimentally discovering that the timing and mass of faecal sacs was linked to feeding frequency (Quan *et al*. 2015). This suggests that the benefits of nest sanitation (Petit *et al*. 1989, Guigueno & Sealy 2012, Ibáñez-Álamo *et al*. 2016)—especially given the visual conspicuousness of faecal sacs—may oppose selection for reduced auditory exposure to predators (Tarwater *et al*. 2009).

Two other factors might influence the length of the departure latency. First, the adults might be watching for predators from the nest—they frequently looked out of the nest during this period (Fig. 6B) and Lambert *et al*. (1995) reported a Blue-rumped Pitta standing at its nest for more than three hours after it spotted the observers. Second, the birds may have been ensuring that nestlings properly handled the food—they also frequently looked into the nest for extended periods during this period.

Nestling biology associated with faecal sacs was comparable to that in other pittas. Nestlings of other species present the sacs to adults in a similar fashion (Gretton 1988 *in* Lambert & Woodcock 1996, Coates 1990) and the sacs appear to be similarly sized (approximately the length of the head, excluding the bill, of the nestling at day 10, *c*.30 mm, similar to African Pittas; Masterson 1987). Gretton (1988 *in* Lambert & Woodcock 1996) found a Gurney's Pitta 'faecal sac dump' 12–15 m from the nest, like ours. Other species also exhibit sex biases in faecal sac extraction, but it is unclear whether they may have been caused by sex biases in visitation rates as at our nest: Coates (1990) noted that the male Hooded Pitta extracts more faecal sacs while Eames (1996) found that female Bar-bellied Pitta extracts more—although Eames' observation period was limited.

Feeding latency (the time between adult arrival and when it feeds the nestlings) decreased dramatically over the first few days and remained low during the rest of the nestling period. Our analysis correlated this segment well with brooding time periods because the male had to wait for the female to move in order to feed the nestlings, which was unnecessary in later brooding periods because the female stopped covering the nestlings' heads. However, this is difficult to disentangle from nestling development—younger chicks may have more difficulty begging and their response to an adult's presence probably takes longer—explaining why the female also deliberated before feeding when she arrived to brood. Our negative trend in latency is consistent with the hypothesis that birds should feed the nestlings as promptly as possible to reduce begging intensity (Tarwater *et al.* 2009), although this did not prevent further begging.

There appear to be no data for other pitta species to compare with our measurements of feeding duration, but their association with quantity of food and handling time are likely to hold true for other members of the family.

***Nestling development and fledging***.—The nestlings fledged 15 days after hatching, which is comparable to the 12–16 days reported for other pittas (Erritzoe 2003) and the 15–16 days suggested by Lambert & Woodcock (1996) at their Black-crowned Pitta nest. By observing ingestion of both eggshells by the female and the actual fledging by the nestlings, we report an accurate timespan of the nestling period for both offspring. We also present the first detailed description of nestling Black-crowned Pittas. They resembled other described nestling pittas after the pin-feathers have opened (Erritzoe & Erritzoe 1998), with their colours matching those of a juvenile. Our observations of a recently fledged juvenile match descriptions of juveniles / immatures in Lambert & Woodcock (1996). Notably, we saw no yellow feathers in the development of the Black-crowned Pitta nestlings, which contrasts with the description of a 'chick' in Lambert & Woodcock (1996). This supports the scepticism of Erritzoe & Erritzoe (1998) and suggests that the yellow-plumaged chick associated with specimen NHMUK 1956.60.234 at the Natural History Museum, Tring, is not a pitta.

Fledging is poorly understood in pittas. Just before the nestlings fledged, the adults' behaviour, including repeated use of the *hyiaaar* call, appeared to be encouraging the nestlings to leave the nest. Such behaviour in the family has otherwise been recorded only by adult Mangrove Pitta *Pitta megarhyncha*. Choy & Wee (2010) reported that while Mangrove Pittas generally fly from their nest following a provisioning visit, they started hopping for long distances shortly before the nestlings fledged. At their nest, the nestlings also left the nest several times before finally fledging. It was interesting to note how easily the nestlings observed by us flew for the first time.

This is the first report of a fledgling-specific vocalisation for any species of pitta—the closest observation is that of a mournful whistle given by a captive full-grown immature Green-breasted Pitta *Pitta reichenowi* (Lambert & Woodcock 1996). Fledgling oscines are known to exhibit abrupt changes in vocal abilities (Clemmons & Howitz 1990, Sawhney *et al*. 2006). These represent steps in the transition from begging calls to adult vocalisations, and might aid adults to locate dependent fledglings (Sawhney *et al*. 2006).

***Vocalisations at the nest***.—Our observations permit us to elaborate on the context of the novel *hyiaaar* call described by Pegan *et al.* (2013; referred to as the 'baudii-like call'). We have direct evidence that it serves as an alarm call when the birds perceived danger to themselves or to the nest, but we also consider that it may be used in contact. This is supported by our observations of the fledging event and the frequent use of this call outside the breeding season, although it is then difficult to assess if danger is imminent. Alarm calls have been recorded around Gurney's, Rainbow, Bar-bellied, Mangrove and Blue-winged Pitta nests and were provoked by intraspecific, human and predatory threats (Round & Treesucon 1986, Zimmermann 1995, Eames 1996, Choy & Wee 2010, Low *et al*. 2016). At a broader scale, an 'alarm call' has been noted for almost all species of pitta (Lambert & Woodcock 1996, Erritzoe & Erritzoe 1998). P. D. Round (*in litt. in* Lambert & Woodcock 1996) noted that Eared Pittas *H. phayrei* may use their 'alarm' call as a 'contact' call, so flexibility in context may be more widespread.

Declines in adult vocal activity have been reported in various other pittas at the onset of nesting, including Gurney's, Bar-bellied, Noisy, Rainbow, Fairy and African Pittas (Round & Treesucon 1986, Eames 1996, Woodall 1997, Zimmermann & Noske 2003, Lin *et al*. 2007a, Tarboton *et al*. 2011). This makes pittas difficult to find during these periods, especially as they may not respond to playback as readily as at other times (Lin *et al*. 2007a). The birds in one Black-crowned Pitta territory continued to be silent after their young fledged, while those in the neighbouring territory began singing regularly relatively shortly afterwards. We believe this is probably either because the latter birds lost their fledglings to predators and had no reason to remain silent, or because the former were warier of humans in their territory due to their extended interactions with us and did not want to attract attention.

We consider that the soft grunt- or cluck-like vocalisations the adults made at the nest entrance before feeding were probably to communicate with either the nestlings or the brooding female. Use of this vocalisation is otherwise difficult to interpret, especially why it was sometimes repeated more than ten times. Intriguingly, this vocalisation or one similar was also reported in ordinary provisioning visits by Hooded Pittas (Coates 1990). The male Black-crowned Pitta almost exclusively gave this call while the female was brooding, but not on every visit. He gave the vocalisation only once, and the female twice, when the nestlings alone were present, and the female gave it once before flying to the nest. Its function is unclear, but we believe our observations help clarify the context in which it is used. Gurney's and Bar-bellied Pittas have been reported making similar sounds under different circumstances. Gurney's Pittas utter a *hoo* when adults change-over at the nest (Gretton 1988 *in* Erritzoe & Erritzoe 1998), while Bar-bellied Pittas give a soft *coo* on approaching the nest, which the chicks answer vocally (Eames 1996). The latter case suggests that other pittas communicate with nestlings before feeds, but further studies are needed to reveal if these vocalisations are analogous.

***Concluding remarks***.—Our observations at a Black-crowned Pitta nest have provided data on the parental roles, rates of provisioning, nestling development, biology associated with faecal sacs and vocal behaviour. This is the first detailed perspective of the nesting biology of any species of *Erythropitta*, permitting initial comparisons with other pitta genera. However, one nest cannot accurately represent the nesting behaviour of an entire genus. Our observations are the first step towards understanding the breeding biology of *Erythropitta* and should be complemented by future studies. Enabled by use of video recordings, we noticed various small behaviours that have otherwise been noted only in one or two species of pitta; given the few detailed studies of the family, we predict that these behaviours are more widespread than have been recorded. We also consider that the manner we subdivided each nest visit enabled interesting insights into the importance of various activities. We hope that others may find this method useful to understand avian biology and eventually to make larger scale comparisons than possible here.

## Acknowledgements

We thank our fellow expedition members who joined our nest-watch rotation: Cat Lauck and Kayleigh Chalkowski. The generous support and guidance of Dr Maklarin Bin Lakim, Fred Tuh Yit Yu, and the Sabah Parks staff who accommodated us and helped navigate permit systems made our work in Sabah possible. We thank Charles Dardia and the Cornell University Museum of Vertebrates, Brad Walker, Jay McGowan, Matt Medler and the Macaulay Library of Natural Sounds, Irby Lovette, and other Cornell Lab of Ornithology staff who provided logistical support and equipment loans, including video and audio-recording equipment. Richard Noske and Udo Zimmermann provided invaluable advice concerning the study of pittas as we prepared our expedition, while Adam Gretton kindly responded to subsequent questions. Additional thanks are owed to Kelly Hallinger for her instrumental help with genetic sexing, Teresa Porri for her assistance with CT scans, Ryan Shipley for permitting us to use his photograph of the nestling, Harry Greene for his help in identifying the snake, Teresa Pegan for providing manuscript advice and encouragement, Guy Kirwan for efficient editorial assistance, and three anonymous reviewers who made helpful comments. The undergraduate-led expedition during which this nest was documented was generously funded by the Ivy Expeditions Fund, Cornell Lab of Ornithology and programme support funds from Cornell University to DWW. *Ethics statement*: all of our field work conformed to the approved Cornell IACUC protocol #2001-0051 to D. W. Winkler, an access license from the Sabah Biodiversity Council, and a research permit issued by Sabah Parks.

References:

Bioacoustics Research Program. 2014. *Raven Pro: interactive sound analysis software* (v. 1.5). Cornell Lab of Ornithology, Ithaca, NY.

Choy, W. M. & Wee, Y. C. 2010. Observations at a Mangrove Pitta *Pitta megarhyncha* nest in Peninsular Malaysia. *BirdingASIA* 14: 30–33.

Clemmons, J. & Howitz, J. L. 1990. Development of early vocalisations and the chick-a-dee call in the Black-capped Chickadee, *Parus atricapillus*. *Ethology* 86: 203–223.

Coates, B. J. 1990. *The birds of Papua New Guinea including the Bismarck archipelago and Bougainville*, vol. 2. Dove Publications, Alderley.

Donald, P. F., Aratrakorn, S., Htun, T. W., Eames, J. C., Hla, H., Thunhikorn, S., Sribua-Rod, K., Tinun, P., Aung, S. M., Zaw, S. M. & Buchanan, G. M. 2009. Population, distribution, habitat use and breeding of Gurney's Pitta *Pitta gurneyi* in Myanmar and Thailand. *Bird Conserv. Intern*. 19: 353–366.

Eames, J. C. 1996. Observations on the nesting behaviour of the Bar-bellied Pitta *Pitta ellioti* [*sic*]. *Bull. Brit. Orn. Cl.* 116: 216–224.

Erritzoe, J. 2003. Family Pittidae (pittas). Pp. 106–160 *in* del Hoyo, J., Elliott, A. & Christie D. A. (eds.) *Handbook of the birds of the world*, vol. 8. Lynx Edicions, Barcelona.

Erritzoe, J. & Erritzoe, H. B. 1998. *Pittas of the world: a monograph on the pitta family*. Lutterworth Press, Cambridge, UK.

Fogden, M. P. L. 1972. The seasonality and population dynamics of equatorial forest birds in Sarawak. *Ibis* 114: 307–343.

Fridolfsson, A. K. & Ellegren, H. 1999. A simple and universal method for molecular sexing of non-ratite birds. *J. Avian Biol*. 30: 116–121.

Gibson-Hill, C. A. 1950. A collection of birds' eggs from north Borneo. *Bull. Raffles Mus*. 21: 106–115.

Gilliard, E. T. & LeCroy, M. 1967. Annotated list of birds of the Adelbert Mountains, New Guinea: results of the 1959 Gilliard Expedition. *Bull. Amer. Mus. Nat. Hist*. 138: 51–82.

Guigueno, M. F. & Sealy, S. G. 2012. Nest sanitation in passerine birds: implications for egg rejection in hosts of brood parasites. *J. Orn*. 153: 35–52.

Haff, T. M. & Magrath, R. D. 2011. Calling at a cost: elevated nestling calling attracts predators to active nests. *Biol. Lett*. 7: 493–495.

Hutchinson, R. & Mears, A. 2006. Extension of the breeding range of Blue-winged Pitta *Pitta moluccensis* in Peninsular Malaysia. *Forktail* 22: 119–120.

Ibáñez-Álamo, J. D., Arco, L. & Soler, M. 2012. Experimental evidence for a predation cost of begging using active nests and real chicks. *J. Orn.* 153: 801–807.

Ibáñez-Álamo, J. D., Ruiz-Raya, F., Rodríguez, L. & Soler, M. 2016. Fecal sacs attract insects to the nest and provoke an activation of the immune system of nestlings. *Frontiers Zool*. 13(3).

Irestedt, M., Ohlson, J. I., Zuccon, D., Käller, M. & Ericson, P. G. P. 2006. Nuclear DNA from old collections of avian study skins reveals the evolutionary history of the Old World suboscines (Aves, Passeriformes). *Zool. Scripta* 35: 567–580.

Kim, E. M., Park, C. R., Kang, C. W. & Kim, S. J. 2012. The nestling diet of fairy pitta *Pitta nympha* on Jeju Island , Korea. *Open J. Ecol*. 2: 178–182.

Lambert, F. R., Eames, J. C. & Cu, N. 1995. The habitat, status, vocalizations and breeding biology of Blue-rumped Pitta *Pitta soror annamensis* in central Vietnam. *Forktail* 10: 151–155.

Lambert, F. & Woodcock, M. 1996. *Pittas, broadbills and asities*. Pica Press, Robertsbridge.

Lin, R. S., Lee, P. F., Ding, T. S. & Kirk Lin, Y. T. 2007a. Effectiveness of playbacks in censusing the Fairy Pitta (*Pitta nympha*) during the breeding season in Taiwan. *Zool. Stud*. 46: 242–248.

Lin, R. S., Yao, C. T. & Lee, P. F. 2007b. The diet of Fairy Pitta *Pitta nympha* nestlings in Taiwan as revealed by videotaping. *Zool. Stud*. 46: 355–361.

Low, B. W., Chia, A., Tan, G. C., Yap, W. J. & Lim, K. K. 2016. First documented records of the Blue-winged Pitta *Pitta moluccensis* breeding in Singapore. *BirdingASIA* 26: 43–46.

Mann, C. F. 2008. *The birds of Borneo: an annotated checklist*. BOU Checklist Series 23. British Ornithologists' Union & British Ornithologists' Club, Peterborough.

Metscher, B. D. 2009. MicroCT for comparative morphology: simple staining methods allow high-contrast 3D imaging of diverse non-mineralized animal tissues. *BMC Physiol*. 9(11).

Meyer, A. B. & Wiglesworth, L. W. 1989. *The birds of Celebes and the neighbouring islands*, vol. 1. R. Friedländer & Sohn, Berlin.

Omar, S. & Nais, J. 1995. Tawau Hills Park: an overview. Pp. 1–6 *in* Ismail, G., Omar, S. & bin Din, L. (eds.) *A scientific journey through Borneo: Tawau Hills Park, Sabah*. Pelanduk Publications, Selangor Darul Ehsan.

Pegan, T. M., Hruska, J. P. & Hite, J. M. 2013. A newly described call and mechanical noise produced by the Black-and-crimson Pitta *Pitta ussheri*. *Forktail* 29: 160–162.

Petit, K. E., Petit, L. J. & Petit, D. R. 1989. Fecal sac removal: do the pattern and distance of dispersal affect the chance of nest predation? *Condor* 91: 479–482.

Pugesek, B. H. 1990. Parental effort in the California gull: test of parent-offspring conflict theory. *Behav. Ecol. Sociobiol*. 27: 211–215.

Quan, R., Li, H., Wang, B. & Goodale, E. 2015. The relationship between defecation and feeding in nestling birds: observational and experimental evidence. *Frontiers Zool.* 12(21).

R Core Team. 2014. *R: a language and environment for statistical computing* (v. 3.1.0). R Foundation for Statistical Computing, Vienna.

Rosell, N. & Ceriban, C. 2012. Whiskered Pitta (*Pitta kochi*) - first documented sighting of its nest and nesting behaviour. *e-BON: Wild Bird Cl. Philippines* https://ebonph.wordpress.com/2012/06/30/whiskered-pitta-nest-and-nesting-behavior/ (accessed 17 March 2017).

Rothschild, W. & Hartert, E. 1914. The birds of the Admiralty Islands, north of German New Guinea. *Novit. Zool*. 21: 281–298.

Round, P. D. & Treesucon, U. 1986. The rediscovery of Gurney's Pitta *Pitta gurneyi*. *Forktail* 2: 53–66.

Round, P. D., Treesucon, U. & Eames, J. C. 1989. A breeding record of the Giant Pitta *Pitta caerulea* from Thailand. *Forktail* 5: 35–47.

Sawhney, M. H., Baker, M. C. & Bisbee, B. R. 2006. Development of vocalisations in nestling and fledgling House Wrens in natural populations. *Bioacoustics* 15: 271–287.

Schneider, C. A., Rasband, W. S. & Eliceri, K. W. 2012. NIH Image to ImageJ: 25 years of image analysis. *Nat. Methods* 9: 671–675.

Siegel, R. B., Weathers, W. W. & Beissinger, S. R. 1999. Assessing parental effort in a Neotropical parrot: a comparison of methods. *Anim. Behav*. 57: 73–79.

Skutch, A. F. 1949. Do tropical birds rear as many young as they can nourish? *Ibis* 91: 430–455.

Tarboton, W., Peek, R. & Chittenden, H. 2011. Nesting observations of African Pitta. *Honeyguide* 57: 41–42.

Tarwater, C. E., Kelley, J. P. & Brawn, J. D. 2009. Parental response to elevated begging in a high predation, tropical environment. *Anim. Behav*. 78: 1239–1245.

Taylor, P. & Taylor, P. 1995. Observations on nesting Noisy Pittas *Pitta versicolor*. *Austr. Bird Watcher* 16: 39–41.

Twining, C. W., Brenna, J. T., Lawrence, P., Shipley, J. R., Tollefson, T. N. & Winkler, D. W. 2016. Omega-3 long-chain polyunsaturated fatty acids support aerial insectivore performance more than food quantity. *Proc. Natl. Acad. Sci. USA* 113: 10920–10925.

Voous, K. H. 1961. Birds collected by Carl Lumholtz in eastern and central Borneo. *Nytt Mag. Zool.* 10(Suppl.): 127–180.

Wells, D. R. 2007. *The birds of the Thai-Malay Peninsula*, vol. 2. Christopher Helm, London.

Woodall, P. F. 1997. Seasonal and diurnal variation in the calls of the Noisy Pitta *Pitta versicolor*, Eastern Whipbird *Psophodes olivaceus* and Green Catbird *Ailuroedus crassirostris* in Brisbane Forest Park, Queensland. *Emu* 97: 121–125.

Zimmermann, U. M. 1995. Displays and postures of the Rainbow Pitta and other Australian pittas. *Austr. Bird Watcher* 16: 161–164.

Zimmermann, U. M. & Noske, R. A. 2003. Breeding biology of the Rainbow Pitta, *Pitta iris*, a species endemic to Australian monsoon-tropical rainforests. *Emu* 103: 245–254.

*Addresses*: Dept. of Ecology and Evolutionary Biology, Cornell Univ., Ithaca, NY, 14853, USA. Eric R. Gulson-Castillo, Emma I. Grieg, Justin M. Hite, Sophia C. Orzechowski & David W. Winkler, Cornell Lab of Ornithology, Ithaca, NY, 14850, USA. Eric R. Gulson-Castillo & David W. Winkler, Cornell Univ. Mus. of Vertebrates, Ithaca, NY, 14850, USA. Justin M. Hite, Kaua'i Forest Birds Recovery Project, Hanapepe, HI, 96716, USA. Sophia C. Orzechowski, Dept. of Wildlife Ecology and Conservation, Univ. of Florida, Gainesville, FL, 32611, USA. Corresponding author: Eric R. Gulson-Castillo, e-mail: erg57@cornell.edu

# Noteworthy seabird records from Paraná state, southern Brazil

*by Nicholas Winterle Daudt, Alice Pereira, Juliana Rechetelo, Ricardo Krul & Luiz Augusto Macedo Mestre*

*Received 16 March 2017; revised 28 July 2017; published 15 September 2017*

*http://zoobank.org/urn:lsid:zoobank.org:pub:3E863833-C195-4A8F-A59A-8F2551C71EE0*

Summary.—We inventoried seabird specimens—skeletons and skins—collected during beach surveys of Paraná, south Brazil, both the mainland coast and offshore islets during the period 1992–94. We found 184 specimens comprising four orders and 17 species. This represents the most important collection of seabirds from Paraná and includes three new records for the state, Cory's Shearwater *Calonectris borealis*, Sooty Shearwater *Puffinus griseus* and Snowy Sheathbill *Chionis albus*. We recommend the removal of two species from the avifauna of Paraná—Shy Albatross *Thalassarche cauta* and Broad-billed Prion *Pachyptila vittata*—due to the lack of tangible evidence. All of this material is held in publicly accessible natural history museums.

Natural history museums and their research collections play an important role in cataloguing biodiversity. Material held in museums aids our understanding of species diversity, evolution and genetics (Winker 2005). Collections are also important for educational and cultural reasons (Arinze 1999). They represent biological 'libraries' and their databases provide a robust starting point for scientific studies (Suarez & Tsutsui 2004, Joseph 2011).

In Brazil, three museums specialise in seabirds: the Museu de Ciências Naturais da Universidade Federal do Rio Grande do Sul, Imbé (MUCIN) and Coleção de Aves da Universidade Federal do Rio Grande do Sul—FURG, Rio Grande (CAFURG), both in Rio Grande do Sul state, and the Museu Oceanográfico do Vale do Itajaí, Itajaí (MOVI) in Santa Catarina state. The MOVI and MUCIN collections also focus on osteological material, which comprises more than 90% of their specimens (Aleixo & Straube 2007; M. Tavares 2017 pers. comm.). In Paraná state, the principal natural history museums are the Museu de Historia Natural do Capão da Imbuia, Curitiba (MHNCI) and Museu de Ciências Naturais da Universidade Federal do Paraná, Curitiba (MCNPR), neither of which specialises in seabirds. In the early 1990s, the establishment of an ornithology laboratory on the Paraná coast and detailed beached bird surveys led to the founding of a seabird osteological collection at the Centro de Estudos do Mar (CEM), Universidade Federal do Paraná (UFPR), Pontal do Paraná (Moraes & Krul 1992). Here we provide a complete list of the specimens collected in Paraná by the ornithology laboratory.

Specimens of seabirds were collected during non-systematic transect surveys between the beaches of Shangrilá (25°37′07″S, 48°24′37″W) and Pontal do Sul (25°33′51″S, 48°21′17″W), covering 9 km of coast in Pontal do Paraná municipality. Beached birds were recorded by *ad libitum* searches, from the surf zone to the landward edge of the beach. Additional opportunistic surveys were undertaken in the Currais archipelago (National Marine Park at *c.*25°44′S, 48°21′W) and Ilha Itacolomis (25°50′31′′S, 48°24′26′′W), as well nearby beaches. All of this material was incorporated in the osteological / skin collection reported here (MCEM or MCEMAV).

Despite the importance of this material to the avifauna of Paraná, there have been few publications based on it—just two conference abstracts both published *c.*20 years ago (Krul & Moraes 1997, Moraes & Krul 1997), making the present study the first publication to fully discuss and inventory the seabird specimens collected on the Paraná coast in 1992–94 by the ornithology laboratory. Here, we propose the inclusion of three new records and the removal of two species from the Paraná state bird list. We considered as 'seabirds' those specimens classed as Sphenisciformes, Procellariiformes, Suliformes (except Phalacrocoracidae and Anhingidae) and Charadriiformes, except Charadrii (but including Chionidae) and Scolopacii (*sensu* Harrison 1985). We followed the taxonomy of the Brazilian Ornithological Records Committee (CBRO) (Piacentini *et al*. 2015), except Shy Albatross *Thalassarche cauta*, where we follow ACAP (2011).

## Comments on the material

The studied seabird collection comprises 184 specimens, belonging to the following orders: Sphenisciformes (9%), Procellariiformes (50%), Suliformes (32%) and Charadriiformes (9%) (Table 1). Sphenisciformes were represented exclusively by Magellanic Penguin *Spheniscus magellanicus* (*n* = 16). Procellariiformes comprised albatrosses (Diomedeidae, *n* = 18) and petrels (Procellariidae, *n* = 75), mostly represented by the genera *Puffinus* (*n* = 32) and *Calonectris* (*n* = 24). Suliformes were exclusively represented by specimens of Magnificent Frigatebird *Fregata magnificens* (*n* = 21) and Brown Booby *Sula leucogaster* (*n* = 37), both of which breed on islands in Paraná (Krul 2004). Charadriiformes were represented by Snowy Sheathbill *Chionis albus* (*n* = 1), Kelp Gull *Larus dominicanus* (*n* =5), terns (Sternidae, *n* = 8) and skuas (Stercorariidae, *n* = 2).

The only specimen data available was that provided on the labels on the specimen boxes. This information covered genus / species identification, date, identifier and collector, and collection locality. Despite poor storage conditions, the skins and skeletons are in good state. We reorganised all of the material based on current CBRO taxonomy and some specimens were reclassified based on comparative osteology (Table 1). Most are skeletons (*n* = 178; 96%), with only six preserved as skins (3%). One Brown Skua *Stercorarius antarcticus* (MCEMAV 34) is preserved as a study skin and partial skeleton. Among osteological material, most (53%) are complete skeletons, with the rest being partial skeletons (40.5%) or complete skulls (6%). One specimen is represented exclusively by the cranium and the jaw (0.5%). All specimens are currently held in the Coleção Científica Ornitológica, Museu de Ciências Naturais da Universidade Federal do Rio Grande do Sul (MUCIN) or Museu de Ciências Naturais da Universidade Federal do Paraná (MCNPR).

## Contribution to Paraná ornithology

The material inventoried here represents the only major collection of seabirds made in Paraná (F. C. Straube *in litt*. 2017), but has been largely overlooked in the ornithological literature. These specimens add to the history of seabird studies made by UFPR on the Paraná coast. In addition, under the criteria proposed by Carlos *et al*. (2010) skins and osteological material (Table 1) provide evidence to support species occurrences. On this basis, we suggest that the following taxa should be included on the primary list of birds recorded in Paraná state (Scherer-Neto *et al*. 2011).

**CORY'S SHEARWATER** *Calonectris borealis*
Trans-equatorial migrant that breeds in the Northern Hemisphere. Regular in Brazilian waters during the species' non-breeding period (González-Solís *et al*. 2007, Dias *et al*. 2011)

TABLE 1
List of seabird specimens collected on the coast of Paraná, southern Brazil, by the ornithology laboratory (CEM-UFPR) in 1992–94, and currently deposited at Museu de Ciências Naturais da Universidade Federal do Paraná (MCNPR) and Museu de Ciências Naturais da Universidade Federal do Rio Grande do Sul (MUCIN). All of the beaches lie within the 9 km covered by regular transects, except Ipanema (25°39′00′′S, 48°26′12′′W), Praia de Leste (25°41′01′′S, 48°27′02′′W), Monções (25°42′46′′S, 48°28′36′′W), Gaivotas (25°43′33′′S, 48°28′56′′W), and the islands Ilha do Mel (25°32′7″S, 48°19′52″W), Ilha dos Currais (Currais archipelago) and Ilha Itacolomis. Legend: u.d. = unknown date.

| **MCEMAV no.** | **Taxon** | **Collection locality** | **Date** | **Material** | **Museum** |
|---|---|---|---|---|---|
| **SPHENISCIFORMES** | | | | | |
| **SPHENISCIDAE** | | | | | |
| 19 | *Spheniscus magellanicus* | Ilha do Mel | 20 Jul 1992 | Skull | MCNPR |
| 27 | *Spheniscus magellanicus* | Atami beach | 19 Aug 1992 | Skull | MCNPR |
| 47 | *Spheniscus magellanicus* | Atami beach | 12 Nov 1993 | Complete skeleton | MCNPR |
| 53 | *Spheniscus magellanicus* | Atami beach | 7 Jul 1993 | Complete skeleton | MCNPR |
| 59 | *Spheniscus magellanicus* | Barranco beach | 24 Sep 1992 | Complete skeleton | MCNPR |
| 63 | *Spheniscus magellanicus* | Atami beach | 12 Nov 1992 | Complete skeleton | MCNPR |
| 66 | *Spheniscus magellanicus* | Barranco beach | 24 Sep 1992 | Complete skeleton | MUCIN |
| 67 | *Spheniscus magellanicus* | Pontal do Sul beach | 12 Sep 1992 | Complete skeleton | MUCIN |
| 75 | *Spheniscus magellanicus* | Atami beach | 24 Sep 1992 | Complete skeleton | MUCIN |
| 84 | *Spheniscus magellanicus* | Barranco beach | 24 Sep 1992 | Complete skeleton | MUCIN |
| 94 | *Spheniscus magellanicus* | Pontal do Sul beach | 2 Aug 1992 | Partial skeleton | MCNPR |
| 143 | *Spheniscus magellanicus* | Ipanema beach | 12 Sep 1992 | Complete skeleton | MCNPR |
| 168 | *Spheniscus magellanicus* | Barranco beach | 24 Sep 1992 | Partial skeleton | MCNPR |
| 169 | *Spheniscus magellanicus* | Barranco beach | 24 Sep 1992 | Partial skeleton | MCNPR |
| 214 | *Spheniscus magellanicus* | Pontal do Sul beach | 28 Jul 1993 | Complete skeleton | MCNPR |
| 226 | *Spheniscus magellanicus* | Shangrilá beach | 17 Jul 1992 | Complete skeleton | MUCIN |
| **PROCELLARIIFORMES** | | | | | |
| **DIOMEDEIDAE** | | | | | |
| 70 | *Thalassarche chlororhynchos* | Barranco beach | 12 Nov 1992 | Partial skeleton | MCNPR |
| 76 | *Thalassarche chlororhynchos* | Pontal do Sul beach | 12 Sep 1992 | Complete skeleton | MUCIN |
| 85 | *Thalassarche chlororhynchos* | Atami beach | 12 Sep 1992 | Complete skeleton | MUCIN |
| 95 | *Thalassarche chlororhynchos* | Pontal do Sul beach | 12 Sep 1992 | Complete skeleton | MCNPR |
| 170 | *Thalassarche chlororhynchos* | Atami beach | 12 Nov 1992 | Partial skeleton | MCNPR |
| 217 | *Thalassarche chlororhynchos* | At sea, near Ilha dos Currais | 16 Jul 1993 | Complete skeleton | MUCIN |
| 227 | *Thalassarche chlororhynchos* | Ilha do Mel | 4 Aug 1993 | Complete skeleton | MCNPR |
| 230 | *Thalassarche chlororhynchos* | Pontal do Sul beach | 28 Jul 1993 | Complete skeleton | MUCIN |
| 79 | *Thalassarche melanophris* | Atami beach | 24 Sep 1992 | Complete skeleton | MCNPR |
| 87 | *Thalassarche melanophris* | Atami beach | 12 Nov 1992 | Complete skeleton | MCNPR |
| 89 | *Thalassarche melanophris* | Pontal do Sul beach | 12 Sep 1992 | Complete skeleton | MCNPR |
| 172 | *Thalassarche melanophris* | Pontal do Sul beach | 11 Jul 1992 | Complete skeleton | MUCIN |
| 187 | *Thalassarche melanophris* | Paraná coast | 1992 | Complete skeleton | MUCIN |
| 242 | *Thalassarche melanophris* | Pontal do Sul beach | 3 Aug 1993 | Complete skeleton | MUCIN |

| MCEMAV no. | Taxon | Collection locality | Date | Material | Museum |
|---|---|---|---|---|---|
| 72 | *Thalassarche melanophris* | Paraná coast | u.d. in 1992–94 | Complete skeleton | MUCIN |
| 73 | *Thalassarche melanophris* | Paraná coast | u.d. in 1992–94 | Complete skeleton | MUCIN |
| 77 | *Thalassarche melanophris* | Paraná coast | u.d. in 1992–94 | Complete skeleton | MUCIN |
| 312 | *Thalassarche* sp. | Atami beach | 30 May 1994 | Partial skeleton | MCNPR |
| **PROCELLARIIDAE** | | | | | |
| 180 | *Macronectes giganteus* | Barranco beach | u.d. in 1992–94 | Complete skeleton | MUCIN |
| 12 | *Fulmarus glacialoides* | Pontal do Sul beach | 2 Jul 1992 | Complete skeleton | MUCIN |
| 96 | *Fulmarus glacialoides* | Atami beach | 28 Jul 1992 | Complete skeleton | MUCIN |
| 128 | *Fulmarus glacialoides* | Shangrilá beach | 19 Aug 1992 | Partial skeleton | MUCIN |
| 136 | *Fulmarus glacialoides* | Pontal do Sul beach | 2 Jul 1992 | Complete skeleton | MUCIN |
| 8 | *Pachyptila belcheri* | Pontal do Sul beach | 3 Jul 1992 | Partial skeleton | MUCIN |
| 26 | *Pachyptila belcheri* | Pontal do Sul beach | 28 Jul 1992 | Skull | MUCIN |
| 97 | *Pachyptila belcheri* | Pontal do Sul beach | 28 Jul 1992 | Partial skeleton | MUCIN |
| 98 | *Pachyptila belcheri* | Pontal do Sul beach | 28 Jul 1992 | Partial skeleton | MUCIN |
| 111 | *Pachyptila belcheri* | Atami beach | 17 Jul 1992 | Complete skeleton | MUCIN |
| 112 | *Pachyptila belcheri* | Pontal do Sul beach | 2 Jul 1992 | Skull | MUCIN |
| 113 | *Pachyptila belcheri* | Atami beach | 17 Jul 1992 | Partial skeleton | MUCIN |
| 114 | *Pachyptila belcheri* | Atami beach | 17 Jul 1992 | Partial skeleton | MUCIN |
| 126 | *Pachyptila belcheri* | Atami beach | 17 Jul 1992 | Partial skeleton | MUCIN |
| 127 | *Pachyptila belcheri* | Atami beach | 17 Jul 1992 | Complete skeleton | MUCIN |
| 129 | *Pachyptila belcheri* | Ipanema beach | u.d. in 1992–94 | Complete skeleton | MUCIN |
| 64 | *Procellaria aequinoctialis* | Pontal do Sul beach | 19 Aug 1992 | Complete skeleton | MUCIN |
| 80 | *Procellaria aequinoctialis* | Assenodi beach | 12 Sep 1992 | Complete skeleton | MUCIN |
| 135 | *Procellaria* sp. | Paraná coast | u.d. in 1992–94 | Partial skeleton | MCNPR |
| 267 | *Calonectris borealis* | Atami beach | 14 May 1994 | Partial skeleton | MCNPR |
| 306 | *Calonectris borealis* | Barranco beach | 30 May 1994 | Complete skeleton | MUCIN |
| 307 | *Calonectris borealis* | Barranco beach | 30 May 1994 | Complete skeleton | MUCIN |
| 308 | *Calonectris borealis* | Barranco beach | 30 May 1994 | Complete skeleton | MUCIN |
| 309 | *Calonectris borealis* | Atami beach | 30 May 1994 | Complete skeleton | MUCIN |
| 310 | *Calonectris borealis* | Barranco beach | 30 May 1994 | Complete skeleton | MUCIN |
| 311 | *Calonectris borealis* | Barranco beach | 30 May 1994 | Complete skeleton | MUCIN |
| 313 | *Calonectris borealis* | Pontal do Sul beach | 30 May 1994 | Complete skeleton | MUCIN |
| 315 | *Calonectris borealis* | Barranco beach | 30 May 1994 | Complete skeleton | MUCIN |
| 316 | *Calonectris borealis* | Barranco beach | 30 May 1994 | Complete skeleton | MUCIN |
| 317 | *Calonectris borealis* | Barranco beach | 30 May 1994 | Complete skeleton | MUCIN |
| 318 | *Calonectris borealis* | Barranco beach | 30 May 1994 | Complete skeleton | MUCIN |
| 321 | *Calonectris borealis* | Barranco beach | 30 May 1994 | Complete skeleton | MUCIN |
| 323 | *Calonectris borealis* | Pontal do Sul beach | 15 May 1994 | Complete skeleton | MUCIN |
| 324 | *Calonectris borealis* | Pontal do Sul beach | 30 May 1994 | Partial skeleton | MCNPR |
| 325 | *Calonectris borealis* | Pontal do Sul beach | 15 May 1994 | Complete skeleton | MCNPR |
| 327 | *Calonectris borealis* | Pontal do Sul beach | 15 May 1994 | Complete skeleton | MCNPR |
| 328 | *Calonectris borealis* | Pontal do Sul beach | 15 May 1994 | Complete skeleton | MCNPR |

| **MCEMAV no.** | **Taxon** | **Collection locality** | **Date** | **Material** | **Museum** |
|---|---|---|---|---|---|
| 331 | *Calonectris borealis* | Barranco beach | 14 May 1994 | Complete skeleton | MCNPR |
| 332 | *Calonectris borealis* | Atami beach | 14 May 1994 | Complete skeleton | MCNPR |
| 334 | *Calonectris borealis* | Atami beach | 14 May 1994 | Complete skeleton | MCNPR |
| 335 | *Calonectris borealis* | Atami beach | 14 May 1994 | Complete skeleton | MCNPR |
| - | *Calonectris borealis* | Paraná coast | u.d. in 1992–94 | Skin | MCNPR |
| 326 | *Calonectris* sp. | Pontal do Sul beach | 15 May 1994 | Complete skeleton | MCNPR |
| 33 | *Puffinus griseus* | Atami beach | 2 Aug 1992 | Skin | MCNPR |
| 58 | *Puffinus griseus* | Pontal do Sul beach | 19 Aug 1992 | Complete skeleton | MUCIN |
| 86 | *Puffinus griseus* | Atami beach | 24 Sep 1992 | Complete skeleton | MUCIN |
| 99 | *Puffinus griseus* | Pontal do Sul beach | u.d. in 1992–94 | Complete skeleton | MUCIN |
| 57 | *Puffinus* cf. *griseus* | Paraná coast | u.d. in 1992–94 | Complete skeleton | MCNPR |
| 3 | *Puffinus gravis* | Pontal do Sul beach | 10 Jun 1992 | Complete skeleton | MUCIN |
| 5 | *Puffinus gravis* | Pontal do Sul beach | 10 Jun 1992 | Partial skeleton | MCNPR |
| 25 | *Puffinus gravis* | Pontal do Sul beach | 28 Jul 1992 | Partial skeleton | MCNPR |
| 30 | *Puffinus gravis* | Barranco beach | 19 Aug 1992 | Skull | MCNPR |
| 148 | *Puffinus gravis* | Barranco beach | 13 Apr 1994 | Skin | MCNPR |
| 250 | *Puffinus gravis* | Pontal do Sul beach | 25 Sep 1993 | Complete skeleton | MCNPR |
| 268 | *Puffinus gravis* | Atami beach | 14 May 1994 | Partial skeleton | MCNPR |
| 269 | *Puffinus gravis* | Barranco beach | 14 May 1994 | Complete skeleton | MCNPR |
| 270 | *Puffinus gravis* | Barranco beach | 14 May 1994 | Complete skeleton | MCNPR |
| 271 | *Puffinus gravis* | Barranco beach | 14 May 1994 | Complete skeleton | MCNPR |
| 329 | *Puffinus gravis* | Pontal do Sul beach | 15 May 1994 | Complete skeleton | MUCIN |
| 330 | *Puffinus gravis* | Barranco beach | 14 May 1994 | Partial skeleton | MUCIN |
| 333 | *Puffinus gravis* | Atami beach | 14 May 1994 | Complete skeleton | MCNPR |
| 166 | *Puffinus* cf. *gravis* | Pontal do Sul beach | 15 Jul 1992 | Partial skeleton | MCNPR |
| 171 | *Puffinus* cf. *gravis* | Pontal do Sul beach | 11 Jul 1992 | Complete skeleton | MCNPR |
| 91 | *Puffinus puffinus* | Atami beach | 12 Nov 1992 | Complete skeleton | MCNPR |
| 100 | *Puffinus puffinus* | Pontal do Sul beach | 2 Jul 1992 | Complete skeleton | MUCIN |
| 130 | *Puffinus puffinus* | Atami beach | 19 Aug 1992 | Complete skeleton | MUCIN |
| 131 | *Puffinus puffinus* | Barranco beach | u.d. in 1992–94 | Complete skeleton | MUCIN |
| 235 | *Puffinus puffinus* | Pontal do Sul beach | 10 Oct 1992 | Complete skeleton | MCNPR |
| 238 | *Puffinus puffinus* | Pontal do Sul beach | 14 Nov 1992 | Complete skeleton | MCNPR |
| 249 | *Puffinus puffinus* | Atami beach | 25 Sep 1993 | Complete skeleton | MCNPR |
| - | *Puffinus puffinus* | Paraná coast | u.d. in 1992–94 | Skin | MCNPR |
| 163 | *Puffinus* sp. | Paraná coast | u.d. in 1992–94 | Partial skeleton | MCNPR |
| 167 | *Puffinus* sp. | Paraná coast | u.d. in 1992–94 | Partial skeleton | MCNPR |
| 184 | *Puffinus* sp. | Paraná coast | u.d. in 1992–94 | Partial skeleton | MCNPR |
| 314 | *Puffinus* sp. | Barranco beach | 30 May 1994 | Partial skeleton | MCNPR |
| **SULIFORMES** | | | | | |
| **FREGATIDAE** | | | | | |
| 4 | *Fregata magnificens* | Pontal do Sul beach | 10 Jun 1992 | Partial skeleton | MCNPR |
| 6 | *Fregata magnificens* | Barranco beach | 10 Jun 1992 | Partial skeleton | MCNPR |

| MCEMAV no. | Taxon | Collection locality | Date | Material | Museum |
|---|---|---|---|---|---|
| 9 | *Fregata magnificens* | Pontal do Sul beach | 10 Jun 1992 | Partial skeleton | MUCIN |
| 10 | *Fregata magnificens* | Pontal do Sul beach | 10 Jun 1992 | Partial skeleton | MUCIN |
| 11 | *Fregata magnificens* | Pontal do Sul beach | 10 Jun 1992 | Partial skeleton | MUCIN |
| 13 | *Fregata magnificens* | Pontal do Sul beach | 10 Jun 1992 | Partial skeleton | MCNPR |
| 24 | *Fregata magnificens* | Pontal do Sul beach | Aug 1992 | Partial skeleton | MUCIN |
| 29 | *Fregata magnificens* | Pontal do Sul beach | 10 Jun 1992 | Partial skeleton | MCNPR |
| 43 | *Fregata magnificens* | Ilha dos Currais | 27 Jan 1993 | Partial skeleton | MCNPR |
| 44 | *Fregata magnificens* | Pontal do Sul beach | 15 Jul 1992 | Skull | MUCIN |
| 48 | *Fregata magnificens* | Ilha dos Currais | 27 Jan 1993 | Partial skeleton | MUCIN |
| 49 | *Fregata magnificens* | Ilha dos Currais | 27 Jan 1993 | Partial skeleton | MUCIN |
| 182 | *Fregata magnificens* | Ilha dos Currais | 6 Aug 1993 | Partial skeleton | MUCIN |
| 186 | *Fregata magnificens* | Ilha dos Currais | 1993 | Partial skeleton | MUCIN |
| 215 | *Fregata magnificens* | Atami beach | 8 Jun 1993 | Partial skeleton | MUCIN |
| 222 | *Fregata magnificens* | Barranco beach | 1 Aug 1993 | Partial skeleton | MUCIN |
| 223 | *Fregata magnificens* | Ilha dos Currais | 24 May 1992 | Partial skeleton | MUCIN |
| 225 | *Fregata magnificens* | Shangrilá beach | Jul 1992 | Skull | MUCIN |
| 239 | *Fregata magnificens* | Atami beach | 12 Nov 1992 | Partial skeleton | MCNPR |
| 240 | *Fregata magnificens* | Ipanema beach | u.d. in 1992–94 | Partial skeleton | MUCIN |
| 241 | *Fregata magnificens* | Atami beach | 24 Sep 1992 | Partial skeleton | MCNPR |
| **SULIDAE** | | | | | |
| 7 | *Sula leucogaster* | Paraná coast | u.d. in 1992–94 | Partial skeleton | MCNPR |
| 14 | *Sula leucogaster* | Paraná coast | u.d. in 1992–94 | Partial skeleton | MCNPR |
| 28 | *Sula leucogaster* | Pontal do Sul beach | 3 Jul 1992 | Partial skeleton | MCNPR |
| 45 | *Sula leucogaster* | Ilha dos Currais | 27 Jan 1993 | Skull | MCNPR |
| 65 | *Sula leucogaster* | Barranco beach | 24 Sep 1992 | Complete skeleton | MUCIN |
| 68 | *Sula leucogaster* | Pontal do Sul beach | 12 Sep 1992 | Partial skeleton | MUCIN |
| 69 | *Sula leucogaster* | Atami beach | 11 Jul 1992 | Complete skeleton | MUCIN |
| 74 | *Sula leucogaster* | Pontal do Sul beach | 11 Jul 1992 | Complete skeleton | MUCIN |
| 78 | *Sula leucogaster* | Paraná coast | u.d. in 1992–94 | Partial skeleton | MUCIN |
| 88 | *Sula leucogaster* | Atami beach | 12 Nov 1992 | Partial skeleton | MUCIN |
| 90 | *Sula leucogaster* | Shangrilá beach | 17 Jul 1992 | Skull and jaw | MUCIN |
| 92 | *Sula leucogaster* | Barranco beach | 12 Nov 1992 | Complete skeleton | MUCIN |
| 93 | *Sula leucogaster* | Barranco beach | 12 Nov 1992 | Partial skeleton | MUCIN |
| 137 | *Sula leucogaster* | Atami beach | 17 Jul 1992 | Complete skeleton | MUCIN |
| 138 | *Sula leucogaster* | Barranco beach | 7 Jun 1993 | Partial skeleton | MCNPR |
| 139 | *Sula leucogaster* | Atami beach | 7 Jun 1993 | Partial skeleton | MUCIN |
| 140 | *Sula leucogaster* | Paraná coast | u.d. in 1992–94 | Complete skeleton | MCNPR |
| 141 | *Sula leucogaster* | Paraná coast | u.d. in 1992–94 | Partial skeleton | MCNPR |
| 162 | *Sula leucogaster* | Atami beach | 19 Aug 1992 | Complete skeleton | MCNPR |
| 165 | *Sula leucogaster* | Barranco beach | 13 Sep 1992 | Partial skeleton | MCNPR |
| 173 | *Sula leucogaster* | Barranco beach | 17 Jul 1992 | Partial skeleton | MCNPR |
| 175 | *Sula leucogaster* | Barranco beach | 28 Jul 1992 | Partial skeleton | MCNPR |

| MCEMAV no. | Taxon | Collection locality | Date | Material | Museum |
|---|---|---|---|---|---|
| 176 | *Sula leucogaster* | Pontal do Sul beach | 3 Jul 1992 | Complete skeleton | MUCIN |
| 178 | *Sula leucogaster* | Ilha dos Currais | 1993 | Complete skeleton | MUCIN |
| 181 | *Sula leucogaster* | Ilha dos Currais | 6 Aug 1993 | Complete skeleton | MUCIN |
| 183 | *Sula leucogaster* | Ilha dos Currais | 6 Aug 1993 | Complete skeleton | MUCIN |
| 216 | *Sula leucogaster* | Monções beach | 10 May 1993 | Partial skeleton | MCNPR |
| 218 | *Sula leucogaster* | Gaivotas beach | u.d. in 1992–94 | Skull | MCNPR |
| 220 | *Sula leucogaster* | Praia de Leste beach | 10 May 1993 | Complete skeleton | MCNPR |
| 236 | *Sula leucogaster* | Ipanema beach | 19 Aug 1992 | Partial skeleton | MCNPR |
| 237 | *Sula leucogaster* | Ipanema beach | 19 Aug 1992 | Partial skeleton | MCNPR |
| 247 | *Sula leucogaster* | Atami beach | 2 Mar 1994 | Partial skeleton | MUCIN |
| 248 | *Sula leucogaster* | Atami beach | 25 Sep 1993 | Partial skeleton | MUCIN |
| 265 | *Sula leucogaster* | Ilha dos Currais | 24 May 1993 | Partial skeleton | MCNPR |
| 319 | *Sula leucogaster* | Barranco beach | 30 May 1994 | Partial skeleton | MUCIN |
| 320 | *Sula leucogaster* | Barranco beach | 30 May 1994 | Partial skeleton | MUCIN |
| 322 | *Sula leucogaster* | Pontal do Sul beach | 15 May 1994 | Complete skeleton | MCNPR |
| 81 | *Sula* sp. | Paraná coast | u.d. in 1992–94 | Partial skeleton | MCNPR |
| **CHARADRIIFORMES** | | | | | |
| **CHIONIDAE** | | | | | |
| 188 | *Chionis albus* | Ilha dos Currais | 13 Jun 1994 | Partial skeleton | MUCIN |
| **STERCORARIIDAE** | | | | | |
| 34 | *Stercorarius antarticus* | Grajaú beach | 7 Nov 1992 | Partial skeleton and skin | MCNPR |
| 232 | *Stercorarius* sp. | Barranco beach | 19 Aug 1992 | Complete skeleton | MUCIN |
| **LARIDAE** | | | | | |
| 219 | *Larus dominicanus* | Barranco beach | 15 Apr 1993 | Complete skeleton | MUCIN |
| 221 | *Larus dominicanus* | Assenodi beach | 15 May 1993 | Partial skeleton | MCNPR |
| 252 | *Larus dominicanus* | Barranco beach | 19 Jan 1994 | Complete skeleton | MUCIN |
| 253 | *Larus dominicanus* | Pontal do Sul beach<br>Atami beach | 3 Apr 1994 | Complete skeleton | MUCIN |
| - | *Larus dominicanus* | Paraná coast | u.d. in 1992–94 | Skin | MCNPR |
| **STERNIDAE** | | | | | |
| 179 | *Sterna* cf. *hirundinacea* | Ilha Itacolomis | u.d. in 1992–94 | Complete skeleton | MUCIN |
| 110 | *Sterna* sp. | Paraná coast | u.d. in 1992–94 | Partial skeleton | MUCIN |
| 124 | *Sterna* sp. | Paraná coast | u.d. in 1992–94 | Partial skeleton | MUCIN |
| 125 | *Sterna* sp. | Paraná coast | u.d. in 1992–94 | Partial skeleton | MUCIN |
| 144 | *Sterna* sp. | Paraná coast | u.d. in 1992–94 | Skull | MCNPR |
| 149 | *Thalasseus acuflavidus* | Pontal do Sul beach | 23 Apr 1994 | Skin | MCNPR |
| 224 | *Thalasseus acuflavidus eurygnathus* | Atami beach | 5 Apr 1993 | Partial skeleton | MUCIN |
| 234 | *Thalasseus acuflavidus eurygnathus* | Atami beach | 19 Aug 1992 | Complete skeleton | MUCIN |

and common during pelagic trips off southern Brazil (Neves *et al*. 2006), with records from the neighbouring states of Santa Catarina (Ghizoni-Jr. *et al*. 2013), São Paulo (Figueiredo 2016) and Rio Grande do Sul (Bencke *et al*. 2010). Krul & Moraes (1997) reported many carcasses on beaches in Paraná in May 1994 (*n* = 55). Skeletons are retained at MUCIN (MCEMAV 306–307; Barrancos beach, 30 May 1994; complete); and MCNPR (MCEMAV 327–328; Pontal do Sul beach, 15 May 1994; complete).

**SOOTY SHEARWATER** *Puffinus griseus*
Trans-equatorial migrant that breeds in the Southern Hemisphere. Follows the Brazilian coast en route to its wintering areas in the North Atlantic, using waters off Rio Grande do Sul and Santa Catarina to forage during the breeding season (Hedd *et al*. 2012, 2014). Common but not abundant during pelagic trips off south-east and southern Brazil (Neves *et al*. 2006), with records off São Paulo, Santa Catarina and Rio Grande do Sul (Bencke *et al*. 2010, Ghizoni-Jr. *et al*. 2013, Figueiredo 2016). Known from Paraná based on eight carcasses (Moraes & Krul 1997). Osteological material is held at MUCIN (MCEMAV 86; Atami beach, 24 September 1992; complete skeleton) and one skin at MCNPR (MCEMAV 33; Atami beach, 2 August 1992).

**SNOWY SHEATHBILL** *Chionis albus*
Southern Hemisphere vagrant to Brazil, based mainly on records from Rio Grande do Sul (Dias *et al.* 2010). Documented records of Snowy Sheathbill for Brazil include the specimen mentioned by Moraes & Krul (1997) for Paraná. The partial skeleton (including complete skull) is deposited at MUCIN (MCEMAV 188; Ilha dos Currais, 13 June 1994). Dias *et al*. (2010) mentioned documented records of *C. albus* from Rio Grande do Sul and Santa Catarina, as well as Bahia and Pernambuco (north-east Brazil).

We suggest removing the following two species from the primary list of bird species recorded in Paraná (Scherer-Neto *et al*. 2011) as follows.

**SHY ALBATROSS** *Thalassarche cauta*
Evidence for the species' occurrence in Paraná is based on a photograph by RK (Fig. 1; Scherer-Neto *et al.* 2011). The specimen was brought alive to CEM-UFPR and, following observation for a few days, was released. No material other than the photograph was retained. Bill colour confirms that the bird was an adult, but the absence of yellow at the base of the culminicorn does not reliably distinguish Shy Albatross and White-capped Albatross *T. steadi* (Carlos 2008). Consequently, the photograph alone does not determine which species was involved. Following ACAP (2011), Pereira *et al.* (2016) presented the first documented record of White-capped Albatross for Brazil. These authors suggested that Shy-type albatrosses recorded in Brazil might be White-capped because numbers of this species recorded as by-catch in Uruguayan pelagic longline fisheries are much larger (Jiménez *et al*. 2009, 2015). We propose moving Shy Albatross to the tertiary list (hypothetical occurrence; lacking any confirmed records) and White-capped Albatross to the secondary list (probable occurrence) for Paraná (Scherer-Neto *et al*. 2011).

**BROAD-BILLED PRION** *Pachyptila vittata*
Moraes & Krul (1997) reported a specimen from Atami beach, Paraná, on 14 May 1994, which was subsequently lost. But, in any case, RK believes that the specimen actually involved an example of Slender-billed Prion *P. belcheri*.

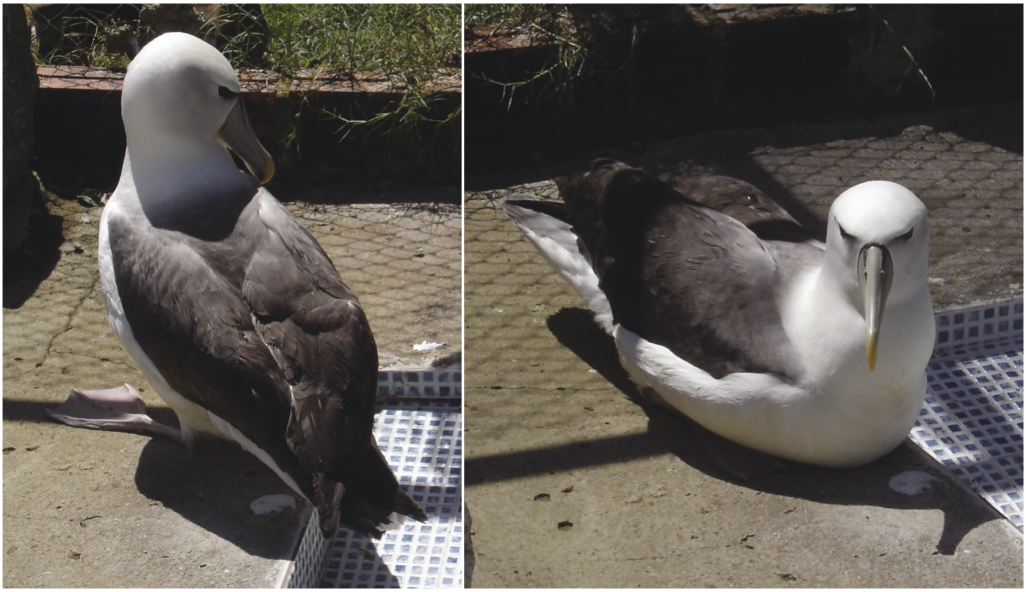


Figure 1. Shy-type albatross *Thalassarche cauta* / *T. steadi*, beached alive at Pontal do Sul beach, Paraná, 3 December 2005 (Ricardo Krul)

## Discussion

The information presented here contributes to our knowledge of seabird occurrence in southern Brazil, from where there are still comparatively few publications focused on beached seabirds (e.g. Vooren & Fernandes 1989, Faria *et al*. 2014), despite their important contribution to overall knowledge of the Brazilian seabird avifauna (Roos & Piacentini 2003, Bugoni 2006, Pereira *et al*. 2016). Although the records do not permit us to elucidate stranding patterns, the data match known seasonality of migrants and other occurrence patterns (Harrison 1985, Vooren & Fernandes 1989). It appears that the species added to the state's bird list had not been documented previously because of the paucity of appropriate studies. Therefore, beach monitoring surveys contribute to knowledge, by providing various data including specimens.

This is the largest collection to date of seabirds in Paraná, with most specimens being skeletons. The osteological material, though, has the advantage that it can be maintained at low cost, being durable and less susceptible to damage (Winker 2000, Olson 2003, Causey & Trimble 2005). Even so, the number of skeletons is <10% of material in Brazilian collections and worldwide, with few exceptions (Causey & Trimble 2005, Aleixo & Straube 2007, Müller & Vieira 2016).

Our work highlights the importance of subjecting specimens to appropriate verification and agrees with the role of public natural history collections (Brooke 2000, Rainbow 2009) both to civil society and government agencies (Suarez & Tsutsui 2004). Open science improves dissemination of knowledge on species' distributions (Baird 2010, Drew 2011). We encourage scientific collections and museums unable to provide open access to their material (via websites) to compile and publish catalogues periodically.

Beach monitoring surveys contribute to documenting seabirds in the country, supplementing field and other studies, improving information on seabird biology and helping to expand scientific collections. Therefore, we encourage salvaging specimens from beach surveys, especially osteological material.

## Acknowledgements

We thank Valéria Moraes-Ornellas who co-founded the ornithology laboratory at CEM-UFPR together with RK. Fernando Sedor (MCNPR-UFPR) and Maurício Tavares (MUCIN-UFRGS) permitted us to check and publish these data. Thanks to Caio J. Carlos for discussing the records of Broad-billed Prion and Shy Albatross, and Fernando C. Straube who improved an early version of this manuscript and discussed the Shy-type albatross record with us. The submitted manuscript benefitted from the valuable suggestions of Bianca P. Vieira, an anonymous reviewer and the editor Guy Kirwan. Anthony C. Grice kindly revised the English language. NWD & AP are supported by Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Brazil.

References:

Agreement on the Conservation of Albatrosses and Petrels (ACAP). 2011. ACAP species assessment: White-capped Albatross *Thalassarche steadi*. http://acap.aq/en/resources/acap-species2/317-white-capped-albatross/file (accessed 22 October 2016).

Aleixo, A. & Straube, F. C. 2007. Coleções de aves brasileiras: breve histórico, diagnóstico atual e perspectivas para o futuro. *Rev. Bras. Orn*. 15: 315–324.

Arinze, E. N. 1999. The role of the museums in society. Public lecture presented on Guyana workshop – museums, peace, democracy and governance in the 21st century. http://www.maltwood.uvic.ca/cam/activities/past_conferences/1999conf/CAM'99-EmmanuelArinze.GuyanaFinal.pdf.

Baird, R. 2010. Leveraging the fullest potential of scientific collections through digitalization. *Biodiver. Inf*. 7: 130–136.

Bencke, G. A., Dias, R. A., Bugoni, L., Agne, C. E., Fontana, C. S., Maurício, G. N. & Machado, D. B. 2010. Revisão e atualização da lista de aves do Rio Grande do Sul, Brasil. *Iheringia, Sér. Zool*. 100: 519–556.

Brooke, M. L. 2000. Why museums matter. *Trends Ecol. Evol*. 15: 136–137.

Bugoni, L. 2006. Great-winged Petrel *Pterodroma macroptera* in Brazil. *Bull. Brit. Orn. Cl*. 126: 52–54.

Carlos, C. J. 2008. A critical look at the alleged Brazilian records of the Indian Yellow-nosed Albatross *Thalassarche carteri*, with comments on mollymawk identification in Brazil (Procellariiformes: Diomedeidae). *Rev. Bras. Orn*. 16: 99–106.

Carlos, C. J., Straube, F. C. & Pacheco, J. F. 2010. Conceitos e definições sobre documentação de registros ornitológicos e critérios para a elaboração de listas de aves para os estados brasileiros. *Rev. Bras. Orn*. 18: 355–361.

Causey, D. & Trimble, J. 2005. Old bones in new boxes: osteology collections in the new millennium. *Auk* 122: 971–979.

Dias, R. A., Agne, C. E., Gianuca, D., Gianuca, A., Barcellos-Silveira, A. & Bugoni, L. 2010. New records, distribution and status of six seabird species in Brazil. *Iheringia, Sér. Zool*. 100: 379–390.

Dias, M. P., Granadeiro, J. P., Phillips, R. A., Alonso, H. & Catry, P. 2011. Breaking the routine: individual Cory's shearwaters shift winter destinations between hemispheres and across ocean basins. *Proc. Roy. Soc. B* 278: 1786–1793.

Drew, J. 2011. The role of natural history institutions and bioinformatics in conservation biology. *Conserv. Biol*. 25: 1250–1252.

Faria, F. A., Burgueño, L. E. T., Weber, F. S., Souza, F. J. & Bugoni, L. 2014. Unusual mass stranding of Atlantic Yellow-nosed Albatross (*Thalassarche chlororhynchos*), petrels and shearwaters in southern Brazil. *Waterbirds* 37: 446–450.

Figueiredo, L. F. A. (ed.) 2016. Lista de aves do Estado de São Paulo. V. 15/1/2016. www.ceo.org.br (accessed 12 October 2016).

Ghizoni-Jr., I. V., Farias, F. B., Vieira, B. P., Willrich, G., Silva, E. S., Mendonça, E. N., Albuquerque, J. L. B., Gass, D. A., Ternes, M. H., Nascimento, C. E., Roos, A. L., Couto, C. C. M., Serrão, M., Serafini, P. P., Dias, D., Fantacini, F. M., Santi, S., Souza, M. C. R., Silva, M. S., Barcellos, A., Albuquerque, C. & Espínola, C. R. R. 2013. Checklist da avifauna da Ilha de Santa Catarina, sul do Brasil. *Atualidades Orn*. 171: 50–75.

González-Solís, J., Croxall, J. P., Oro, D. & Ruiz, X. 2007. Trans-equatorial migration and mixing in the wintering areas of a pelagic seabird. *Front. Ecol. Environ*. 5: 297–301.

Harrison, P. 1985. *Seabirds: an identification guide*. Houghton Mifflin, Boston.

Hedd, A., Montevecchi, W. A., Otley, H., Phillips, R. A. & Fifield, D. A. 2012. Trans-equatorial migration and habitat use by sooty shearwaters *Puffinus griseus* from the South Atlantic during the nonbreeding season. *Mar. Ecol. Prog. Ser*. 449: 277–290.

Hedd, A., Montevecchi, W. A., Phillips, R. A. & Fifield, D. A. 2014. Seasonal sexual segregation by monomorphic sooty shearwaters *Puffinus griseus* reflects different reproductive roles during the pre-laying period. *PLoS ONE* 9: e85572.

Jiménez, S., Domingo, A., Marquez, A., Abreu, M., D'Anatro, A. & Pereira, A. 2009. Interactions of long-line fishing with seabirds in the south-western Atlantic Ocean, with a focus on White-capped Albatrosses (*Thalassarche steadi*). *Emu* 109: 321–326.

Jiménez, S., Marquez, A., Abreu, M., Forselledo, R., Pereira, A. & Domingo, A. 2015. Molecular analysis suggests the occurrence of Shy Albatross in the south-western Atlantic Ocean and its by-catch in longline fishing. *Emu* 115: 58–62.

Joseph, L. 2011. Museum collections in ornithology: today's record of avian biodiversity for tomorrow's world. *Emu* 111: i–xii.

Krul, R. 2004. Aves marinhas costeiras do Paraná. Pp. 37–56 *in* Branco, J. O. (ed.) *Aves marinhas insulares brasileiras: bioecologia e conservação*. Ed. Univali, Itajaí.

Krul, R. & Moraes, V. S. 1997. *Calonectris diomedea* (Procellariiformes, Procellariidae) no litoral do Paraná. P. 105 *in* Coelho, A. G. M., Nascimento, I. L. S., Nascimento, J. L. X. & Azevedo-Junior, S. M. (eds.) *IV Congresso Brasileiro de Ornitologia, Resumos*. Sociedade Brasileira de Ornitologia, Recife.

Moraes, V. S. & Krul, R. 1992. Uma coleção especial de aves marinhas no Estado do Paraná. P. 33 *in* Sander, M., Petry, M. V. & Voss, W. A. (eds.) *II Congresso Brasileiro de Ornitologia, Resumos*. Sociedade Brasileira de Ornitologia, Campo Grande.

Moraes, V. S. & Krul, R. 1997. Dados sobre algumas aves pelágicas visitantes da costa do Brasil. P. 45 *in* Coelho, A. G. M., Nascimento, I. L. S., Nascimento, J. L. X. & Azevedo-Junior, S. M. (eds.) *IV Congresso Brasileiro de Ornitologia, Resumos*. Sociedade Brasileira de Ornitologia, Recife.

Müller, I. H. & Vieira, B. P. 2016. Estado de preservação dos espécimes na Coleção de Aves da Universidade Federal de Santa Catarina. *Atualidades Orn*. 194: 52–74.

Neves, T., Vooren, C. M., Bugoni, L., Olmos, F. & Nascimento, L. 2006. Distribuição e abundância de aves marinhas na região sudeste-sul do Brasil. Pp. 11–35 *in* Neves, T., Bugoni, L. & Rossi-Wongtschowski, C. L. B. (eds.) *Aves oceânicas e suas interações com a pesca na região sudeste-sul do Brasil.* Instituto Oceanográfico, Universidade de São Paulo, São Paulo.

Olson, S. L. 2003. Development and uses of avian skeleton collections. *Bull. Brit. Orn. Cl*. 123A: 26–34.

Pereira, A., Daudt, N. W., Nuss, A., Tavares, M. & Carlos, C. J. 2016. The first confirmed record of the White-capped Albatross *Thalassarche steadi* in Brazil. *Rev. Bras. Orn*. 24: 286–289.

Piacentini, V. Q., Aleixo, A., Agne, C. E., Maurício, G. N., Pacheco, J. F., Bravo, G. A., Brito, G. R. R., Naka, L. N., Olmos, F., Posso, S., Silveira, L. F., Betini, G. S., Carrano, E., Franz, I., Lees, A. C., Lima, L. M., Pioli, D., Schunck, F., Amaral, F. R., Bencke, G. A., Cohn-Haft, M., Figueiredo, L. F. A., Straube, F. C. & Cesari, E. 2015. Annotated checklist of the birds of Brazil by the Brazilian Ornithological Records Committee. *Rev. Bras. Orn*. 23: 91–298.

Rainbow, P. S. 2009. Marine biological collections in the 21st century. *Zool. Scripta* 38 (Suppl. 1): 33–40.

Roos, A. L. & Piacentini, V. Q. 2003. Revisão dos registros sul-brasileiros do gênero *Phoebetria* Reichenbach, 1853 e primeiro registro documentado de *Phoebetria palpebrata* (Forster, 1785) (Procellariiformes: Diomedeidae) para Santa Catarina. *Ararajuba* 11: 223–225.

Scherer-Neto, P., Straube, F. C., Carrano, E. & Urben-Filho, A. 2011. *Lista de aves do Paraná*. Hori Consultoria Ambiental, Curitiba.

Suarez, A. V. & Tsutsui, N. D. 2004. The value of museum collections for research and society. *BioScience* 54: 66–74.

Vooren, C. M. & Fernandes, A. C. 1989. *Guia de albatrozes e petréis do sul do Brasil*. Sagra, Porto Alegre.

Winker, K. 2000. Obtaining, preserving, and preparing bird specimens. *J. Field Orn*. 71: 250–297.

Winker, K. 2005. Bird collections: development and use of scientific resource. *Auk* 122: 966–971.

*Addresses*: Nicholas W. Daudt and Alice Pereira, Setor de Coleções (Ornitologia), Museu de Ciências Naturais (MUCIN), Universidade Federal do Rio Grande do Sul (UFRGS), Imbé, RS, Brazil, e-mails: nicholaswdaudt@gmail.com, vakkerstormsjo@gmail.com. NWD also at Programa de Pós-Graduação em Oceanografia Biológica, Instituto de Oceanografia, Universidade Federal do Rio Grande—FURG, Rio Grande, RS, Brazil. AP also at Programa de Pós-Graduação em Biologia Animal, Instituto de Biociências, Universidade Federal do Rio Grande do Sul (UFRGS), Porto Alegre, RS, Brazil. Juliana Rechetelo, Ricardo Krul and Luiz A. M. Mestre, Laboratório de Ornitologia, Centro de Estudos do Mar (CEM), Universidade Federal do Paraná (UFPR), Pontal do Paraná, PR, Brazil, e-mails: jurechetelo@gmail.com, ricardokrul@gmail.com, luiz.mestre@ufpr.br

# Blue Cranes *Anthropoides paradiseus* at Etosha Pan, Namibia: what is the origin of this isolated population?

*Adrian J. F. K. Craig*

*Received 13 April 2017; revised 8 June 2017; published 15 September 2017*

*http://zoobank.org/urn:lsid:zoobank.org:pub:0BEAEB91-D218-4E7F-84CA-8911A811E187*

Summary.—There is an isolated breeding population of Blue Cranes *Anthropoides paradiseus* around Etosha Pan, in northern Namibia, despite a lack of regular reports of the species from adjoining regions of Botswana, southern Namibia or even north-western South Africa. A search for historical records of Blue Cranes north of South Africa suggests occasional vagrancy to southern Namibia, eastern Botswana and perhaps Zimbabwe, with consistent sightings of resident, breeding birds only from Etosha since 1918. It is apparently not a relict population. While the natural establishment of a breeding population by rare vagrants appears unlikely, there is no documented evidence for the alternative explanation that birds were deliberately introduced to this locality.

Current data indicate that Blue Crane *Anthropoides paradiseus* is restricted to South Africa (with occasional records in Lesotho and Swaziland of non-breeders), except for an isolated breeding population around the Etosha Pan in northern Namibia (Taylor *et al*. 2015). Although the vegetation type of the region is 'Mopani', the cranes are restricted to grassland near pans and lakes (Allan 1997). The largest numbers of cranes in the Etosha region (up to 138 birds) were reported in the 1970s following a period of good rains. Since then numbers have declined, and by March 2012 no more than 35 individuals were counted (Simmons 2015). Three possible scenarios exist to account for this odd distribution: (1) this outlier represents a relict population, the last survivors of a formerly wider range; (2) natural dispersal lead to the establishment of a breeding population at Etosha; or (3) these birds were deliberately introduced at some point in the past.

Andersson (1872) stated that the species was 'not uncommon in Damara and Great Namaqualand during the rainy season, but migrates on the return of the dry.' J. H. Gurney, who edited the book for publication following Andersson's death, added a footnote: 'I have not seen a Damara-Land example of this crane', but he did not doubt the accuracy of the identification. On the map in Andersson (1872), Great Namaqualand extends from the Orange River to 25°S, with Damara Land lying between 20° and 25°S. There is one 19th-century specimen record from southern Namibia. A Swedish collector, Gustav de Vylder, shot a Blue Crane near Brukkaros (25°52'S, 17°46'E) on 27 May 1873 (Rudner & Rudner 1998); the specimen is in the Stockholm museum, along with other birds presented by de Vylder. The date in the catalogue reflects the date of acquisition (1876) and the locality is given as 'Afr. merid.' (G. Frisk pers. comm.). Axel Eriksson, another Swede who lived and traded primarily in Namibia during the period 1866–1901 (Brinck 1955) and collected >1,000 bird specimens, apparently had just one crane specimen, a Grey Crowned Crane *Balearica regulorum* from the Cunene River at the border between Namibia and Angola, in his collection (Rudebeck 1955). In a lengthy narrative account of Namibian birds, Fleck (1894) mentioned only Wattled Cranes *Bugeranus carunculatus*, although he included a description of the Etosha region, where he noted bustards and ostriches as being common. Reichenow (1900) listed distributional records of Blue Crane based on the literature, and in

© 2017 The Authors; Journal compilation © 2017 British Ornithologists' Club ISSN-2513-9894 (Online)

the atlas volume of *Die Vögel Afrikas* (Reichenow 1902) he provided approximate locality data for those records cited in the text. Most are clearly in South Africa; Andersson (1872) was Reichenow's only source for Namibia.

Grote (1922) reported on a small collection of birds from the Etosha area, collected by Dr Leo Waibel in 1914; his collecting trip was cut short by the outbreak of the First World War. Grote mentioned Ostrich *Struthio camelus*, Kori Bustard *Ardeotis kori* and Northern Black Korhaan *Eupodotis afraoides* as common large ground birds in the area, but Blue Cranes were apparently not encountered. Finch-Davies (1918) spent a year in Namibia on military service, and travelled widely, collecting birds when possible. He noted seeing a pair of Blue Cranes at the southern edge of the Etosha Pan. Hoesch (1938) observed several pairs of Blue Crane at the eastern edge of the pan near Onguma, and in their account of the birds of Namibia, Hoesch & Niethammer (1940) described the range of Blue Crane as restricted to the Etosha area. Winterbottom (1971) also considered that the species was confined to a limited area south and east of Etosha Pan, but noted one record from Stampriet (24°20'S, 18°24'E), 630 km south of Etosha. In an atlas based largely on museum material, Snow (1978) did not map any Blue Crane localities for Zimbabwe or Botswana, and just one in Namibia away from the Etosha region, in map square 24°S 18°E (apparently Winterbottom's record).

'Matebele (Buckl.)' (Reichenow 1900: 263) suggests a locality in Zimbabwe, but Buckley (1874) clearly stated that Blue Cranes were encountered only on the Transvaal highveld (northern South Africa) before crossing the Limpopo River. However, 'Maschona IX. X. (James., Marsh.)' (Reichenow 1900) refers to Marshall (1900: 263), who stated that 'All the three South-African Cranes occur in Mashonaland', noting that Wattled Crane was the least common, whereas he had seen flocks comprising 20–30 individuals of both Blue Crane and Grey Crowned Crane. An earlier collecting trip by Jameson, accompanied by Ayres, also reported all three species in Mashonaland (*c.*18°S in north-western Zimbabwe) albeit 'seen, but not procured' (Shelley 1882). 'Sambesi X "Quibanda" gen. (Cap., Ivens)' (Reichenow 1900) refers to the Portuguese expedition that crossed Africa from Angola to Mozambique. However, this appears to be an error as the only crane collected on the Zambezi was a Wattled Crane (Capelo & Ivens 1886: 446). Priest (1934) had only two confirmed personal records of Blue Cranes in Zimbabwe, one in the Umvukwes (17°10'S, 30°43'E) and the other just south of Harare (18°19'S, 31°08'E); he considered the species very rare. In a later review of the avifauna of Zimbabwe, Irwin (1980) did not include Blue Crane as an accepted species. He nevertheless noted that, although records from the 19th century for the area of Harare and Umvukwe might have involved confusion with Wattled Cranes, these and subsequent reports from the 1930s could have been genuine vagrants from South Africa. There have been no records from Zimbabwe during the Southern African Bird Atlas Project, which commenced in 1987 and is currently in the second phase of data collection (SABAP2 2017).

In their account of South African birds, Holub & von Pelzeln (1882) described the heartland of the Blue Crane as north-central South Africa, but reported personal observations in south-east Botswana, and stated that its range extended north to the Zambezi, without providing specific localities. Holub (1890) made no mention of Blue Cranes north of South Africa on his later travels. Reichenow (1900: 263) listed only 'Westgriqualand, Betschuanaland (Holub)'. Although Smithers (1964) included an extensive review of historical collections from Botswana, he had no records of Blue Cranes, and did not even mention the species in a list of 'Species not recorded but likely to occur'. Penry (1994) had records from Makgadigadi Pans and Gaborone, and categorised Blue Crane as a rare and unpredictable visitor to Botswana. There were records from the Gaborone area during the first bird atlas period (Allan 1997), and one report of breeding at Makgadigadi

(Allan 2005), but there have been no records in Botswana during the current atlas period (SABAP2 2017). This single breeding record does not suggest that vagrants are likely to establish new outlying populations.

The distributional data in standard handbooks and field guides provide no indication of which records are 'current' and which 'historical'. Stark & Sclater (1906) listed Blue Crane records from Mashonaland in Zimbabwe (Ayres, Marshall), and Damaraland and Great Namaqualand (Namibia) during the rainy season (Andersson), but did not mention Botswana. Sclater (1930: 110) gave the range of Blue Crane as 'Africa south of the Zambesi, chiefly on the high veld; not on the coast-lands of Natal and Zululand'. However, Roberts (1940: 89) simply remarked 'Distribution confined to South Africa'; no maps were included. Mackworth-Praed & Grant (1962: 259) stated boldly 'South-west Africa to Southern Rhodesia, the Transvaal, Cape Province and Natal', while their map has the whole region south of the Cunene and Zambesi Rivers shaded, except Mozambique. In the second edition of *Roberts* the Etosha population, a sight record from Mashonaland in Zimbabwe, and outliers in the south-western Cape in South Africa were mapped (McLachlan & Liversidge 1957: 114). This map was unchanged in the third edition, but the text stated 'Now also Western Cape' (McLachlan & Liversidge 1970: 146). For the fourth edition of *Roberts* the shaded areas on the map extended to the Western Cape, with another patch around Etosha; and the text was modified to read 'Now also Western Cape and Etosha' (McLachlan & Liversidge 1978: 152). Originally absent from the fynbos biome (Allan 1997), Blue Cranes colonised areas cleared for agriculture, and by the 1980s the species was considered a 'Common resident and summer visitor' in the Western Cape (Hockey *et al*. 1989: 52–53). This range expansion occurred from adjoining areas where the species was common and nested regularly.

In the first modern field guide for southern African birds, Newman (1983: 138) showed the regular distribution of the Blue Crane as South Africa from the Western Cape to the north-eastern Highveld (excluding the north-west Cape), Lesotho, western Swaziland, and the Etosha region. Two vagrant records were mapped, one in south-east Namibia and the other in the Limpopo region of South Africa, but none for Botswana or Zimbabwe. This map was reproduced in the fifth edition of *Roberts* with the text specifying 'isolated population at Etosha, n Namibia; occasional in sw Botswana' (Maclean 1985: 187). However, in the sixth edition the text was modified to read 'isolated population at Etosha and in Bushmanland, n Namibia; occasional in nw Botswana', and the map shows a broad band extending from Etosha into north-west Botswana (Maclean 1993: 184). Urban (1986) summarised the distribution of Blue Crane north of South Africa: 'Namibia, occurs mainly north of 20°S and south and east of Etosha Pan, rare to vagrant south of 20°S; Botswana, rare Makgadigadi; Zimbabwe, vagrant to rare Mashonaland with persistent reports of sightings.' For the seventh edition of *Roberts*, Allan (2005: 309–311) wrote 'Isolated br[eeding] population at Etosha NP, Namibia since at least early 1800s; vagrant elsewhere in Namibia. Recent records from Caprivi unconfirmed. Small numbers regular in extreme se Botswana; occasionally north to Makgadigadi Pan (1 br[eeding] record). Several unconfirmed records from Zimbabwe'. The fourth edition of the field guide by Sinclair *et al*. (2011: 152) showed the regular range of Blue Crane in South Africa and the isolated population in Etosha, with crosses indicating vagrants in the Caprivi region, southern Namibia, south-east and north-east Botswana, and north-west Zimbabwe (Mashonaland).

So the available evidence indicates that over the past 140 years there have certainly been records of vagrant Blue Cranes well to the north of their present South African range, in both Namibia and Botswana, and probably also in Zimbabwe. However, there is no evidence that the species has regularly nested north of the Limpopo River or in the western sector of the

Orange River, except in the Etosha Pan region. Thus there is no support for the hypothesis that this isolated population represents a remnant of a formerly wider distribution. Was the Etosha population founded by lucky colonists with a critical mass of breeding birds, or was there a deliberate introduction? This is not merely an academic question, as the Namibian population is currently rated 'critically endangered' and a range of conservation measures has been proposed (Simmons 2015). Genetic comparisons may clarify the source of these birds. Within South Africa, no exchange between different subpopulations of Blue Cranes has been noted, with the most extensive movement by a ringed bird being 426 km; in the Namibian population movements of up to 120 km have been recorded (Simmons 2015). The distance from Etosha to the nearest current South African record of Blue Cranes is 1,200 km (SABAP2 2017).

## Acknowledgements

I am most grateful to Göran Frisk (formerly of the Naturhistoriska Riksmuseet, Stockholm) for information concerning specimens held in this collection, and to Susan Mvungi (Niven Library, FitzPatrick Institute, Univ. of Cape Town) and Walter Sontag (Naturhistorisches Museum, Vienna) for assistance with reference material. Michael Mills provided useful comments on the submitted manuscript.

References:

Allan, D. G. 1997. Blue Crane. Pp. 314–315 *in* Harrison, J. A, Allan, D. G, Underhill, L. G., Herremans, M., Tree, A. J. & Parker, V. (eds.) *The atlas of Southern African birds*, vol. 1. BirdLife South Africa, Johannesburg.

Allan, D. G. 2005. Blue Crane. Pp. 309–311 *in* Hockey, P. A. R., Dean, W. R. J. & Ryan, P. G. (eds.) *Roberts—birds of southern Africa*. Seventh edn. Trustees of the John Voelcker Bird Book Fund, Cape Town.

Andersson, C. J. 1872. *Notes on the birds of Damara Land and the adjacent countries of south-west Africa.* Arranged and edited by J. H. Gurney. John van Voorst, London.

Brinck, P. 1955. Swedish exploration of South African animal life during 200 years. Pp. 11–61 *in* Hanström, B., Brinck, P. & Rudebeck, G. (eds.) *South African animal life: results of the Lund University Expedition in 1950-1951*, vol. 1. Almqvist & Wiksell, Stockholm.

Capelo, H. & Ivens, R. 1886. *De Angola* á *contra-costa*. vol. 2. Imprensa Nacional, Lisbon.

Fleck, E. 1894. Das Vogelleben Deutsch-Südwestafrikas und dessen Schauplatz. *J. Orn*. 42: 291–347, 353–415.

Grote, H. 1922. Zur Avifauna des nördlichen Deutsch-Südwestafrika. *J. Orn*. 70: 39–49.

Hockey, P. A. R., Underhill, L. G., Neatherway, M. & Ryan, P. G. 1989. *Atlas of the birds of the southwestern Cape*. Cape Bird Club, Cape Town.

Hoesch, W. 1938. Ornithologische Beobachtungen auf einer Fahrt ins Etoscha-Gebiet (SW. Afrika). *J. Orn*. 86: 222–233.

Hoesch, W. & Niethammer, G. 1940. Die Vogelwelt Deutsch-Südwestafrikas: namentlich des Damara- und Namalandes. *J. Orn*. 88 (Sonderheft): 1–404.

Holub, E. 1890. *Von der Kapstadt ins Land der Maschukulumbe. Reisen in südlichen Afrika in den Jahren 1883-87*, Bd. 2. A. Hölder, Wien.

Holub, E. & von Pelzeln, A. 1882. *Beiträge zur Ornithologie Südafrikas*. A. Hölder, Wien.

Irwin, M. P. S. 1980. *The birds of Zimbabwe*. Quest Publishing, Harare.

Mackworth-Praed, C. W. & Grant, C. H. B. 1962. *Birds of the southern third of Africa*, vol. 1. Longmans, London.

Maclean, G. L. 1985. *Roberts' birds of southern Africa*. Fifth edn. Trustees of the John Voelcker Bird Book Fund, Cape Town.

Maclean, G. L. 1993. *Roberts' birds of southern Africa*. Sixth edn. Trustees of the John Voelcker Bird Book Fund, Cape Town.

Marshall, G. A. K. 1900. Notes on Mashonaland birds. *Ibis* 42: 221–270.

McLachlan, G. R. & Liversidge, R. L. 1957. *Roberts' birds of South Africa*. Second edn. Trustees of the John Voelcker Bird Book Fund, Cape Town.

McLachlan, G. R. & Liversidge, R. L. 1970. *Roberts' birds of South Africa*. Third edn. Trustees of the John Voelcker Bird Book Fund, Cape Town.

McLachlan, G. R. & Liversidge, R. L. 1978. *Roberts' birds of South Africa*. Fourth edn. Trustees of the John Voelcker Bird Book Fund, Cape Town.

Newman, K. 1983. *Newman's birds of southern Africa*. Macmillan, Johannesburg.

Penry, H. 1994. *Bird atlas of Botswana*. Univ. of Natal Press, Pietermaritzburg.

Priest, C. D. 1934. *Birds of Southern Rhodesia*, vol. 2. William Clowes & Sons, London.

Reichenow, A. 1900. *Die Vögel Afrikas*, Bd. 1. Neumann, Neudamm.

Reichenow, A. 1902. *Die Vögel Afrikas*. Atlas. Neumann, Neudamm.

Roberts, A. 1940. *The birds of South Africa*. Central News Agency, Johannesburg & H. F. & G. Witherby, London.

Rudebeck, G. 1955. Aves I. 1. On an old collection of birds from South West Africa and adjacent areas. Pp. 426–551 *in* Hanström, B., Brinck, P. & Rudebeck, G. (eds.) *South African animal life: results of the Lund University Expedition in 1950-1951*, vol. 2. Almqvist & Wiksell, Stockholm.

Rudner, I. & Rudner, J. (eds.) 1998. *The journal of Gustav de Vylder, naturalist in South-western Africa, 1873-1875*. Van Riebeeck Soc., Cape Town.

SABAP2. 2017. Blue Crane. http://sabap2.adu.org.za/species_info.php?spp=216#menu_left (accessed 8 June 2017).

Shelley, G. E. 1882. On a collection of birds made by Mr J. S. Jameson in south-eastern Africa, with notes by Mr T. Ayres. *Ibis* 24: 349–368.

Simmons, R. E. 2015. Blue Crane *Grus paradisea*. Pp. 60–63 *in* Simmons, R. E., Brown, C. J. & Kemper, J. (eds.) *Birds to watch in Namibia: red, rare and endemic species.* Namibia Nature Foundation, Windhoek.

Sinclair, I., Hockey, P., Tarboton, W. & Ryan, P. 2011. *Birds of southern Africa*. Fourth edn. Struik, Cape Town.

Smithers, R. H. N. 1964. *A checklist of the birds of the Bechuanaland Protectorate and the Caprivi Strip*. Trustees of the National Museums of Southern Rhodesia, Cambridge, UK.

Snow, D. W. (ed.) 1978. *An atlas of speciation in African non-passerine birds*. Brit. Mus. (Nat. Hist.), London.

Stark, A. & Sclater, W. L. 1906. *The birds of South Africa*, vol. 4. R. H. Porter, London.

Taylor, M. R., Peacock, F. & Wanless, R. M. (eds.) 2015. *The Eskom Red Data book of birds of South Africa, Lesotho and Swaziland*. BirdLife South Africa, Johannesburg.

Urban, E. K. 1986. Gruidae, cranes. Pp. 131–145 *in* Urban, E. K., Fry, C. H. & Keith, S. (eds.) *The birds of Africa*, vol. 2. Academic Press, London.

Winterbottom, J. M. 1971. *A preliminary checklist of the birds of South West Africa*. S.W.A. Scientific Soc., Windhoek.

*Address*: Dept. of Zoology & Entomology, Rhodes University, Grahamstown, 6140, South Africa, e-mail: A.Craig@ru.ac.za

# 'The chequered history of Chattering Kingfisher *Todiramphus tutus* on Tahiti': a response

*by Michael Lee & David T. Holyoak*

*Received 1 April 2017; revised 1 July 2017; published 15 September 2017*

*http://zoobank.org/urn:lsid:zoobank.org:pub:E2B55130-E626-4934-960C-27A8A809ED1C*

Summary.—Van der Vliet & Jansen's (2015) review of the provenance of museum specimens and field sightings of Chattering Kingfisher *Todiramphus t. tutus*, intended to resolve long-standing confusion with respect to the identification and type locality of the species, led them to conclude that it never occurred on Tahiti. They also concluded that Society Kingfisher *T. veneratus*, previously considered to be sympatric with Chattering Kingfisher throughout the Society Islands, never occurred in the Leeward group of those islands. However, the historic reports and specimens of the naturalist R. P. Lesson of 1827, which were overlooked by van der Vliet & Jansen, and the published field records for *T. tutus* on Tahiti by D. T. Holyoak in 1972, which were dismissed by these authors, suggest their conclusions are misconceived.

Chattering *Todiramphus tutus* and Society (Tahitian) Kingfishers *T. veneratus* have been long understood to be sympatric on Tahiti, in the Society Islands of French Polynesia. While Society Kingfisher is relatively common and widespread on Tahiti and neighbouring Mo'orea, Chattering Kingfisher has been considered rare, its range restricted to upland valleys of Tahiti, with very few verified sightings during at least the last 100 years. Cibois & Thibault (2009) following Monnet *et al*. (1993), reviewed the status of Chattering Kingfisher on Tahiti, examining sight records by local birdwatchers and ornithologists published in *Te Manu*. They were unable to verify these sightings due to the lack of detailed descriptions and concluded the reports were probably of misidentified Society Kingfishers.

Subsequently, Jansen & van der Vliet (2015) investigated the location of the type specimen(s) of Chattering Kingfisher evidently collected during one or more of James Cook's three expeditions to the Pacific in 1769–79. They concluded that the type material was lost. Specimens of South Pacific kingfishers taken during these expeditions were first described by Latham (1782) and then binominally by Gmelin (1788), who gave the type locality for the 'Respected' (now Chattering) Kingfisher *Alcedo tuta* (now *T. tutus*) as Tahiti, for the 'Venerated' (now Society) Kingfisher *A. venerata* (now *T. veneratus*) as (apparently) Ha'apai, Tonga, and for several varieties of 'Sacred' Kingfisher *A. sacra* (now *T. chloris*) as the Society Islands and elsewhere in the western Pacific. Similarities in the original vernacular names and plethora of scientific names (all alluding to sacredness), similar vocalisations, and superficial similarities in plumage coloration have long caused confusion. In addition to the Tahitian names *'otatare* and *ruro* for the Chattering and Society Kingfisher respectively (Gouni & Zysman 2007), a third Tahitian name, *eatooa*, quoted by Jansen & van der Vliet (2015) from Cook's third expedition, appears to be *e atua*, Polynesian for 'a god', reflecting the status of kingfishers in Tahitian cosmology, and not another kingfisher name.

A second paper by van der Vliet & Jansen (2015) reported the results of a comprehensive search of online database records, including information obtained by e-mail, relating to most extant specimens of Chattering Kingfisher, except for its two endemic subspecies in the Cook Islands, which were only named in 1974 (Holyoak 1974a, 1980). Those from

© 2017 The Authors; Journal compilation © 2017 British Ornithologists' Club ISSN-2513-9894 (Online)

the Society Islands comprise 115 specimens held in 17 museums worldwide. Of the 13 specimens with provenance stated as Tahiti, the oldest being three collected by Andrew Garrett in the 1860s, van der Vliet & Jansen (2015) found eight 'questionable' and five others unable to be investigated as the details of the collector were unknown. Like Cibois & Thibault (2009), they noted the possibility of labelling confusion due to 'Tahiti', the administrative capital of French Polynesia, being used as a generalisation for other lesser-known islands in the Society group. Van der Vliet & Jansen also reviewed historic sightings of Chattering Kingfishers on Tahiti in the 20th century. They pointed out that the Whitney South Sea Expedition (1920–23) and the surveys by Monnet *et al*. (1993) did not record the species, and they dismissed the published reports of Wilson (1907) and Holyoak (1974b) who did. It led them, after previously noting that the status of Chattering Kingfisher on Tahiti was unclear (Jansen & van der Vliet 2015), to conclude that 'Chattering Kingfisher never occurred on Tahiti'.

At 1,045 km² in area and up to 2,241 m in altitude, Tahiti is by far the largest and highest of the Society Islands. 'Far more landbirds have been recorded alive' on Tahiti since European contact 250 years ago than anywhere else in eastern Polynesia (Steadman 2006). The Society Islands are a chain of eroded volcanoes and outlying atolls extending nearly 750 km in a north-west–south-east direction in the central South Pacific, which geographers and administrators divide into Windward and Leeward groups. Tahiti and nearby Mo'orea are the principal islands of the Windward group, while a sea gap of *c*.132 km separates Mo'orea from the nearest of the Leeward group, Huahine.

Van der Vliet & Jansen (2015), in proposing that Chattering Kingfisher (*tutus*) never occurred on Tahiti, concluded that it has always been restricted to five of the high Leeward Islands: Huahine, Ra'iātea, Taha'a, Bora Bora and Maupiti, where it is still present. They also dismissed the reliability of specimens recorded from the northern atoll of Tūpai (or Motu Iti), considering them 'questionable' and 'unusual' on the grounds that the present range of the species is restricted to volcanic islands. They concluded that *tutus* never occurred on Tūpai. Thereafter, they went further, proposing that Society Kingfisher (*veneratus*) never occurred on the Leeward group, only on the Windward Islands.

These inferences concerning the respective distributions of Chattering and Society Kingfishers are mutually reinforcing. By dismissing long-accepted assumptions of sympatry, they apparently provide a neat and simple solution to a long-standing ornithological problem. Van der Vliet & Jansen (2015) appear to have also been influenced by theoretical biogeographic considerations. In support of a biogeographic dividing line between the Windward and Leeward groups, they cite the allopatric subspeciation (speciation following del Hoyo & Collar 2014, Thibault & Cibois 2017) of Grey-green Fruit Dove *Ptilinopus purpuratus* and Raiatea Fruit Dove *P. chrysogaster*, and the speciation of two extinct parakeets *Cyanoramphus zealandicus* (endemic to Tahiti) and *C. ulietanus* (endemic to Ra'iātea). They argued: 'These examples demonstrate that the avifauna of the Leeward Islands has its own history, independent of the Windward Islands of Tahiti and Moorea, making the absence of Chattering Kingfisher on Tahiti unsurprising'. They also pointed out that there is no paleontological record of Chattering Kingfisher from Tahiti, an absence that nevertheless has little significance because there is no fossil record of *any* bird known from Tahiti. The only significant site with avian fossils in the Society Islands is at Fa'ahia, on Huahine (Steadman 2006).

Van der Vliet & Jansen (2015) made no reference in either of their papers to the records published by R. P. Lesson. This is an unfortunate omission, given that it was Lesson in a paper published in *Mémoires de la Société d'Histoire naturelle de Paris* (1827: 419–422) who first erected the genus *Todiramphus* for the two kingfishers in question: Chattering Kingfisher

Left: Figure 1. Chattering Kingfisher *Todiramphus tutus* (as *T. sacer*) from Lesson (1827a) (Biodiversity Heritage Library, digitised by NCSU Libraries; www.biodiversitylibrary.org)

Right: Figure 2. Society Kingfisher *T. v. veneratus* (as *T. divinus*) from Lesson (1827a) (Biodiversity Heritage Library, digitised by NCSU Libraries; www.biodiversitylibrary.org)

(as *Todiramphus sacer*, now *T. tutus*; Fig. 1) and Society Kingfisher (as *T. divinus*, now *T. veneratus*; Fig. 2). This was based on his own field observations and specimens taken during his visit to the Society Islands, where he explicitly recorded both species as being present on Tahiti and Bora Bora. Lesson, a naval surgeon and zoologist, was a leading scientist in the 1822–25 scientific circumnavigation by the French naval corvette *La Coquille* under the command of L. I. Duperrey. The expedition's scientific achievements were considerable, especially in ornithology (Cuvier 1825, Dickinson *et al.* 2015, Lee 2016). *La Coquille* called at the Society Islands in 1823, staying at Tahiti from 3 to 22 May and at Bora Bora from 25 May to 9 June. At both islands Lesson and his colleagues undertook extensive surveys and collected specimens (Cuvier 1825, Duperrey 1826, 1828). The timing of the visit was historically significant, entailing the first ornithological survey of the Society Islands since those by Cook's naturalists Johann & Georg Forster and Anders Sparrman in 1774. Its timing was critical because it took place just a few years before the invasion of Black Rat *Rattus rattus*, an arboreal predator which has had a devastating impact on the avifauna of eastern Polynesia and most islands of remote Oceania, including New Zealand, where birds evolved in the absence of predatory mammals (Atkinson 1985). Today, just 12 of the 19 landbirds first recorded by European explorers on the Society Islands are extant, several of them being highly endangered (Steadman 2006). The accounts of Lesson and his colleagues P. Garnot and J. S. C. Dumont d'Urville therefore provide a valuable snapshot of the state of the environment on Tahiti and Bora Bora at this period.

The zoological results of the *La Coquille* voyage authored by Lesson and Garnot were published in two volumes, each in two parts, with four biological atlases of coloured engravings, including one for mammals and birds (Duperrey 1826a,b, 1828, 1830, Cretella

Figure 3. Adult Chattering Kingfisher *Todiramphus tutus* (syntype; sex undetermined, collected by R. P. Lesson between 26 May 1823 and 9 June 1823, on Bora Bora) (Muséum national d'Histoire naturelle, Paris: Birds (ZO) MNHN-ZO-2006-545).

Figure 4. Juvenile (?) Society Kingfisher *T. v. veneratus* (syntype; sex undetermined, collected by R. P. Lesson between 26 May 1823 and 9 June 1823, on Bora Bora) (Muséum national d'Histoire naturelle, Paris: Birds (ZO) MNHN-ZO-2006-561)

2010). As noted, Lesson reported the descriptions and distribution of both Chattering and Society Kingfishers in his paper in *Mémoires de la Société d'Histoire naturelle* (1827a), again in *Bulletin des Sciences naturelles et de géologie* (1827b), in Duperrey *Zoologie* (1828), in his *Manuel d'ornithologie* (1828), in *Traité d'ornithologie* (1831) and in his popular work *Voyage autour du monde* (1838). Thus, contrary to van der Vliet & Jansen's (2015) findings, Lesson repeatedly reported both Chattering and Society Kingfishers on Tahiti *and* Bora Bora. Of Chattering Kingfisher, Lesson wrote, in translation: 'This bird is very common on the islands of Tahiti and Bora Bora' (Lesson 1827a: 422, 1827b: 270, 1828: 101, Duperrey 1828: 687). In regard to Society Kingfisher, Lesson commented that he would have considered it to be the female of the preceding species but for distinctive differences in the shape of the bill, adding, 'We procured for ourselves only two individuals killed at the island of Bora Bora' (Lesson 1827a: 422, 1827b: 271, 1828: 102, Duperrey 1828: 688). Again in his *Traité* in respect of both species he noted: 'Habite O-Taiti et Borabora' = lives on Tahiti and Bora Bora (Lesson 1831: 249–250).

Lesson evidently based his morphological descriptions of both kingfisher species on specimens he collected at Bora Bora (Voisin & Voisin 2008). In the present collections of the

Muséum national d'Histoire naturelle, Paris (MNHN), there are three kingfisher specimens from the Society Islands taken by the *La Coquille* expedition. Two are of *Todiramphus tutus* (named *T. sacer* by Lesson; Fig. 3) and one is of *T. veneratus* (*T. divinus sensu* Lesson; Fig. 4). The three specimens are considered syntypes of their respective species. Type locality in each case is Bora Bora. Weighing against the possibility that the *T. veneratus* specimen came from Tahiti is that subtle differences in feather coloration and pattern to that of the Tahiti *veneratus* suggests it represents a possible extinct Bora Bora subspecies (Voisin & Voisin 2008).

The localities for Lesson's accounts and specimens are supported by those of Wilson (1907). However, Wilson's presumed 'error' in reporting Society Kingfishers on Bora Bora led van der Vliet & Jansen (2015) to decide that 'it is clear that he was confused', and to cite this 'confusion' as a reason to discredit the reliability of his reports of Chattering Kingfisher on Tahiti. This is another mutually reinforcing argument. Van der Vliet & Jansen's conviction that Society Kingfishers never occurred on Bora Bora, nor on the other Leeward islands, induced them to calculate an 'error rate' in labelling of Society Islands kingfisher museum specimens of 5.7%. This 'error' percentage they applied to labelled Chattering Kingfishers, suggesting that 'at least six specimens could be mislabelled'. But this argument can be inverted to arrive at the opposite conclusion. If Wilson was right concerning his identification of Society Kingfishers on Bora Bora, then he is likely to have also been right about Chattering Kingfishers on Tahiti.

DTH undertook ornithological surveys on Tahiti in August 1972, at which time he reported observing 11 individuals of Chattering Kingfisher in Mataiea district, 'tous vers 1000 m' = all at around 1,000 m altitude (Holyoak 1974b, Holyoak & Thibault 1984). We note that Cibois & Thibault (2009) also recorded that most of the recent unverified sightings, years 2002–08, are from the same area, the south-western quarter of Tahiti Nui. While three were from further north-west at Papehue, given the roughly circular shape of Tahiti Nui, all of these sites, being at similar altitude and approximately similar distances inland, are relatively close together. While R. P. Lesson, A. Garrett and S. B. Wilson can no longer answer for themselves, DTH's response to van der Vliet & Jansen's interpretations is that he has no doubts concerning the sightings he reported of *T. tutus* on Tahiti in 1972 (Holyoak 1974b, Holyoak & Thibault 1984). They were seen repeatedly, and very soon after he had handled many specimens of the species in the American Museum of Natural History, New York (AMNH), and on days when *T. veneratus* was also seen. Furthermore, his field work on 12–20 July 1972 involved observing *T. tutus* on Bora Bora, then on Ra'iātea (see Holyoak 1974a: 167–169). Consequently, he was fully familiar with the species when he met it a few weeks later in the Mataiea district of Tahiti. As recorded in Holyoak & Thibault (1984: 143), *tutus* (11 individuals) and *veneratus* (16 individuals) were then found in sympatry in the "Vallée de Mataiea", making repeated comparison possible. *T. tutus* was recognised by its white collar around the nape (lacking in *T. veneratus*), combined with brighter blue back and wing-coverts.

The two specimens of *T. tutus* collected on Tahiti by Wilson in 1904 are at AMNH (Wilson 1907) and we can find no reason to doubt the locality data. Holyoak (1974b: 169) further pointed out that Wilson's two skins from Tahiti differed from Leeward group birds in having a broader black neck-band. This sample was considered insufficient for separating subspecies, but the small size of the Tahiti population in 1972 precluded collecting specimens to check. Holyoak (1974b: 170–171) also noted that some *T. v. veneratus* from Tahiti at AMNH (Whitney Collection) display a small amount of white on the neck, suggestive of hybridisation with *T. t. tutus*. This observation and the suggested explanation, implying at least some co-existence of the two species, was not repeated in Holyoak &

Thibault (1984) and it was overlooked by van der Vliet & Jansen (2015). Thus, as noted by Holyoak & Thibault (1984: 138), the type locality of Tahiti given for *T. tutus* by Gmelin (1788) might be correct after all; and for the populations of the Leeward group the name *T. t. wiglesworthi* (Sharpe) is available if they can be shown to differ.

Militating against van der Vliet & Jansen's proposed biogeographical demarcation between the Leeward and Windward Islands, and their supposedly 'independent' avifaunas, is that some taxa are or were common to both groups: the formerly sympatric species of imperial pigeons *Ducula aurorae* and *D. galeata*, Tahiti Reed Warbler *Acrocephalus caffer* and Blue Lorikeet *Vini peruviana*, among others (Steadman 2006). Blue Lorikeet progressively disappeared from the high islands of the Society group from the late 19th century following the arrival of Black Rats. However, in 1823, Lesson observed Blue Lorikeet ('as common as sparrows in France') living in close association with kingfishers under the fronds of coconut palms on both Tahiti and Bora Bora (Duperrey 1826b: 295, 298, Lesson 1838: 351). Unfortunately, the Society Islands avifauna has been so reduced since first human settlement in *c*.1070 (Wilmshurst *et al*. 2011), that it is difficult to discern neat patterns and historical connections from the wreckage. Steadman (2006) concluded that this problem resulted from 'illogical discontinuities that are more likely due to anthropogenic extinctions', adding 'these avifaunas are so depleted from their condition at human contact as to challenge biologically cogent analysis'. Despite these knowledge gaps, there is evidence that the Society Islands avifauna included both sympatric and allopatric elements. Sympatric pairings of kingfishers in Oceania, while rare, do occur (as van der Vliet & Jansen concede), for example on three islands of Vanuatu in the south-west Pacific and on Palau in Micronesia (Steadman 2006). That kingfishers are sedentary territorial predators, as pointed out by Cibois & Thibault (2009), does not appear to preclude sympatry.

That being said, and notwithstanding that the impact on island avifaunas of alien predators such as Black Rat is well understood, the asymmetric response of two species of kingfishers to post-European contact environmental changes in the Windward islands on the one hand, where Chattering Kingfisher has been extirpated (or is extremely rare), and in the Leeward group on the other, where Society Kingfisher has been extirpated, merits further investigation. Van der Vliet & Jansen's (2015) inductive presumptions, however, raise more questions than they answer. The comment by Sharpe (1868: 97) about Chattering Kingfisher, approvingly quoted by them—'The confusion which has existed respecting the present species is probably unparalleled in the annals of Ornithological Science'—appears even more apposite today. Ironically, it was this confusion, or 'embarrassment' as Lesson put it, pertaining to Latham and Gmelin's kingfisher species, which he believed he had finally resolved by erecting *Todiramphus* with its two sympatric Society Island species. Lesson's accounts and his specimens cannot be dismissed easily, nor can the published observations of DTH: they are certainly problematic for any revisionist theory challenging historic records of the ranges of both Chattering Kingfisher and Society Kingfisher in the Society Islands.

## Acknowledgements

We thank Dr Patrick Boussès and Jean-Claude Thibault (Muséum national d'Histoire naturelle, Paris), Alice Cibois (Muséum d'histoire naturelle, Genève) and Dr Brian Gill (Auckland War Memorial Museum) for helpful advice and comments.

References:

Atkinson, I. A. E. 1985. The spread of commensal species of *Rattus* to oceanic islands and their effects on island avifaunas. Pp. 35–81 *in* Moors, P. J. (ed.) *Conservation of island birds*. International Council for Bird Preservation, Cambridge, UK.

Cibois, A. & Thibault, J.-C. 2009. Combien d'espèces de martins-chasseurs existe-t-il à Tahiti? *Te Manu* 65: 16–18.

Cretella, M. 2010. The complete collation and dating of the section *Zoologie* of the *Coquille* voyage. *Boll. Malacologico* 46: 83–103.

Cuvier, G. 1825. Rapport sur la partie zoologique de l'Expédition Duperrey. *Ann. Sci. Natur*. 6: 5–20.

Dickinson, E. C., Bruce, M. D. & David, N. 2015. A review of the authorship and dates of publication of birds newly described from the "*Voyage de la Coquille*" (1822-1825) with comments on some spellings. *Zool. Bibliography* 3: 69–162.

Duperrey, L. I. [Lesson, R. P.] 1826a. *Voyage autour du monde exécuté par ordre du roi, sur la corvette de sa majesté, La Coquille, pendant les années 1822, 1823, 1824 et 1825 etc., atlas – histoire naturelle, zoologie*. A. Bertrand, Paris.

Duperrey, L. I. [Lesson, R. P. & Garnot, P.] 1826b. *Voyage autour du monde exécuté par ordre du roi, sur la corvette de sa majesté, La Coquille, pendant les années 1822, 1823, 1824 et 1825 etc., zoologie*, vol. 1(1). A. Bertrand, Paris.

Duperrey, L. I. [Lesson, R. P. & Garnot, P.] 1828. *Voyage autour du monde exécuté par ordre du roi, sur la corvette de sa majesté, La Coquille, pendant les années 1822, 1823, 1824 et 1825 etc., zoologie*, vol. 1(2). A. Bertrand, Paris.

Duperrey, L. I. 1830. *Voyage autour du monde exécuté par ordre du roi, sur la corvette de sa majesté, La Coquille, pendant les anneés 1822, 1823, 1824 et 1825 etc., zoologie*, vol. 2(1–2). A. Bertrand, Paris.

Gmelin, J. F. 1788. *Systema naturae*, vol. 1. G. E. Beer, Leipzig.

Gouni, A. & Zysman, T. 2007. *Oiseaux du Fenua. Tahiti et ses îles*. Tethys Editions, Tahiti.

Holyoak, D. T. 1974a. Undescribed land birds from the Cook Islands, Pacific Ocean. *Bull. Brit. Orn. Cl*. 94: 145–150.

Holyoak, D. T. 1974b. Les oiseaux des îles de la Société. *L'Oiseau et RFO* 44: 1–27, 153–184.

Holyoak, D. T. 1980. *Guide to Cook Islands birds*. Cook Islands Library and Museum Society Inc., Rarotonga.

Holyoak, D. T. & Thibault, J.-C. 1984. Contribution à l'étude des oiseaux de Polynésie orientale. *Mem. Mus. Natl. Hist. Nat. Paris* 127: 1–209.

del Hoyo, J. & Collar, N. J. 2014. *HBW and BirdLife International illustrated checklist of the birds of the world*, vol. 1. Lynx Edicions, Barcelona.

Jansen, J. J. F. J. & van der Vliet, R. E. 2015. The chequered history of the Chattering Kingfisher *Todiramphus tutus* in Tahiti. I: type specimens. *Bull. Brit. Orn. Cl.* 135: 108–120.

Latham, J. 1782. *A general synopsis of birds*, vol. 1(2). B. White, London.

Lee, M. 2016. A previously un-noticed record of the grey warbler (*Gerygone igata*) by R.-P. Lesson in the Bay of Islands, April 1824. *Notornis* 63: 173–175.

Lesson, R. P. 1827a. Description du genre Todiramphe et de deux espèces d'oiseaux qui le composent. *Mém. Soc. Hist. Nat. Paris* (2)3: 419–421, pl. 11–12.

Lesson, R. P. 1827b. Description d'un nouveau genre d'oiseau. Todiramphe. *Todiramphus. Bull. Sci. Natur. G*éol. [*Bull. Férussac*] 12: 268–271.

Lesson, R. P. 1828. *Manuel d'ornithologie*, vol. 2. Roret Libraire, Paris.

Lesson, R. P. 1831. *Traité d'ornithologie.* F. G. Levrault, Bruxelles.

Lesson, R. P. 1838. *Voyage autour du monde sur la corvette La Coquille*, vol. 1. Alburgh.

Monnet, C., Thibault, J.-C. & Varney, A. 1993. Stability and changes during the twentieth century in the breeding landbirds of Tahiti (Polynesia). *Bird Conserv. Intern*. 3: 261–280.

Sharpe, R. B. 1868. *A monograph of the Alcenididae*. Privately published, London.

Steadman, D. W. 2006. *Extinction & biogeography of tropical Pacific birds*. Univ. of Chicago Press.

Thibault, J.-C. & Cibois, A. 2017. *Birds of eastern Polynesia. A biogeographic atlas*. Lynx Edicions, Barcelona.

van der Vliet, R. E. & Jansen, J. J. F. J. 2015. The chequered history of Chattering Kingfisher *Todiramphus tutus* on Tahiti. II: review of status. *Bull. Brit. Orn. Cl*. 135: 121–130.

Voisin, C. & Voisin, J.-F. 2008. List of type specimens of birds in the collections of the Muséum national d'Histoire naturelle (Paris, France) 18. Coraciiformes. *J. Natl. Mus. (Prague), Nat. Hist. Ser*. 177: 1–25.

Wilson, S. B. 1907. XVIII – Notes on birds of Tahiti and the Society group. *Ibis* 49: 373–379.

Wilmshurst, J. M., Hunt, T., Lipo, C. & Anderson, A. 2011. High precision radiocarbon dating shows recent and rapid initial human colonization of east Polynesia. *Proc. Natl. Acad. Sci. USA* 108: 1815–1820.

*Addresses*: Michael Lee, 4/300 Parnell Road, Parnell, Auckland, 1052. New Zealand, e-mail: mikeleeauckland@gmail.com. David T. Holyoak, Quinta da Cachopa, Rua da Barcoila 274, Barcoila, 6100-014 Cabeçudo, Portugal; e-mail: holyoak9187@gmail.com

# Reply to Lee & Holyoak: how definite are 20th-century reports of Chattering Kingfisher *Todiramphus tutus* from Tahiti?

*by Roland E. van der Vliet & Justin J. F. J. Jansen*

*Received 9 June 2017; revised 11 July 2017; published 15 September 2017*

*http://zoobank.org/urn:lsid:zoobank.org:pub:5C4A7202-8677-499B-B4D3-3F6132F2BE96*

Summary.—Lee & Holyoak (2017) focused on Lesson as a source that we had neglected in our discussion of Chattering Kingfisher *Todiramphus tutus* on Tahiti. They are apparently confident in the accuracy of specimen labels from Lesson's era despite that the labelling of even Lesson's own specimens is poor. Based on meticulous notes taken during the Whitney South Sea Expedition by Beck and Quayle in the early 1920s, as well as their specimen material, we demonstrate that they never collected *T. tutus* on Tahiti, where they collected only Society (Tahitian) Kingfisher *T. veneratus*. Lee & Holyoak's suggestion that both species occurred in the Society Islands but became extinct in either the western Leeward Islands (*veneratus*) or eastern Windward Islands (*tutus*) seems to be a case of selective extinction following an established biogeographical divide. We believe that the observed pattern is best explained by the fact that *veneratus* was never present on the Leeward Islands and *tutus* never occurred on Tahiti: this represents the most parsimonious interpretation of the available data.

Lee & Holyoak's (2017) commentary on our papers concerning the occurrence of Chattering Kingfisher *Todiramphus tutus* raises many interesting points. Let us first summarise our original findings. For 115 specimens of Chattering Kingfisher *T. t. tutus* (hereafter *tutus*) in museums worldwide, we compiled data on collection locality, collector and date. For at least eight specimens reportedly taken on Tahiti (of 13 specimens labelled such), we identified problems of provenance. For the remaining five, no collector was mentioned, preventing our researching their precise locality. Problems also arose with the provenance of the only two specimens reported from the atoll of Tupai. We concluded that *tutus* never occurred on Tahiti or Tupai (Jansen & van der Vliet 2015, van der Vliet & Jansen 2015). Another important conclusion was that the oldest two specimens of *tutus* were probably collected by George Bass, who visited French Polynesia, including Tahiti, in 1802 (Jansen 2014). It is unfortunate that Lee & Holyoak (2017) neglect this point because he appears to have been an important source of bird specimens from this region in the period between Cook and Lesson. This brings us to Lee & Holyoak's (2017) arguments. Some of these appear to represent long-standing misconceptions (for example, concerning the use of label data on old specimens), while others relate to the situation in French Polynesia (e.g. biogeography of the Society Islands).

## Poor labelling: Lesson's specimens as an example

Lee & Holyoak (2017) are apparently confident in the accuracy of specimen labels in the early era of collecting. This is strange because, for specimens of *tutus*, even Holyoak himself (*in* Thibault & Holyoak 1984: 138) alluded to the possibility that 'beaucoup de vieux specimens libelles <<Otahiti>> ont pu être collectes ailleurs dans les Iles de la Société' (many old specimens labelled << Otahiti >> could have been collected elsewhere in the Society Islands), without providing details. In that sense, our papers can be considered a follow-up to his statement. In them, we referred to, for example Rasmussen & Prŷs-Jones (2003), who demonstrated that poor labelling was almost common practice in the early collecting era. Many cases of simply inaccurate labelling, rather than fraudulent activity, are known, even in the modern era (e.g. Peterson *et al*. 2004, Boessenkool *et al*. 2009).

As Lee & Holyoak (2017) discuss Lesson, his specimens in Muséum national d'Histoire naturelle, Paris (MNHN) well illustrate this point. The voyage of *La Coquille* took Lesson around the world between 8 November 1822 and 24 March 1825, visiting amongst others the Falklands, Chile, Peru, Tuamotu, Tahiti, Bora Bora, several islands in New Guinea and Indonesia, Australia (Sydney), New Zealand, Mauritius, Réunion, St. Helena and Ascension (Cretella 2010). From our research at MNHN, we have concluded that Lesson twice donated specimens from the *La Coquille* expedition to the museum: in April 1825 (168 specimens of 139 species) and on 24 August 1825 (416 specimens of 252 species) (Ms in MNHN Lab, Catalogue 1823 à 1829), i.e. 584 specimens arrived at MNHN, of which many were used for exchange. None of Lesson's specimens has an original label. The only information available, for some, is on the base of their pedestals, but this was added later by someone else, in some instances years after the specimen was collected. It is easy to imagine that mistakes were made during the process. It is also difficult to interpret specimen dates from acquisition books as these were commenced only in *c*.1854 (Jansen 2014), i.e. Lesson's specimens had already been present in excess of 25 years.

Of the kingfishers among these 584 specimens, in the MNHN archives we have located three documents relating to the first batches (varying in content and with different numbering) and an incomplete manuscript, drafted by Lesson in 1824. The latter excludes the Pacific section of the voyage (Bibliothèque centrale, MNHN, Ms 354). Table 1 shows that Lesson sent 26 kingfisher specimens to MNHN of which 14 were mounted for the galleries (leaving 12 for exchange). Nine of these (cat. nos. 73–78) arrived with the first donation, and the rest (cat. nos. 135–142) with the second. From Table 1, it is clear that four kingfishers

TABLE 1
Details of kingfisher specimens in the Catalogue 1823 à 1829, collected by Lesson and which arrived at the Muséum national d'Histoire naturelle (Paris) in either April 1825 (pp. 100–101) or 24 August 1825 (p. 132). Presented are page number, catalogue number, name, original collection location as drafted, the number of individuals and any additional information.

| **Catalogue 1823 à 1829** | | | | | |
|---|---|---|---|---|---|
| **Page** | **Cat. no.** | **Name** | **Locality** | **Ind.** | **Additional information** |
| 100–101 | 73 | Martin Pêcheur | Waigeo | 1 | Guadicaud |
| 100–101 | 74 | Martin Pêcheur | Nelle Irelande | 1 | (mounted for the galleries) |
| 100–101 | 75 | Martin Pêcheur | de Cap | 1 | |
| 100–101 | 76 | Martin Pêcheur | Otahite et Bourbon | 4 | à tête verte |
| 100–101 | 77 | Martin Pêcheur | de Bourbon | 1 | |
| 100–101 | 78 | Martin Pêcheur | de BoraBora | 1 | (mounted for the galleries) |
| 132 | 135 | Martin-chasseur | N. G. | 3 | Guadicaud (mounted for the galleries) |
| 132 | 136 | Martin-chasseur | Waigeo | 1 | |
| 132 | 137 | Martin-chasseur | N. G. | 1 | (mounted for the galleries) |
| 132 | 138 | Martin-chasseur | Malouines | 3 | à tête verte (one mounted for the galleries) |
| 132 | 139 | Martin-chasseur | N. Ze | 4 | (mounted for the galleries) |
| 132 | 140 | Martin-chasseur | Taiti | 2 | (mounted for the galleries) |
| 132 | 141 | Martin Pêcheur | Bourou | 2 | tamatioïde |
| 132 | 142 | Martin Pêcheur | N. Guinea | 1 | (mounted for the galleries) |
| Total | | | | 26 | |

TABLE 2

The number of kingfisher specimens collected during the *La Coquille* voyage (1822–25), with the current scientific name, acquisition book number or recent renumbered registration number, collection location based on the acquisition book and the type catalogue in which the specimens were published in.

| Species | Acq. book no. | Location | Type catalogue |
|---|---|---|---|
| *Melidora macrorrhina* | MNHN-ZO-2006-563 | Nlle Guinee | Voisin & Voisin (2008: 3) |
| *Syma torotoro* | MNHN-ZO-2006-562 | Nlle Guinee | Voisin & Voisin (2008: 5) |
| *Todiramphus albicilla albicilla* | MNHN A.C. 3467 | Nelle Irelande | |
| *Todiramphus veneratus veneratus* | MNHN-ZO-2006-561 | BoraBora | Voisin & Voisin (2008: 7–8) |
| *Todiramphus tutus* | MNHN-ZO-2006-545 | BoraBora | Voisin & Voisin (2008: 5) |
| *Todiramphus tutus* | MNHN-ZO-2006-544 | BoraBora | Voisin & Voisin (2008: 5) |
| *Todiramphus sanctus vagans* | MNHN-ZO-2006-564 | Nelle Zelande | Voisin & Voisin (2008: 8) |
| *Alcedo meninting* | MNHN A.C. 3506a | Nlle Guinee | |

from Tahiti and Bourbon (Réunion) were registered under one entry, probably meaning that they concerned similar-coloured species like Collared *T. chloris* or Sacred Kingfishers *T. sanctus*. In Table 1 note also the mention of both the Malouines (Falkland Islands) and Bourbon (Réunion) where no kingfishers occur, although both localities were visited by Lesson on *La Coquille*, illustrating just one way in which errors of location can find their way into history.

At present (June 2017) only eight of these kingfishers are present at MNHN (Table 2). Note that both *Todiramphus albicilla* and *Alcedo meninting* do not occur in New Ireland and New Guinea, respectively, contrary to what is mentioned in the acquisition books.

Lee & Holyoak (2017) appear surprised that we did not refer to Lesson (1827), wherein he described the genus *Todiramphus*. We did, of course, read this paper but, as our concern was not taxonomic, there was no reason to cite it. Furthermore, the descriptions Lesson gave of both species are not type descriptions as is abundantly clear from our papers. However, we might note that Lesson's paper appeared in 1827, four years after his visit to the Society Islands and two years after his return to Europe. Given all of the problems with Lesson's labelling, we are less certain than Lee & Holyoak (2017) that Lesson had his collection localities right for each specimen. For the same reason, we do not believe that much can be inferred from Lesson's texts quoted by Lee & Holyoak.

## Arrival of rats (*Rattus* spp.) in the Pacific

Lee & Holyoak (2017) afford extra significance to Lesson's specimens from French Polynesia because, according to them, they were collected in an environment free of Black Rats *Rattus rattus*. They state that Lesson's 'timing was critical because it took place just a few years (*c.*10) before the invasion of Black Rat'. Lee & Holyoak (2017) rightly state that the arrival of this invasive species had 'a devastating impact on the avifauna of eastern Polynesia'. Whether Brown Rat *R. norvegicus* or Black Rat arrived first is potentially important because predation of landbirds by Brown Rats is much less severe than by Black Rats.

Quoting Sparrman, who accompanied Cook on his second circumnavigation, Atkinson & Atkinson (2000) reported that rats were already a great pest on Tahiti in 1773. These probably concerned Polynesian Rats *R. exulans* introduced by local Polynesians. Furthermore, Atkinson (1973) noted (quoting Cook 1785: 81 discussing his third voyage) that Cook let rats ashore on (at least) Raiatea and Moorea. Because Polynesian Rats did not occur in Cook's port(s) of departure and other ports of call, these must have been Brown or

Black Rats. Black Rat had been established in Britain for centuries, while Brown Rat was a relative newcomer, with the first reliable reports in England in 1730 (Hedrich 2006). Being the more aggressive species, Brown Rats outcompeted Black Rats relatively quickly almost everywhere in Europe including Britain. However, how strong the resulting decline of Black Rat had been when Cook set sail in 1776 is unclear.

Based on interspecific competition and the start of intercontinental travel by ship, Atkinson (1985) concluded that Brown Rat would have been first to arrive on the Pacific islands. However, Atkinson & Atkinson (2000) noted that Brown Rats did not appear to reach the Pacific islands until the 19th century. It can be deduced that those rats that Cook introduced in the Society Islands, prior to Lesson's visit, may have been Black Rats, which therefore could have arrived much earlier in French Polynesia than Lee & Holyoak (2017) acknowledge. This means that assumptions by Lee & Holyoak (2017) regarding Lesson visiting islands not impacted by predatory rats, is not necessarily true. This furthermore indicates that their conclusions based on this assumption are not necessarily valid. In reality, however, it is impossible to be certain which species (Brown or Black Rat) was introduced first in the Society Islands.

## Variation in Tahitian Kingfisher *Todiramphus veneratus*

Lee & Holyoak (2017) provide a very brief description of the kingfisher that Holyoak claims to be *tutus*. It does not add much to those details provided by Holyoak (1974) and Holyoak & Thibault (1984). No photographs, videos or specimens are apparently available. The level of detail provided by Holyoak is in our view insufficient to claim these birds as *tutus*. That Holyoak does not doubt his own sightings is not necessarily sufficient for them to be accepted. He describes in Lee & Holyoak (2017) that '*tutus* was recognised [by him] by its white collar around the nape (lacking in *T. veneratus*), combined with brighter blue back and wing-coverts.' In response to several recent claims of *tutus* in 2002–08, Cibois & Thibault (2009) already noted plumage similarities between *tutus* and *veneratus*. They emphasised, for example, that *veneratus* can show bluer upperparts than previously known. A study into kingfisher taxonomy led us to study 82 specimens of *veneratus*. Full details will be published elsewhere, but focusing on the important feature of the neck-band, most specimens of *veneratus* lack a neck-band or even an indication of one. However, a few show some white spots, a clear small white neck-band or, very rarely, a distinctly coloured neck-band (orange / green / white). That *veneratus* can show a white neck-band means that it can resemble *tutus* in this respect, as alluded to by Lee & Holyoak (2017). However, unlike Lee & Holyoak (2017), we believe this reflects variation within *veneratus* rather than hybridisation between *veneratus* and *tutus* as suggested by Lee & Holyoak (2017).

## Biogeography of the Leeward and Windward Islands

Lee & Holyoak (2017) appear to dispute the different biogeographical histories of the western Leeward Islands and eastern Windward Islands. While it is difficult to draw firm conclusions from an impoverished biological class like birds, Hembry & Balukjian (2016) analysed a wide range of taxa. Their conclusion, that 'the most common phylogeographical division seen in Societies taxa is between the Windward and Leeward Society Islands', supports our assumptions based on a small number of bird species. They specifically mentioned Grey-green Fruit Dove *Ptilinopus purpuratus* as a probable example of this biogeographical pattern, while they considered *Acrocephalus* reed warblers to be also consistent with it. Both of these examples were also given by us (van der Vliet & Jansen 2015). We concur with Lee & Holyoak (2017) that not all landbird species on the Society

Islands display this biogeographical pattern, as is evident from the genus *Ducula*. However, the example of Blue Lorikeet *Vini peruviana* to demonstrate their point is less fortunate because this species can cover relatively large distances over water (up to five km regularly recorded, but it is perhaps capable of larger distances; Ziembicki & Raust 2006).

## The Whitney South Sea Expedition in the Society Islands

One important point of reference is the visit by the Whitney South Sea Expedition (WSSE) to the south Pacific (including the Society Islands) in the early 1920s, collecting birds for the American Museum of Natural History (AMNH), New York, in the process discovering many taxa described as new to science. The expedition was not without its controversy though, and the number of specimens taken by WSSE sparked outrage even at the time, with New Zealand denying the expedition collecting permits in the Cook Islands (Collar 2000). Rigorous collecting by WSSE in areas they visited, combined with their equally detailed record-taking (see below), means that we attach high value to their results.

At AMNH, the kingfishers that WSSE collected on the Society Islands numbered 71 *veneratus* from Tahiti (6 October 1920–13 January 1923), 30 *youngi* on Moorea (13 June 1921–5 November 1921) and 14 *tutus* on Raiatea (10 December 1921–10 January 1922) and Bora Bora (12–13 January 1922). Due to their efficient labelling, we can deduce that all of their *veneratus* were assigned to Tahiti, all *youngi* to Moorea and all *tutus* to Raiatea or Bora Bora. The principal collectors were Rollo Beck and Ernest Quayle. The diaries of both men are available.

From Beck's diaries, it is evident that both he and Quayle visited highland areas on Tahiti up to 1,220 m, i.e. the elevation where Holyoak sighted his kingfishers. This is reinforced by Quayle's diaries as detailed by Monnet *et al*. (1993). Lee & Holyoak (2017), emphasising the broadly circular shape of Tahiti Nui, note that the sites of Holyoak's observations and those of unverified sightings in 2002–08, would have been 'at similar altitude and approximately similar distances inland'. Due to the size of the island, Lee & Holyoak (2017) conclude that the locations would have been close together. Because Beck and Quayle visited sites at similar elevations, these were probably also close to those of Holyoak's sightings. If *tutus* was really that readily encountered at that elevation in that region of Tahiti (as seems to have been the case based on the numbers observed by Holyoak), it is very surprising that WSSE did not collect it there. Despite staying *c*.9 months on Tahiti spread over several visits between September 1920 and April 1923, WSSE did not collect a single specimen of *tutus* on Tahiti.

Quayle's diaries reveal that he 'was primarily engaged in collecting, but he evidently noted all of the land and freshwater bird species he encountered' (Monnet *et al*. 1993). Again, according to Monnet *et al*. (1993), Quayle '... explored the island more intensively than the other members of the expedition, and in his journal, he noted ecological observations as few naturalists did at this time. […] He mentioned 19 localities where he collected (or observed) birds.' Monnet *et al*. (1993) identified 15 of Quayle's collecting sites, with four being impossible to determine, and investigated 14 of the known localities between 1986 and 1991, but not the 15th, Vaiote. Because this site is in the smaller, eastern part of Tahiti (Tahiti Iti), where Holyoak did not observe kingfishers, it is of no concern here. Like WSSE, Monnet *et al*. (1993) failed to observe *tutus* on Tahiti.

Overall, we still find it difficult to credit that WSSE would not have collected *tutus* on Tahiti, had it occurred there, given their intensive collecting and visits to appropriate elevations, especially as WSSE worked on Tahiti 50 years earlier than Holyoak. The field work and collecting practice of WSSE reinforces a point discussed earlier: if collectors record data precisely during field work, few (if any) errors occur during subsequent labelling with respect to, for example, date and locality. Because data for specimens collected during WSSE can be checked against the diaries of Beck and Quayle, in our opinion they can be deemed trustworthy.

## A case of selective extinction?

Lee & Holyoak (2017) mention three implicit or explicit hypotheses in our papers. Foremost, we propose that (1) *tutus* never occurred on Tahiti or (2) on Tupai. Lee & Holyoak (2017) furthermore state that (3) *veneratus* never occurred on the Leeward Islands should be considered a further conclusion. In contrast, they advance a scenario where *veneratus* and *tutus* occurred in sympatry on both the Windward and Leeward Islands (except perhaps for *tutus* occurring on Moorea). They rightly state that this occurs elsewhere in Oceania, despite that kingfishers are territorial predators. While we obviously agree that this trait does not exclude sympatry, it also means that kingfishers are often clearly detectable by all observers.

Knowledge of both species in the Society Islands in the 1800s was scant to say the least. Most if not all contemporary literature considered that *veneratus* occurred on the Society Islands, and *tutus* (or taxa with which *tutus* was synonymised) also on Tahiti (e.g. Gray 1859, Finsch & Hartlaub 1867, Sharpe 1868, 1892, 1906, Wiglesworth 1891). These sources often referred to the less precisely delineated 'Society Islands' among which, for biogeographical reasons outlined above, it is important to distinguish the Leeward and Windward groups. Confusion in that era was exaggerated because several influential works disagreed as to the specific status of *tutus*, sometimes considering *veneratus* and *tutus* as conspecific; hence our quotation of Sharpe (1868), repeated by Lee & Holyoak (2017). This was still true in 1904 when S. B. Wilson visited the Society Islands (Wilson 1907). Wilson (1907) described both *veneratus* and *tutus* as (fairly) common in the Society Islands, noting that *veneratus* was 'fairly common, especially on the island of Bora-Bora'. As noted above, even WSSE was unable to collect any *veneratus* on Bora Bora or the other Leeward Islands, only 20 years later.

Considering the present-day distribution of both taxa, the scenario outlined by Lee & Holyoak (2017) represents a case of selective extinction, wherein *veneratus* must have died out quite rapidly between Wilson's visit in 1904 and that by WSSE in 1921–22 to Raiatea and Bora Bora. Furthermore, according to their scenario, *tutus* must have become extinct on Tahiti alone (given the lack of credible reports since Holyoak's in 1972) whereas it still thrives in the Leeward group. Yet, this selective extinction occurred in the presence of the same predators (rats) on both groups and coincidentally followed an established biogeographical divide between the archipelagos. We consider this to be an unrealistic scenario not supported by facts, and we do not agree with Lee & Holyoak (2017) to consider the current distribution of *veneratus* as a working hypothesis. We believe that the available facts support only one plausible hypothesis, namely that (1) *veneratus* never occurred on the Leeward Islands, while (2) *tutus* was never present on Tahiti. Reaching this conclusion we cannot help wondering how Lee & Holyoak believe that *tutus* became extinct on Tahiti so soon after Holyoak's sightings, but also how *veneratus* on Bora Bora slipped to extinction so swiftly after Wilson's sightings, despite being considered common?

Our conclusions are supported by the WSSE results. As stated, we believe their data are trustworthy and therefore that accurate distributions can be inferred from their specimens. In this case, based on their data concerning kingfishers collected in the Society Islands, we conclude that *veneratus* occurs only on Tahiti, *youngi* only on Moorea, and *tutus* does not occur on Tahiti and Moorea, but in the Leeward group. From van der Vliet & Jansen (2015) we contend that nominate *tutus* not only occurs on Raiatea and Bora Bora (where

WSSE collected it) but also on Huahine, Maupiti and Tahaa. For *veneratus*, this follows all modern world checklists (e.g. Peters 1955, Dickinson & van Remsen 2013, del Hoyo & Collar 2014, Clements *et al*. 2016, Gill & Donsker 2017) and other literature (e.g. Pratt *et al*. 1987, Fry *et al*. 1992). That *tutus* never occurred on Tahiti is the most logical explanation for the observed distributional pattern, and represents the most parsimonious interpretation of the available data.

## Acknowledgements

Jérôme Fuchs and Patrick Boussès, both at MNHN, are thanked for their help during the preparation of this reply. Paul Sweet at AMNH was of great assistance in supplying photographs of *tutus* and *veneratus*. Laurent Raty helped us to decipher the French word tamatioïde.

References:

Atkinson, I. A. E. 1973. Spread of the ship rat (*Rattus r. rattus L.*) in New Zealand. *J. Roy. Soc. New Zealand* 3: 457–472.

Atkinson, I. A. E. 1985. The spread of commensal species of *Rattus* to oceanic islands and their effects on island avifaunas. Pp. 35–81 *in* Moors, P. J. (ed.) *Conservation of island birds*. International Council for Bird Preservation, Cambridge, UK.

Atkinson, I. A. E. & Atkinson, T. J. 2000. Land vertebrates as invasive species on islands served by the South Pacific Regional Environment Programme. Pp. 19–84 *in* Sherley, G. (ed.) *Invasive species in the Pacific: a technical review and draft regional strategy*. South Pacific Regional Environment Programme (SPREP), Apia, Samoa.

Boessenkool, S., Star, B., Scofield, R. P., Seddon, P. J. & Waters, J. M. 2009. Lost in translation or deliberate falsification? Genetic analyses reveal erroneous museum data for historic penguin specimens. *Proc. Roy. Soc. Lond. Ser. B* 277: 1057–1064.

Cibois, A. & Thibault, J.-C. 2009. Combien d'espèces de martins-chasseurs existe-t-il à Tahiti? *Te Manu* 65: 16–18.

Clements, J. F., Schulenberg, T. S., Iliff, M. J., Roberson, D., Fredericks, T. A., Sullivan, B. L. & Wood, C. L. 2016. The eBird / Clements checklist of birds of the world: v. 2016. www.birds.cornell.edu/clementschecklist/download/.

Collar, N. J. 2000. Collecting and conservation: cause and effect. *Bird Conserv. Intern*. 10: 1–15.

Cretella, M. 2010. The complete collation and dating of the section *Zoologie* of the *Coquille* voyage. *Boll. Malacologico* 46: 83–103.

Dickinson, E. C. & Remsen, J. V. (eds.) 2013. *The Howard & Moore complete checklist of the birds of the world*, vol. 1. Fourth edn. Aves Press, Eastbourne.

Finsch, O. & Hartlaub, G. 1867. *Beitrag zur Fauna Centralpolynesiens. Ornithologie der Viti-, Samoa- und Tonga-Inseln*. H. W. Schmidt, Halle.

Fry, C. H., Fry, K. & Harris, A. 1992. *Kingfishers, bee-eaters and rollers*. Christopher Helm, London.

Gill, F. & Donsker, D. 2017. IOC world bird list (v. 7.2). doi: 10.14344/IOC.ML.7.2.

Gray, G. R. 1859. *Catalogue of the birds of the tropical islands of the Pacific*. Trustees of the Brit. Mus., London.

Hedrich, H. J. 2006. Taxonomy and stocks and strains. Pp. 71–92 *in* Suckow, M. A., Weisbroth, S. H. & Franklin, C. L. (eds.) *The laboratory rat*. Second edn. Academic Press, Toronto.

Hembry, D. H. & Balukjian, B. 2016. Molecular phylogeography of the Society Islands (Tahiti; South Pacific) reveals departures from hotspot archipelago models. *J. Biogeogr*. 43: 1372–1387.

Holyoak, D. T. 1974. Les oiseaux des îles de la Société. Part 2. *L'Oiseau et R.F.O*. 44: 153–184.

Holyoak, D. T. & Thibault, J.-C. 1984. Contribution à l'étude des oiseaux de Polynésie orientale. *Mém. Mus. Natl. Hist. Nat. Paris* 127: 1–209.

del Hoyo, J. & Collar, N. J. 2014. *HBW and BirdLife International illustrated checklist of the birds of the world*, vol. 1. Lynx Edicions, Barcelona.

Jansen, J. J. F. J. 2014. Towards the resolution of long-standing issues regarding the birds collected during the Baudin expedition to Australia and Timor (1800–1804): a review of original documents reveals new details about collectors, donors, numbers and disbursement. *J. Natl. Mus. (Prague), Nat. Hist. Ser*. 183: 5–18.

Jansen, J. J. F. J. & van der Vliet, R. E. 2015. The chequered history of the Chattering Kingfisher *Todiramphus tutus* in Tahiti. I: type specimens. *Bull. Brit. Orn. Cl*. 135: 108–120.

Lee, M. & Holyoak, D. T. 2017. 'The chequered history of Chattering Kingfisher *Todiramphus tutus* on Tahiti': a response. *Bull. Brit. Orn. Cl*. 137: 211–217.

Lesson, R. P. 1827. Description du genre *Todiramphe* et de deux espèces d'oiseaux qui le composent. *Mém. Soc. Hist. Nat. Paris* (2)3: 419–421, pl. 11–12.

Monnet, C., Thibault, J.-C. & Varney, A. 1993. Stability and changes during the twentieth century in the breeding landbirds of Tahiti (Polynesia). *Bird Conserv. Intern*. 3: 261–280.

Peters, J. L. 1955. *Check-list of the birds of the world*, vol. 5. Mus. Comp. Zool., Harvard Univ., Cambridge, MA.
Peterson, A. T., Navarro-Sigüenza, A. G. & Pereira, R. S. 2004. Detecting errors in biodiversity data based on collectors' itineraries. *Bull. Brit. Orn. Cl*. 124: 143–151.
Pratt, H. D., Bruner, P. L. & Berrett, D. G. 1987. *The birds of Hawaii and the tropical Pacific*. Princeton Univ. Press.
Rasmussen, P. C. & Prŷs-Jones, R. P. 2003. History vs mystery: the reliability of museum specimen data. *Bull. Brit. Orn. Cl*. 123A: 66–94.
Sharpe, R. B. 1868. *A monograph of the Alcenididae*. Privately published, London.
Sharpe, R. B. 1892. *Catalogue of the birds in the British Museum*, vol. 17. Trustees of the Brit. Mus., London.
Sharpe, R. B. 1906. *The history of the collections of the natural history departments of the British Museum. Birds*. Trustees of the Brit. Mus., London.
van der Vliet, R. E. & Jansen, J. J. F. J. 2015. The chequered history of the Chattering Kingfisher *Todiramphus tutus* Tahiti. II: present status. *Bull. Brit. Orn. Cl*. 135: 121–130.
Voisin, C. & Voisin, J.-F. 2008. List of type specimens of birds in the collection of the Muséum National d'Histoire naturelle (Paris, France). 18. Coraciiformes. *J. Natl. Mus. (Prague), Nat. Hist. Ser*. 177: 1–25.
Wiglesworth, L. K. 1891. *Aves polynesiae: a catalogue of the birds of the Polynesian subregion*. R. Friedländer & Sohn, Berlin.
Wilson, S. B. 1907. XVIII – Notes on birds of Tahiti and the Society group. *Ibis* 49: 373–379.
Ziembicki, M. & Raust, P. 2006. Status and conservation of the *Vini* lorikeets of French Polynesia. Rep. to Loro Parque Foundation and Conservation des espèces et des populations animales (CEPA). Société d'Ornithologique de Polynésie, Papeete.

*Addresses*: Roland E. van der Vliet, 2e Daalsedijk 169, 3551 EG Utrecht, the Netherlands, e-mail: rollie_nl@yahoo.com. Justin J. F. J. Jansen, c/o Naturalis Biodiversity Center, P.O. Box 9517, 2300 RA Leiden, the Netherlands, e-mail: justin.jansen@naturalis.nl

# Observations of five little-known tubenoses from Melanesia in January 2017

*by Robert L. Flood, Angus C. Wilson & Kirk Zufelt*

*Received 2 June 2017; revised 27 July 2017; published 15 September 2017*

*http://zoobank.org/urn:lsid:zoobank.org:pub:CEE9CBAA-CEE5-4508-9EAC-DA5D42690BD3*

Summary.—We present observations of five little-known tubenoses made during a pelagic expedition from Vanuatu to New Ireland, Melanesia, in January 2017: Beck's Petrel *Pseudobulweria becki*, an all-dark *Pseudobulweria*, Magnificent Petrel *Pterodroma* (*brevipes*) *magnificens*, Vanuatu Petrel *P.* (*cervicalis*) *occulta* and Heinroth's Shearwater *Puffinus heinrothi*. Our observations provide some new insights into the following issues: Beck's Petrel—timing of breeding and search for the breeding grounds; all-dark *Pseudobulweria*—possible existence of an undescribed taxon in seas north-east of Papua New Guinea; Magnificent Petrel—sightings consistent with the argument for a distinct population; Vanuatu Petrel—variation in the underwing pattern and implications for its separation from White-necked Petrel *Pterodroma* (*c.*) *cervicalis*; and Heinroth's Shearwater—timing of breeding and search for the breeding grounds.

## Background and Methods

Until fairly recently, the tubenoses of Melanesia were known mainly from the ill-fated Mencke Expedition (1900–01) and the rather more successful 1927–29 leg of the Whitney South Seas Expedition (see, e.g. Heinroth 1902, Murphy 1928, 1930). Little or nothing further was reported until the late 20th century. Recent studies have added important new findings, although large gaps in knowledge remain. We planned a pelagic expedition through Melanesian waters to study the five least-known tubenoses of the region: Beck's Petrel *Pseudobulweria becki* (rediscovered 2007; Shirihai 2008a), an unidentified all-dark *Pseudobulweria* (first seen 2003; Shirihai 2008a), Magnificent Petrel *Pterodroma* (*brevipes*) *magnificens* (described by Bretagnolle & Shirihai 2010), Vanuatu Petrel *P.* (*cervicalis*) *occulta* (resurrected 1983; Boles *et al*. 1985; rediscovered at sea in Vanuatu waters 2006–07; Shirihai & Bretagnolle 2010; breeding colony discovered in 2009 in northern Vanuatu; Totterman 2009), and Heinroth's Shearwater *Puffinus heinrothi* (rediscovered 1979; Hadden 1981; first documented at sea 2003; Shirihai 2004).

Our expedition dates were 6–31 January 2017, on board the 18 m-yacht *Sauvage* that specialises in visits to remote locations. A route was set from Port Vila, Vanuatu, to Silur Bay, New Ireland, Papua New Guinea, via the Banks Islands, Vanuatu, and Kolombangara Island, in the Solomon Islands, and returning to Kolombangara Island (Fig. 1). The distance travelled was *c.*3,000 km. The dates and route promised a reasonable chance of encountering our target taxa. The lunar cycle is important when visiting breeding colonies of petrels (e.g. Pinet *et al*. 2011, Rubolini *et al*. 2014) as greatest activity is usually around the new moon. However, a near four-week-long expedition, a few days short of a complete lunar cycle, made it impossible to visit all colonies and potential breeding areas around the new moon.

Potential challenges included the typhoon season (January–April) and the prevailing (opposing) north-west winds. However, eventually calm conditions throughout the expedition posed more problems; slowing our passage, becalming the petrels, and significantly reducing the effectiveness of chumming. Nevertheless, during daylight, while

© 2017 The Authors; Journal compilation © 2017 British Ornithologists' Club

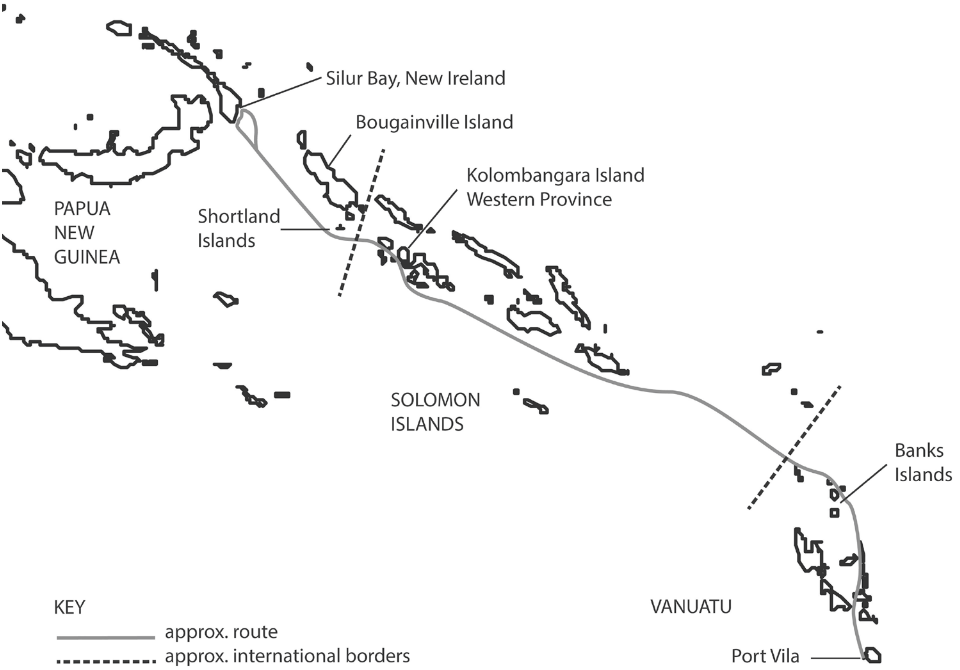


Figure 1. Map of the route followed by *Sauvage* January 2017. Departed Port Vila, Vanuatu, morning of 6 January, travelled to the Banks Islands, northern Vanuatu, arriving at Vanua Lava at noon on 8 January. Departed Vanua Lava at dusk on 10 January, then travelled to Western Province, Solomon Islands, arriving at Noro, Kohinggo Island, 16 January. Departed Noro late morning on 17 January passing through Blackett Strait, then to New Ireland, Papua New Guinea, arriving at Silur Bay early morning 20 January. Departed mid-morning 22 January, returned to Western Province, Solomon Islands, arriving at Vella Gulf at dusk 24 January. Repeatedly cruised Blackett Strait until disembarking at Gizo Island early afternoon 31 January (also visited Vella Gulf and Fergusson Passage).

motoring or sailing, we operated a fish-oil drip and, at key locations, towed onion bags full of semi-decomposed sardines. We attempted drifting and chumming several times, by establishing an oil slick and adding fish products, but this was largely unsuccessful due to an almost complete lack of wind. Wind disperses the smell of the chum and aids tubenose flight.

## Results and Discussion

**BECK'S PETREL** *Pseudobulweria becki*

At first light on 20 January, at *c.*06.30 h, *Sauvage* was *c.*15 km south-east of Silur Bay in south-eastern New Ireland (Fig. 2). The first Beck's Petrel was seen *c.*10 km offshore as we approached the bay. The majority of sightings over the next few days were within 5 km of shore, mainly <2 km of shore, with some just 50 m from land. The birds rarely approached closer to the vessel than 100 m. We were unable to identify any fresh juveniles among the best-seen birds. A few were in active primary moult (see below) and the rest showed some degree of wear. Sightings on 20–22 January in the vicinity of Silur Bay were as follows. 20 January—24 birds to 08.30 h flying north, then eight to 15.30 h flying north / south, and two sat in the bay, with 12 to 16.00 h flying south during a squall, ten to 18.00 h flying south, and eight birds to dusk milling around the mouth of the bay (none within it). 21 January—18 to 08.30 h flying north, then 13 flying north / south to 15.30 h and two sat in the bay, but none

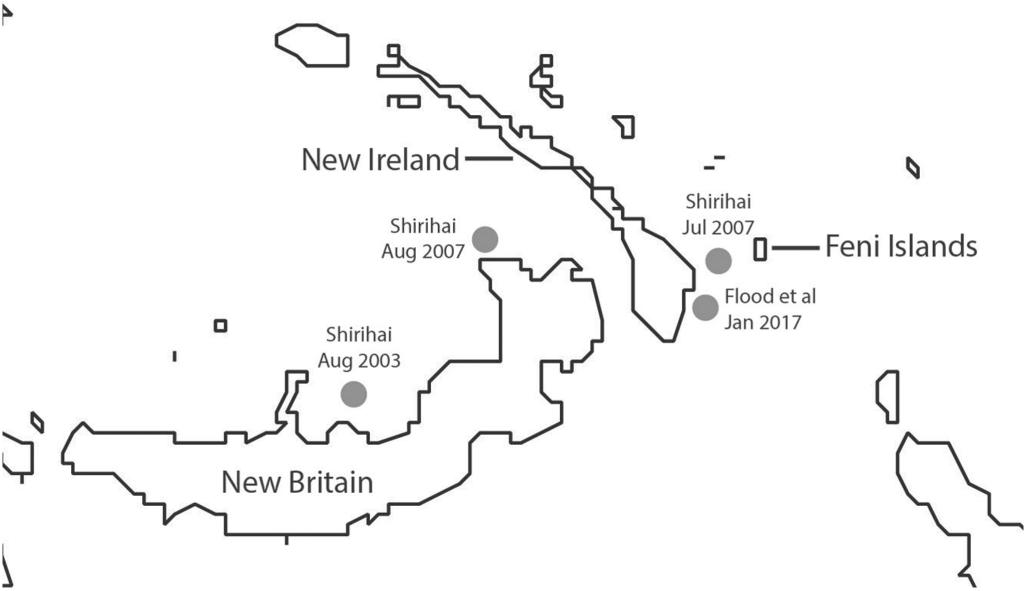


Figure 2. Map of the eastern Bismarck archipelago (including New Britain, New Ireland and Bougainville), showing localities mentioned in the text, and the locations of our and Shirihai's (2008a) sightings of an unidentified all-dark *Pseudobulweria*.

beyond 5 km in the direction of the Fini Islands to the east, 11.30 h to 15.30 h, then 18 and a Tahiti Petrel *P. rostrata* to dusk, with some Beck's Petrels milling at the mouth of Silur Bay. 22 January—none to 08.30 h, then three to 12.30 h while motoring south to Cape St. George, followed by 12 to dusk while sailing south-southeast from Cape St. George, most within the first 15 km, none beyond 40 km.

Wind and sea conditions were calm during the first two days, with just the occasional squall descending from the Hans Meyer Range (highest peak 2,379 m). On 22 January, the wind turned north-west force 4, giving blustery conditions and a choppy sea south of Cape St. George. Beck's Petrels favoured these windy conditions and few were seen in the lee of the island. Conditions returned to calm by early evening.

Very few Beck's / Tahiti Petrels were seen elsewhere. 10 January—one *P. rostrata* off Vanua Lava, Vanuatu. 19 January—one Beck's / Tahiti Petrel distantly *c.*90 km south-east of Cape St. George. 23 January—three *P. rostrata c.*100–200 km south-southeast of Cape St. George. Tahiti Petrels were seen well and fairly easily identified by size, structure and flight behaviour (see Shirihai 2008a).

The breeding grounds of Beck's Petrel are unknown and finding them is critical to its conservation. Concentrations off Cape St. George in July / August (Shirihai 2008a,b) and at Silur Bay in March / April (Bird 2012, Bird *et al.* 2014, Bird & Gaskin 2016) strongly suggest breeding in the nearby Hans Meyer Range. Our January sightings, mainly within or near Silur Bay, add weight to the supposition that Beck's Petrel breeds nearby.

The above sightings are consistent with a breeding season February / March–July / August. However, the closely related Tahiti Petrel is thought to breed year-round, with egg-laying peaks varying locally (Carboneras *et al.* 2017). Our sightings do not exclude this possibility for Beck's Petrel. Although our study found fewer birds in January compared to March / April (Bird 2012, Bird *et al.* 2014), some birds were loafing off Silur Bay in the evening, like active breeders. That said, other individuals were in active primary moult. Two examples photographed show outer five / six primaries old, moult ongoing among the inner five / four primaries. Procellariidae in active primary moult are unlikely to be nesting, as they usually start primary moult post-breeding. So, moulting birds could have been post-breeding adults, or immatures. Immature Procellariidae tend to disperse from the breeding grounds for several years, but dispersal patterns for Beck's Petrel are unknown.

## ALL-DARK *PSEUDOBULWERIA*

On 21 January 2017, at *c*.15.10 h, we observed an all-dark *Pseudobulweria* resembling Fiji Petrel *P. macgillivrayi*, *c*.1 km offshore at the northern end of Silur Bay, New Ireland (04°25'S, 153°06'E; Fig. 2). It had been a calm day until a light squall descended from the Hans Mayer Range giving a 10–15 knot wind from the south-east. *Sauvage* was travelling south following the coastline *c*.1 km offshore. A fish-oil drip was running and we towed sardines from *c*.15.00 h. The bird was initially spotted in the wake by RLF. Flight was strong and purposeful as it progressed to within 150 m, before flying off in a more leisurely fashion to *c*.0.5 km from shore, then heading back and crossing the wake *c*.200 m away, before finally flying off north following the coast. The bird was in view for *c*.2 minutes and was also seen by ACW, KZ & M. Danzenbaker. Photographs were hurriedly taken as the bird crossed the wake, but the images are small and out of focus.

At first sight, head on, RLF thought that it was another Beck's Petrel. However, its flight action was more hurried and purposeful than Beck's Petrel, conveying the impression of a smaller bird. Overall dark plumage—eliminating Beck's Petrel, unless melanistic—was first seen when the bird peeled off toward the coast. Compared to Beck's Petrel, our bird was perhaps 10% smaller, with a more heavily built head and body, an apparently heavier bill, less pointed wings, and relatively short tail. The overall plumage was blackish, brownish black in the best light, with uniformly dark upperwings. A probable all-dark *Pseudobulweria* was briefly seen by RLF & ACW off Cape St. George, in southern New Ireland, at *c*.15.00 h on 22 January 2017, but it was further away than the first bird.

The main potential confusion genus for *Pseudobulweria* is *Bulweria*. The latter has long slim wings, elongated rear body, and all-dark plumage except for upperwing ulnar bars—typically strong in Bulwer's Petrel *B. bulwerii*, dull in Jouanin's Petrel *B. fallax* (Shirihai *et al*. 2009: 140). There are reports of Bulwer's Petrel in the region, including one during our expedition, but the main potential confusion species is Jouanin's Petrel, given its size and typically dull upperwing ulnar bars. Shirihai *et al*. (2009: 141) noted that experienced observers will differentiate Fiji Petrel (hence a Fiji-like Petrel) from *Bulweria* by their characteristic flight. Our experience includes >200 Jouanin's Petrels off Oman (Flood 2016) and at least three different populations of Bulwer's Petrel (e.g. Flood & Fisher 2011). Two of us have experience in distinguishing all-dark Mascarene Petrel *P. aterrima* from Bulwer's Petrel (Flood *et al*. 2015).

The flight actions of our bird were more like a *Pterodroma* than a *Bulweria*. Flight was consistently strong and steady, with fairly stiff wingbeats, and the bird climbed to >8 m on several occasions. *Bulweria* has especially low wing loading, consequently an effortless buoyant flight, gliding for long periods, meandering or with erratic changes of direction, has flexible wingbeats, and flies low over the water in relatively calm conditions such as on 21 January 2017. Given the same conditions, the flight action of Jouanin's Petrel is slower than the smaller Bulwer's Petrel, with floppier wingbeats (Flood 2016).

Shirihai (2008a: 13) reported three sightings of all-dark *Pseudobulweria* that resembled Fiji Petrel in the Bismarck Archipelago (Fig. 2). The main characteristics of our bird on 21 January 2017 match his birds. We are aware of two other sightings of all-dark *Pseudobulweria* in the same general area: 12 April 2007, at 01º42'S, 153º56'E, and 19 April 2008, at 05º38'S, 153º56'E (S. N. G. Howell, P. Fraser & I. Sinclair *in litt*. 2017).

It seems unlikely that the relatively tight cluster of all-dark *Pseudobulweria* sightings around New Britain and New Ireland simply reflects greater effort. Since 2006, several commercial and privately funded expeditions have sailed from New Caledonia / Fiji northward, without encountering all-dark *Pseudobulweria* in Vanuatu or the Solomons. In addition, evidence to date indicates that Fiji Petrel is very rare, with only eight observed during an intensive search off Gau, Fiji, where it probably breeds (Shirihai *et al*. 2009). Thus, if the birds are Fiji Petrels, then either the region is a key foraging zone for the Gau population (breeding *c*.3,000 km away), or it holds a previously undiscovered population.

Alternatively, the Papua New Guinea all-dark *Pseudobulweria* may be an undescribed taxon. Indeed, following his work off Gau, Shirihai *et al*. (2009: 145) concluded that the Bismarck birds had a different shape and flight behaviour compared to Fiji Petrel.

Our sighting off Silur Bay, as with Beck's Petrel (Bird *et al*. 2014), suggests that breeding might occur in the Hans Meyer Range. The possibility that all-dark *Pseudobulweria* breed in the region should be kept in mind when searching for the breeding grounds of Beck's Petrel.

### MAGNIFICENT PETREL *Pterodroma* (*brevipes*) *magnificens*

All except one of our sightings of Magnificent Petrel were south of Vanua Lava, Banks Islands, northern Vanuatu, where it apparently breeds (Bretagnolle & Shirihai 2010, Tennyson *et al*. 2012). 7 January—42 birds over the deep waters enclosed to the west by the islands of Malekula and Espiritu Santo, and to the east by Pentecost and Maewo. 8 January—four birds during the morning approach to Vanua Lava. 9 January—one close to Vanua Lava late evening. Photographs show birds in fresh plumage. No other *Cookilaria* were seen during the expedition.

Collared Petrels were categorised into four plumage-types by Watling (1986), illustrated with photographs in Bretagnolle & Shirihai (2010: 294). Using the latter, Magnificent Petrels are mainly 'dark grey' (darkest category), with some paler below and categorised 'smoky' (Bretagnolle & Shirihai 2010: 287). Most of our birds were 'dark grey' with a minority 'smoky.' None were of the paler types 'grey peppering' or 'pure white'.

Bretagnolle & Shirihai (2010: 293) reported 180 Magnificent Petrels during their expedition to the Banks Islands in December 2009. They were mainly 'dark grey' (*c*.90%) with the rest 'smoky' (*c*.10%). On 24 April 2014, an expedition cruiser crossed the same deep waters between Malekula and Espiritu Santo on the one hand, and Pentecost and Maewo on the other. A squall pushed a group of *c*.20 Magnificent Petrels across the ship's bow. Again, most were 'dark grey' with the rest 'smoky' (C. Collins *in litt*. 2017). The palest 'smoky' individual (Fig. 3) stood out from the rest of the group. Concentrations of entirely dark-morph birds ('dark grey' and 'smoky') in December 2009 (180), in April 2014 (*c*.20) and in January 2017 (46) point to a distinct population.

Bretagnolle & Shirihai (2010) described Magnificent Petrel as a race of Collared Petrel *P. brevipes*, based on its smaller size, monomorphic plumage and timing of breeding. They stated that the vast majority of their December 2009 birds were juveniles and therefore concluded that Magnificent Petrel must breed in the austral summer, or earlier (criteria for ageing not given). Elsewhere, Collared Petrel typically breeds in the austral autumn / winter (mainly March–August, and could look quite fresh in December), is not known to breed year-round, and largely disperses from the breeding colonies (Watling 1986).

However, taxon status for Magnificent Petrel was contested by Tennyson *et al*. (2012). They questioned the presence of a larger and paler bird, collected concurrently with the type series of *P. b. magnificens*, which Bretagnolle & Shirihai (2010) considered to be a visiting *P. brevipes*. Its inclusion makes the Vanua Lava population more like other populations of Collared Petrel; it increases the biometric mean values and points to polymorphism.

Figure 3. Presumed Magnificent Petrel *Pterodroma* (*brevipes*) *magnificens*, between Malekula and Espiritu Santo Islands, and Pentecost and Maewo Islands, Vanuatu, 24 April 2014 (Kirk Zufelt). Rather distant when photographed, this is the palest bird of 60 seen in these waters in April 2014 and January 2017. This individual is a shade lighter than the palest Magnificent Petrel in Bretagnolle & Shirihai (2010: 294, Fig. 8). Bretagnolle & Shirihai stated that the bird in their Fig. 8 was borderline between 'dark grey' and 'smoky', thus we label this bird 'smoky'. Bretagnolle & Shirihai (2010: 291, Table 2) scored Magnificent Petrels at sea off Banks Islands, Vanuatu, and found that 10.53% were smoky (the rest extreme / dark grey); they scored the type series from the same waters and found 20% were smoky (the rest extreme / dark grey).

Tennyson *et al*. (2012) visited Vanua Lava in March 2011. At night they captured two birds with similar biometrics, one 'dark grey', the other 'paler' (flashlight photographs in Tennyson *et al*. 2012: 43). They presented this as evidence that pale birds can be the same size as Magnificent Petrel. Despite the particularly strong flashlight on the paler bird, it shows a grey wash to the underparts, perhaps sufficient to qualify as 'smoky'.

Tennyson *et al*. (2012) also reported that paler birds seen in the spotlight encompassed the three paler morphs of Collared Petrel. Accordingly, they concluded that the *Cookilaria* breeding on Vanua Lava is Collared Petrel, with a higher proportion of dark-morph birds than other colonies, and that the birds observed by Bretagnolle & Shirihai in December 2009 were fresh adults ready to breed in the austral autumn / winter, as at other colonies of *P. brevipes*. In our experience, interpreting plumage shades in a spotlight is subjective and potentially unreliable. We prefer to restrict our comments to specimens and well-photographed birds. However, sightings at the colony on Vanua Lava in March (autumn) is within the main breeding period of Collared Petrels elsewhere.

During our visit to Vanua Lava on 8–10 January, just one bird was seen near the breeding island, in the evening, and there was no other sign of birds returning to the colony. We spent three afternoons and evenings north-east of Vanua Lava at the December 2009 'hotspot' for Magnificent Petrels (H. Shirihai *in litt*. 2017) and Vanuatu Petrels *P.* (*c.*) *occulta* (Bretagnolle & Shirihai 2010: 139).

One explanation is that conditions for returning to the colony were less favourable during our visit, given calm weather and an 81–85% waxing moon (although a fair number of Vanuatu Petrels were seen, see below). Bretagnolle & Shirihai experienced more favourable conditions, with a new moon becoming a *c*.50% waxing moon. However, our visit was *c*.1 month later than that by Bretagnolle & Shirihai. Thus, if their birds were juveniles, then our visit may have followed post-breeding dispersal.

### VANUATU PETREL *Pterodroma* (*cervicalis*) *occulta*

Observed at sea from *c*.50 km south to *c*.150 km north of Vanua Lava, Banks Islands, northern Vanuatu, where breeding has recently been documented (Totterman 2009). Birds were sparsely distributed at sea. Nevertheless, our sightings give some indication of foraging range in the breeding season. The rest of our sightings were off Vanua Lava.

We arrived at Vanua Lava at noon on 8 January and departed at dusk on 10 January. Late afternoon and evening were spent north-east of Vanua Lava at a 'hotspot' for returning Vanuatu Petrels (Shirihai & Bretagnolle 2010; Fig. 4). At night we drifted off north-east Vanua Lava. Morning and midday were mainly spent searching for feeding frenzies of

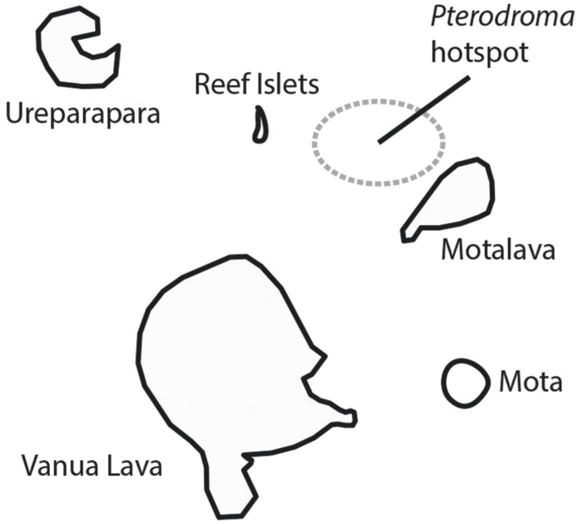


Figure 4. Map of the northern Banks Islands, North Vanuatu, marking the locations mentioned in the text, as well as the 'hotspot' for returning Magnificent Petrels (H. Shirihai *in litt*. 2017) and Vanuatu Petrels (Bretagnolle & Shirihai 2010).

Figure 5. Vanuatu Petrel *Pterodroma* (*cervicalis*) *occulta*, between the Reef Islands and Mota Lava, *c*.12 km north-east of Vanua Lava, 9 January 2017, with extensive white 'tongues' on the underside of the primaries, like extreme examples of White-necked Petrel *Pterodroma* (*c.*) *cervicalis* (Kirk Zufelt)

seabirds (frigatebirds *Fregata*, boobies *Sula*, noddies *Anous* and terns *Sterna*) that often attracted small numbers of Vanuatu Petrels. Groups of 2–6 *P.* (*c.*) *occulta* were found loafing at sea in the late afternoon and evening, north-east of Vanua Lava, between the Reef Islets and Mota Lava. Birds were observed landing, swimming toward each other, and preening. 8 January—six at sea while approaching Vanua Lava, five in the afternoon with feeding frenzies, then 20 at the 'hotspot' in the evening, with two or more calling occasionally 1 km offshore 22.00–23.00 h (the *toooooo-wit* call described by Totterman 2009: 60). 9 January—six in the afternoon with feeding frenzies, and ten at the 'hotspot' in the evening. 10 January—three in the afternoon with feeding frenzies, but none at the 'hotspot' before departure at dusk. 11 January—five at sea, mainly with feeding frenzies.

Identification of Vanuatu Petrel away from the Banks Islands necessitates correct judgement of size and the extent of white 'tongues' on the underside of the primaries beyond the greater primary-coverts (Shirihai & Bretagnolle 2010: 135). We found greater variation in the underwing pattern than Shirihai & Bretagnolle (2010). Their Fig. 6 (p. 137) shows a White-necked Petrel with extensive white 'tongues'. The legend states that such extensive white has yet to be found in Vanuatu Petrel and might reliably identify White-necked Petrel. On 9 January, we found two same-sized Vanuatu Petrels together on the sea between the Reef Islands and Mota Lava, *c.*12 km north-east of Vanua Lava. They eventually flew off. One had a fairly typical underwing pattern, with largely dark primaries, while the other had extensive white 'tongues', equivalent to the extreme for White-necked Petrel shown in Shirihai & Bretagnolle (2010: Fig. 6; compare our Fig. 5). At the other extreme, studies in the Kermadec Islands found that 9% of White-necked Petrels had a mainly dark underside to the primaries like typical Vanuatu Petrel (Shirihai & Bretagnolle 2010: 136 and Fig. 8). Consequently, pelagic identification of Vanuatu and White-necked Petrels away from their respective breeding islands will depend solely on correct judgement of size, which of course is difficult to establish at sea.

## HEINROTH'S SHEARWATER *Puffinus heinrothi*

The locations of our sightings correspond with suspected breeding on Rendova and Kolombangara Islands, Solomon Islands, and on Bougainville Island, Papua New Guinea (Harrison 2014; Fig. 1). We observed five at sea: 17 January—one in Vella Gulf, between Kolombangara, Ghizo and Vella Lavella Islands; 18 January—two singles off the Shortland Islands, Solomons; 19 January—two singles *c.*65 km west of the north-west end of Bougainville Island. The rest of our sightings involved singles and small groups in the Blackett Strait, a narrow oceanic passage between the islands of Kolombangara and Kohinggo, Western Province, Solomons (Fig. 6). We found Heinroth's Shearwaters strongly associated with sizeable mixed feeding and rafting flocks of noddies and terns (as did Cheshire 2010 and Harrison 2014). Flocks went into frenzies over feeding tuna that pushed bait fish to the surface. Fish activity during our visit occurred mainly early to

Figure 6. Map of the study area for Heinroth's Shearwater *Puffinus heinrothi* showing Blackett Strait, Vella Gulf and Fergusson Passage.

Figure 7. Moulting Heinroth's Shearwater *Puffinus heinrothi*, Blackett Strait, between Kolombangara and Kohinggo Islands, Solomons, 29 January 2017; outer three primaries old and moult ongoing in middle primaries (Kirk Zufelt)

mid-morning, and mid-afternoon to late evening (Gibbs 1996 also noted evening activity off Kolombangara), but may have been influenced by tidal flows. We made the following sightings in Blackett Strait: 17 January—two at *c*.12.00 h as we motored en route to New Ireland; 25 January—having just returned from New Ireland, four in the evening; 26 January—at 07.30–09.30 h 6–8 birds, then 15.30–17.45 h 10–12, *c*.16 in total. 27 January—at 07.30–09.30 h 6–8 birds, not searched for in afternoon; 28 January—at 07.30–09.30 h 6–8 birds, then 15.30–17.30 h 8–10, *c*.14 in total; 29 January—at 07.30–10.30 h 16–18 birds, not searched for in afternoon; 30 January—at 07.30–11.30 h 6–8 birds, none in afternoon (also no noddies or terns); 31 January—at 07.30–11.30 h 6–8 birds, then disembarked *Sauvage*. There was some turnover in Blackett Strait. For example, on 26 January the majority were pale morph, whereas on 28 January approximately the same number of birds were seen but most were dark morph. Some, recognisable by a distinct marking, or by wear or moult in the primaries, were seen only once. We estimate a total of 30–50 in Blackett Strait.

On 20–25 March 2013, Harrison (2014) observed flocks of 1–25 birds, usually 50–60 per day in Vella Gulf adjoining Blackett Strait. On 21 September 2015, P. Sweet (*in litt*. 2017) saw 25 simultaneously in the adjoining Fergusson Passage. There were fewer birds present during our January expedition compared to the March and September visits.

Our photographs reveal a range of wear and moult in the flight feathers. Few birds had fresh plumage. Most showed light to moderate wear, the most worn feathers often being the central tail feathers, and the tail was heavily abraded in one individual. At least one bird showed moult contrast in a full set of secondaries. The only bird in active primary moult had old, worn and bleached pp8–10, with moult ongoing in the middle primaries (Fig. 7). Accordingly, the birds could have been a mix of immatures and adults, given a fixed breeding season (e.g. January / March–August / September); or largely / all adults, given a protracted season.

That said, the breeding season of Heinroth's Shearwater is barely known. No egg or nest has ever been found (Pikacha & Sirikolo 2010, Harrison 2014). Including our sightings, there are documented records offshore from suspected breeding islands in January, March, April, July, August and September (Hadden 1981, Gibbs 1996, Tarburton 2009, 2017, Harrison 2014; C. Collins *in litt*. 2017, P. Sweet *in litt*. 2017). Two records on Bougainville

© 2017 The Authors; Journal compilation © 2017 British Ornithologists' Club ISSN-2513-9894 (Online)

Figure 8. An immature White-bellied Sea Eagle *Haliaeetus leucogaster* attempting to predate a lone Heinroth's Shearwater *Puffinus heinrothi* on the sea, Blackett Strait, between Kolombangara and Kohinggo Islands, Solomons, 27 January 2017 (Kirk Zufelt)

are consistent with a regular breeding period (Hadden 1981: 23). A fledgling was found in August near the sea at Arawa, probably on its first flight. Nearby, inland at Panguna, an adult was found in July, probably en route to or from its nest. Significantly more birds in Vella Gulf in March 2013 (Harrison 2014), compared to Vella Gulf and Blackett Strait in January 2017, may mark the period of return to the breeding grounds (January–March). Thus breeding could occur January / March–August / September. Consistent with this is evidence of dispersal to Sulawesi, Indonesia, in October–March (at least). Sightings include flocks of 70+ off Taliabu (November 2012) and 209 north of Mangole, Sula Islands (March 2017) documented by photographs and video (Eaton *et al*. 2016; J. del Hoyo, J. Eaton, R. Hutchinson *in litt*. 2017).

Out of synch with the above timing, however, is the type specimen, a fledgling collected in New Britain on 27 May 1901 (Heinroth 1902). If our moulting bird was a juvenile in its second pre-basic moult, then it too may have fledged May / June. Fledglings in May / June and August would point to a protracted breeding season, with one or more egg-laying peaks.

The feeding behaviour that we observed was much as described by Shirihai (2004) and Harrison (2014). Finally, we witnessed an immature White-bellied Sea-eagle *Haliaeetus leucogaster* make a failed attempt to predate a lone Heinroth's Shearwater on the sea. The shearwater avoided capture by diving (Fig. 8). We were surprised to observe White-bellied Sea Eagle as Sanford's Sea-eagle *H. sanfordi* replaces it in the Solomons (identification substantiated in Wilson *et al*. in prep.).

## Acknowledgements

Many thanks to Cloe, Didier & Sophie Wattrelot for a safe passage and first-class service on their yacht *Sauvage*. Many thanks to Hadoram Shirihai for providing pre-expedition information, especially at-sea petrel 'hotspots' in northern Vanuatu. We are grateful to the following for responses to our queries: Josep del Hoyo, Chris Filardi, Peter Harrison, Colin Miskelly, Paul Sweet and Michael Tarburton. Lastly, we warmly acknowledge our colleagues Mike Danzenbaker and John & Jemi Holmes for their companionship and sharing of photographs.

References:

Bird, J. P. 2012. Targeted searches to identify nesting grounds of Beck's Petrel (*Pseudobulweria becki*). *Notornis* 59: 180–184.

Bird, J. P. & Gaskin, C. 2016. Beck's expedition 2016. Unpubl. rep. BirdLife International.

Bird, J. P., Carlile, N. & Miller, M. G. R. 2014. A review of records and research actions for the Critically Endangered Beck's Petrel *Pseudobulweria becki*. *Bird Conserv. Intern*. 24: 287–298.

Boles, W. E., Bartram, K. & Clancy, G. P. 1985. First Australian specimen of the White-necked Petrel. *Austr. Birds* 19: 51–54.

Bretagnolle, V. & Shirihai, H. 2010. A new taxon of Collared Petrel *Pterodroma brevipes* from the Banks Islands, Vanuatu. *Bull. Brit. Orn. Cl*. 130: 286–301.

Carboneras, C., Jutglar, F. & Kirwan, G. M. 2017. Tahiti Petrel (*Pseudobulweria rostrata*). *In* del Hoyo, J., Elliott, A., Sargatal, J., Christie, D. A. & de Juana, E. (eds.) *Handbook of the birds of the world Alive*. Lynx Edicions, Barcelona (retrieved from http://www.hbw.com/node/52521 on 25 July 2017).

Cheshire, N. 2010. Procellariiformes observed around Papua New Guinea including the Bismarck archipelago from 1985 to 2007. *South Austr. Orn*. 36: 9–24.

Eaton, J. A., van Balen, B., Brickle, N. W. & Rheindt, F. E. 2016. *Birds of the Indonesian archipelago: Greater Sundas and Wallacea*. Lynx Edicions, Barcelona.

Flood, R. L. 2016. Cory's Shearwater *Calonectris borealis*, Persian Shearwater *Puffinus persicus*, Jouanin's Petrel *Bulweria fallax* and Red-necked Phalarope *Phalaropus lobatus*, Muscat to Djibouti and into the Red sea, March / April 2015. *Sandgrouse* 38: 27–35.

Flood, R. L. & Fisher, E. A. 2011. *North Atlantic seabirds: storm-petrels & Bulwer's Petrel*. Pelagic Birds & Birding Multimedia ID Guides, Scilly.

Flood, R. L., Cook, E., Danzenbaker, M., Koch, D., Shemilt, J. & Zufelt, K. 2015. Barau's Petrel, Mascarene Petrel and other tubenoses off Réunion, Indian Ocean, in December 2014. *Dutch Birding* 37: 295–301.

Gibbs, D. 1996. Notes on Solomon Island birds. *Bull. Brit. Orn. Cl*. 116: 18–25.

Hadden, D. 1981. *Birds of the North Solomons*. Wau Ecology Institute, New Guinea.

Harrison, P. 2014. At-sea observations of Heinroth's shearwater (*Puffinus heinrothi*). *Notornis* 61: 97–102.

Heinroth, O. 1902. Ornithologische Ergebnisse der '1. Deutschen Südsee Expedition von Br. Mencke.' *J. Orn*. 50: 390–457.

Murphy, R. C. 1928. Birds collected during the Whitney South Seas Expedition. IV. *Amer. Mus. Novit*. 322: 1–5.

Murphy, R. C. 1930. Birds collected during the Whitney South Seas Expedition XI. *Amer. Mus. Novit*. 419: 1–15.

Pikacha, P. & Sirikolo, M. 2010. *Biodiversity of the Crater Area and surrounding mountain forests, Kolombangara Island*. WWF & Kolombangara Island Biodiversity and Conservation Association, Ringgi.

Pinet, P., Jaeger, A., Cordier, E., Potin, G. & Le Corre, M. 2011. Celestial moderation of tropical seabird behavior. *PLoS ONE* 6(11): e27663.

Rubolini, D., Maggini, I., Ambrosini, R., Imperio, S., Paiva, V. H., Gaibani, G., Saino, N. & Cecere, J. G. 2014. The effect of moonlight on Scopoli's Shearwater *Calonectris diomedea* colony attendance patterns and nocturnal foraging: a test of the foraging efficiency hypothesis. *Ethology* 121: 284–299.

Shirihai, H. 2004. Voyage of discovery. *Birdwatch* 143: 36–39.

Shirihai, H. 2008a. Rediscovery of Beck's Petrel *Pseudobulweria becki*, and other observations of tubenoses from the Bismarck archipelago, Papua New Guinea. *Bull. Brit. Orn. Cl*. 128: 3–16.

Shirihai, H. 2008b. Tubenoses at the Bismarck archipelago: surveying at-sea populations of the Beck's Petrel. In search of the Fiji-like Petrel expedition #3. Unpubl. rep.

Shirihai, H. & Bretagnolle, V. 2010. First observations at sea of Vanuatu Petrel *Pterodroma* (*cervicalis*) *occulta*. *Bull. Brit. Orn. Cl*. 130: 132–140.

Shirihai, H., Pym, T. Kretzschmar, J., Moce, K., Taukei, A. & Watling, D. 2009. First observations of Fiji Petrel *Pseudobulweria macgillivrayi* at sea: off Gau Island, Fiji, in May 2009. *Bull. Brit. Orn. Cl*. 129: 129–148.

Tarburton, M. K. 2009. New birds and other interesting sightings from Melanesia. *Muruk* 9: 56–93.

Tarburton, M. K. 2017. Kulambangara (Kolombangara) Island Bird Checklist, New Georgia Group, Solomon Islands. http://birdsofmelanesia.net/solomons8.html/kulambangra.pdf

Tennyson, A. J. D., Miskelly, C. M. & Totterman, S. L. 2012. Observations of collared petrels (*Pterodroma brevipes*) on Vanua Lava, and a review of the species' breeding distribution. *Notornis* 59: 39–48.

Totterman, S. L. 2009. Vanuatu petrel (*Pterodroma occulta*) discovered breeding on Vanua Lava, Banks Islands, Vanuatu. *Notornis* 56: 57–62.

Watling, D. 1986. Notes on the Collared Petrel *Pterodroma* (*leucoptera*) *brevipes*. *Bull. Brit. Orn. Cl*. 106: 63–70.

Wilson, A. C., Holmes, J., Danzenbaker, M., Flood, R. L., Wong, J. A.-P. & Zufelt, K. In prep. White-bellied Sea Eagle *Haliaeetus leucogaster* in the western Solomons.

*Addresses*: Robert L. Flood, 14 Ennor Close, Old Town, St Mary's, Isles of Scilly, TR21 0NL, UK, e-mail: live2seabird@gmail.com. Angus C. Wilson, 4 Washington Square Village, New York, NY 10012, USA, e-mail: oceanwanderers@gmail.com. Kirk Zufelt, 1001 Third Line East, Sault Sainte Marie, Ontario, P6A 6J8, Canada, e-mail: zufelt_k@shaw.ca

# First data on breeding ecology of Red-billed Pied Tanager *Lamprospiza melanoleuca*, including the nest and egg

*by Tomaz Nascimento de Melo & Renata da Silva Xavier*

*Received 20 February 2017; revised 18 June 2017; published 15 September 2017*

*http://zoobank.org/urn:lsid:zoobank.org:pub:0B027258-DC6A-4E80-88AB-99B8D7C2C5E8*

Red-billed Pied Tanager *Lamprospiza melanoleuca* is a monotypic species of Mitrospingidae. It is sexually dimorphic, with the female having the hindneck, mantle, rump and uppertail-coverts grey, rather than blue as in males (Hilty 2011). *L. melanoleuca* occurs in Amazonia, from south-east Peru, across northern Bolivia and Brazil to the Guianas, in the canopy of *terra firme* forest, where it is typically observed in monospecific groups of 3–8 individuals, although the species does join mixed-species flocks; it is uncommon and occurs at low density, in part due to its large territories (Hilty 2011). The only data on breeding period were presented by Kirwan (2009), who observed adults with two or three young in August in Mato Grosso and in September at Manaus, Amazonas. We present the first information on the species' breeding behaviour.

Our observations were made at the Museu da Amazônia (MUSA; 03°00.197"S, 59°56.382"W), north-east of the city of Manaus, Amazonas, Brazil. The MUSA area covers 200 ha within the Adolpho Ducke Forest Reserve, a 10,000-ha fragment of *terra firme* forest. The wet season is between November and May, and the dry season is in June–October. Mean annual temperature is 26°C (Baccaro *et al*. 2008). The MUSA has a tower, 42 m tall, surrounded by forest, which permits the observation of bird species that are otherwise little studied without the access to the forest canopy (Melo 2015, Melo & Xavier 2016). To document some behaviours, we made videos using a Canon SX50 with 50× zoom lens. Our videos have been deposited in the Internet Bird Collection (IBC; www.hbw.com/ibc). Seventeen hours of observations were made monitoring the nest.

On 7 January 2017, a flock of *L. melanoleuca* comprising two males and a female were observed several times carrying nest material to the canopy of a rubber tree *Hevea brasiliensis* (Euphorbiaceae) adjacent to the tower. The nest was in the early stages of construction, on a horizontal branch 28 m above ground. When depositing material, the birds constantly lay down in the centre in the nest, apparently to give it shape (T. Melo; www.hbw.com/ibc/133966). Twice a male was observed passing material to the female, which was in the nest. The birds were observed carrying material and adding spider webs to the nest's walls until 28 January. The behaviour did not appear to follow a strict pattern, but the birds were more active during the morning and late afternoon, and would disappear for up to four hours.

On 29 January, the female was observed in the nest making unusual circular movements with the tail raised, but no egg was seen. The nest could be categorised as a low cup type (*sensu* Simon & Pacheco 2005). Although it was impossible to precisely identify the components of the nest or to measure it, some materials could be identified, such as white filaments similar to a type of fungi, wire-like mammal hair, spider webs and green 'leafy' lichen, which was the most abundant material and camouflaged the nest (Fig. 1). When viewed from above, the nest could be seen to be placed on the widest point of the horizontal branch supporting it.

On 30 January, the nest held one egg, which was white with brown spots (Fig. 2). The female alone was observed incubating (T. Melo; www.hbw.com/ibc/1333992), which

Figure 1. Female Red-billed Pied Tanager *Lamprospiza melanoleuca* on nest, Museu da Amazônia, Manaus, Amazonas, Brazil, January 2017 (Renata da Silva Xavier)

Figure 2. Nest of Red-billed Pied Tanager *Lamprospiza melanoleuca*, with single white egg spotted brown, Museu da Amazônia, Manaus, Amazonas, Brazil, January 2017 (Tomaz Nascimento de Melo)

© 2017 The Authors; Journal compilation © 2017 British Ornithologists' Club

departed the nest, leaving the egg exposed, for more than two hours. When the adults arrived in the nest tree they vocalised frequently, whereas the female remained silent when alone at the nest, vocalising only when she departed. On the nest, the female sometimes raised the tail, arranged the interior with her bill and changed position. The only agonistic behavior that we observed was during the nest's construction. The female several times attacked a Lineated Woodcreeper *Lepidocolaptes albolineatus* foraging on a nearby branch, forcing the woodcreeper to depart the tree.

On 5 February the nest had completely disappeared. It was impossible to define the cause, but predation appears the most likely. The trees around the tower are constantly used as perches by potential nest predators, e.g. Channel-billed Toucan *Ramphastos vitellinus* and Green Aracari *Pteroglossus viridis*, and also constitute a foraging route for groups of Pied Tamarins *Saguinus bicolor* and Capuchin Monkeys *Sapajus apella*.

There are very few data concerning the breeding biology of any of the four species of Mitrospingidae, with nothing being known for Olive-backed Tanager *Mitrospingus oleagineus* and for Olive-green Tanager *Orthogonys chloricterus* the only published information available involves an observation of birds carrying nest material to a bromeliad within a tall tree (Hilty 2011). In contrast, two nests of Dusky-faced Tanager *Mitrospingus cassinii* have been described and, unlike the nest of *L. melanoleuca*, these comprised a cup slung between narrow vertical branches (Skutch 1972, Hilty 2011, Ocampo & Montoya 2014). Also in contrast to the nest of Red-billed Pied Tanager, lichens were not used as material. Clutch size in the latter species is stated to be 1–2 eggs (Hilty 2011) and these are similar in coloration to that we observed for Red-billed Pied Tanager. For *L. melanoleuca* cooperation was observed during the nestbuilding period, with all three individuals participating, but only the female was witnessed incubating the single egg. The presence of helpers, although rare among most birds, is known from several families (Cockburn 2006) and appears to be a comparatively frequent phenomenon among species traditionally classified as tanagers, embracing genera such as *Tangara*, *Neothraupis*, *Cypsnagra* and *Habia* (e.g., Skutch 1954, 1961, Willis 1961, Snow & Collins 1962, Long & Heath 1994, Sick 1997, Isler & Isler 1999, Gelis *et al*. 2006). In addition, at one nest of *Mitrospingus cassinii* the two nestlings were fed by at least three (and possibly as many as seven) adults (Skutch 1972). It is possible that in *L. melanoleuca*, helpers also participate in parental care, although this must be confirmed or refuted by future observations. The sum of all available breeding data for *Mitrospingus cassinii* (Ocampo & Montoya 2014) suggests a relative lack of obvious seasonality and, given our observations and those of Kirwan (2009), the same might be true for *L. melanoleuca*.

**Acknowledgements**

We are grateful to the Museu da Amazônia for supporting our field studies and to Gabriel Leite and Guy M. Kirwan for important suggestions concerning the submitted manuscript.

References:

Baccaro, F. B., Drucker, D. P., Vale, J., Oliveira, M. L., Magalhães, C., Lepsch-Cunha, N. & Magnusson, W. E. 2008. A Reserva Ducke. Pp. 11–20 *in* Oliveira, M. L., Baccaro, F. B., Braga-Neto, R. & Magnusson, W. E. (orgs.) *Reserva Ducke—a biodiversidade amazônica através de uma grade*. Ed. Áttema Design, Manaus.

Cockburn, A. 2006. Prevalence of different modes of parental care. *Proc. Roy. Soc. Lond. Ser. B* 273: 1375–1383.

Gelis, R. A., Greeney, H. F. & Dingle, C. 2006. Cooperative breeding and first nest description for Golden Tanager *Tangara arthus*. *Cotinga* 26: 79–81.

Hilty, S. 2011. Family Thraupidae (tanagers). Pp. 46–329 *in* del Hoyo, J., Elliott, A. & Christie, D. A. (eds.) *Handbook of the bird of the world*, vol. 16. Lynx Edicions, Barcelona.

Isler, M. L. & Isler, P. R. 1999. *The tanagers: natural history, distribution, and identification*. Second edn. Smithsonian Institution Press, Washington DC.

Kirwan, G. M. 2009. Notes on the breeding ecology and seasonality of some Brazilian birds. *Rev. Bras. Orn.* 17: 121–136.

Long, A. J. & Heath, M. F. 1994. Nesting ecology and helping behavior in the Azure-rumped Tanager in Mexico. *Condor* 96: 1095–1099.

Melo, T. N. 2015. Da torre, é só alegria! *Atualidades Orn*. 187: 18–20.

Melo, T. N. & Xavier, R. S. 2016. Description of the nest and parental care of Spotted Tanager *Tangara punctata*. *Bull. Brit. Orn. Cl*. 136: 116–120.

Ocampo, D. & Montoya, A. 2014. Dusky-faced Tanager (*Mitrospingus cassinii*). *In* Schulenberg, T. S. (ed.) Neotropical Birds online. Cornell Lab of Ornithology, Ithaca, NY. http://neotropical.birds.cornell.edu/portal/species/overview?p_p_spp=592396 (accessed June 2017).

Sick, H. 1997. *Ornitologia brasileira*. Ed. Nova Fronteira, Rio de Janeiro.

Simon, J. E. & Pacheco, S. 2005. On the standardization of nest descriptions of Neotropical birds. *Rev. Bras. Orn*. 13: 143–154.

Skutch, A. F. 1954. *Life histories of Central American birds*, pt. 1. Pacific Coast Avifauna 31. Cooper Orn. Soc., Berkeley, CA.

Skutch, A. F. 1961. Helpers among birds. *Condor* 63: 198–226.

Skutch, A. F. 1972. *Studies of tropical American birds*. Publ. Nuttall Orn. Cl. 10. Nuttall Orn. Cl., Cambridge, MA.

Snow, D. W. & Collins, C. T. 1962. Social breeding behavior of Mexican tanager. *Condor* 64: 161.

Willis, E. O. 1961. A study of nesting ant-tanagers in British Honduras. *Condor* 63: 479–503.

*Addresses*: Tomaz Nascimento de Melo, Museu da Amazônia (MUSA), Av. Margarita, s/n°, Cidade de Deus, Manaus, Amazonas, Brazil, e-mail: tomaznmelo@hotmail.com. Renata da Silva Xavier, Escola Estadual de Tempo Integral Bilíngue Professor Djalma da Cunha Batista, Av. General Rodrigo Otávio 1600, 69077-000, Manaus, Amazonas, Brazil, e-mail: renatadasilvaxavier@yahoo.com.br

# Range extension for Wedge-billed Woodcreeper *Glyphorynchus spirurus cuneatus* in north-east Brazil

*by Juan Ruiz-Esparza, André Criscoulo, Patricio A. da Rocha, Raone Beltão-Mendes, Saulo M. Silvestre, Saulo Bomfim, Daniela Pinheiro Bitencurti Ruiz-Esparza & Stephen F. Ferrari*

*Received 13 April 2017; revised 16 July 2017; published 15 September 2017*

*http://zoobank.org/urn:lsid:zoobank.org:pub:46DC77AE-70DD-4997-A9E3-6BB0C54B4FF0*

Wedge-billed Woodcreeper *Glyphorynchus spirurus* is the smallest dendrocolaptid in Brazil. It occurs from Mexico to Bolivia, including Amazonian Brazil and the Atlantic Forest (Sick 1997). Thirteen subspecies are recognised, of which eight occur in Brazil (Piacentini *et al*. 2015). *G. s. cuneatus* is endemic to the east coast of Brazil, in the states of Bahia and Espírito Santo.

On 20 March 2016, a *G. spirurus* (Fig. 1) was trapped in a mist-net at Fazenda Rio Fundo (11°08′07″S, 37°18′43″W), Itaporanga D'Ajuda municipality, Sergipe, Brazil. This private reserve encompasses fragments of forest, with a total area of *c*.800 ha, within a matrix of eucalypt and bamboo plantations, and pasture. Vegetation is typical deciduous Atlantic Forest of coastal *restinga* habitats in Sergipe, growing on sandy soils with a continuous canopy of 5–10 m in height (Beltrão-Mendes *et al*. 2011).

Our record of *G. spirurus* represents an extension of the species' range in eastern Brazil (BirdLife International 2017) by *c*.195 km north (Fig. 2), based on the published literature. However, two previously unpublished specimens for Sergipe are held at the Museu de Zoologia da Universidade de São Paulo (MZUSP 83411–412). These were collected by

Figure 1. Wedge-billed Woodcreeper *Glyphorynchus spirurus cuneatus*, municipality of Itaporanga D'Ajuda, Sergipe, Brazil, March 2016 (Saulo Silvestre)

© 2017 The Authors; Journal compilation © 2017 British Ornithologists' Club ISSN-2513-9894 (Online)

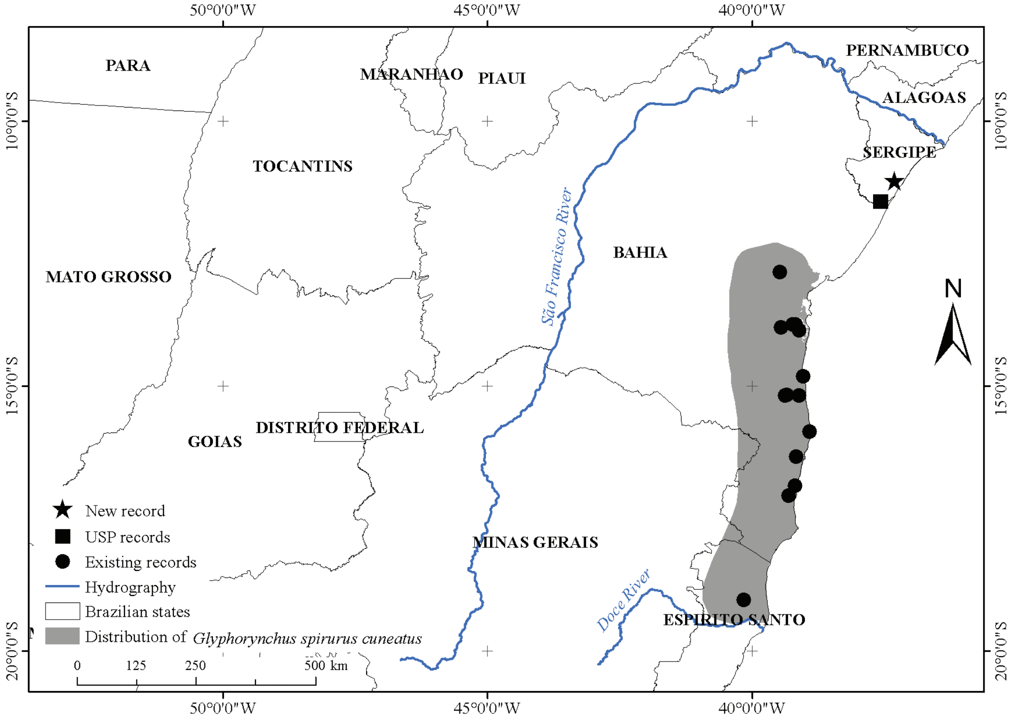


Figure 2. Available localities for Wedge-billed Woodcreeper *Glyphorynchus spirurus cuneatus* in eastern Brazil, including the new record (star) presented here. The range polygon follows BirdLife International (2017).

A. Urben-Filho & F. C. Straube at Fazenda Sabão, Indiaroba municipality (11°31′02″S, 37°34′28″W), on 2 April 2006.

The range extension reported here indicates that *G. s. cuneatus* may occur throughout the coastal Atlantic Forest between northern Espírito Santo and Sergipe, and that the northern and southern limits of its range may coincide with the rios São Francisco and Doce, respectively (Fig. 2). These rivers play a prominent role in the zoogeography of Atlantic Forest vertebrates, e.g. White-shouldered *Pyriglena leucoptera* and Fringe-backed Fire-eyes *P. atra* (Sick 1997) or the primates Coimbra-Filho's Titi *Callicebus coimbrai* and Coastal Black-handed (Southern Bahian) Titi *C. melanochir* (Ferrari *et al*. 2013).

In south-western Amazonia, the range of *Glyphorynchus s. inornatus* is delimited by the rios Aripuanã and Jiparaná (Fernandes *et al*. 2013). However, further research is necessary to define the northernmost limit of the range of *G. s. cuneatus*, including the zoogeographic role of the São Francisco River, given the extensive deforestation that has impacted this region (Marini & Garcia 2005, Olmos 2005, Silveira & Straube 2008,, Hilário *et al*. 2017).

## Acknowledgements

We are grateful to CNPq for research grants to JRE (402582/2015-2), RB-M (503372/2014-5) and SFF (303994/2011-8, 483220/2013-2). We also thank Dr Luis F. Silveira and Marcelo Félix for providing information concerning the specimens held at the Museu de Zoologia da Universidade de São Paulo.

References:

Beltrão-Mendes, R., Cunha, A. A. & Ferrari, S. F. 2011. New localities and perspectives on the sympatry between two endangered primates (*Callicebus coimbrai* and *Cebus xanthosternos*) in northeastern Brazil. *Mammalia* 75: 103–105.

BirdLife International. 2017. Species factsheet: *Glyphorynchus spirurus*. http://datazone.birdlife.org/ (accessed 15 March 2017).

Fernandes, A. M., Gonzales, J., Wink, M. & Aleixo, A. 2013. Multilocus phylogeography of the Wedge-billed Woodcreeper *Glyphorynchus spirurus* (Aves, Furnariidae) in lowland Amazonia: widespread cryptic diversity and paraphyly reveal a complex diversification pattern. *Mol. Phyl. & Evol*. 66: 270–282.

Ferrari, S. F., Santos Junior, E., Freitas, E., Fontes, I., Souza-Alves, J. P., Jerusalinsky, L., Beltrão-Mendes, R., Chagas, R. R. D., Hilario, R. & Baião, S. A. A. 2013. Living on the edge: habitat fragmentation at the interface of the semi-arid zone in the Brazilian northeast. Pp. 121–135 *in* Marsh, L. K. & Chapman, C. A. (eds.) *Primates in fragments: complexity and resilience*. Springer-Verlag, New York.

Hilário, R. R., Jerusalinsky, L., Santos, S. Beltrão-Mendes, R. & Ferrari, S. F. 2017. A primate at risk in northeast Brazil: local extinctions of Coimbra Filho's titi (*Callicebus coimbrai*). *Primates* 58: 343–352.

Marini, M. Â. & Garcia, F. I. 2005. Conservação de aves no Brasil. *Megadiversidade* 1: 96–102.

Olmos, F. 2005. Aves ameaçadas, prioridades e políticas de conservação no Brasil. *Natureza & Conservação* 3: 21–42.

Piacentini, V. Q., Aleixo, A., Agne, C. E., Maurício, G. N., Pacheco, J. F., Bravo, G. A., Brito, G. R. R., Naka, L. N., Olmos, F., Posso, S., Silveira, L. F., Betini, G. S., Carrano, E., Franz, I., Lees, A. C., Lima, L. M., Pioli, D., Schunck, F., Amaral, F. R., Bencke, G. A., Cohn-Haft, M., Figueiredo, L. F. A., Straube, F. C. & Cesari, E. 2015. Annotated checklist of the birds of Brazil by the Brazilian Ornithological Records Committee. *Rev. Bras. Orn*. 23: 91–298.

Sick, H. 1997. *Ornitologia brasileira*. Ed. Nova Fronteira, Rio de Janeiro.

Silveira, L. F. & Straube, F. C. 2008. Aves ameaçadas de extinção no Brasil. Pp 379–678 in Machado, A. B., Drummond, G. M. & Paglia, A. P. (eds.) *Livro vermelho da fauna brasileira ameaçada de extinção*. Ministério do Meio Ambiente, Brasília.

*Addresses*: Juan Ruiz-Esparza, Núcleo de Educação e Ciências Agrárias, Univ. Federal de Sergipe, Campus do Sertão, Rodovia Engenheiro Jorge Neto, km 3, Silos, 49680-000, Nossa Senhora da Glória, Brazil, e-mail: juancolorado21@hotmail.com. André Criscoulo, Dept. of Ecology, Univ. Federal de Sergipe, Av. Marechal Rondon s/n, 49100-000, São Cristóvão, Brazil. Patricio A. da Rocha, Graduate Program in Biological Sciences, Laboratory of Mammalian Studies, Univ. Federal da Paraíba, Centro de Ciências Exatas e da Natureza, Campus I, Castelo Branco, 58051900, João Pessoa, Brazil. Raone Beltrão-Mendes, Dept. of Ecology, Univ. Federal de Sergipe, Av. Marechal Rondon s/n, 49100-000, São Cristóvão, Brazil. Saulo Meneses Silvestre de Sousa, Graduate Program in Tropical Biodiversity, Univ. Federal do Amapá, Rod. Juscelino Kubitschek, km 2 Jardim Marco Zero, 68.903-419, Macapá, Brazil. Saulo Bomfim, Dept. of Ecology, Univ. Federal de Sergipe, Av. Marechal Rondon s/n, 49100-000, São Cristóvão, Brazil. Daniela Pinheiro Bitencurti Ruiz-Esparza, Nucleus of Education in Agricultural and Earth Sciences, Univ. Federal de Sergipe, Campus do Sertão, Rodovia Engenheiro Jorge Neto, km 3, Silos, 49680-000, Nossa Senhora da Glória, Brazil. Stephen F. Ferrari, Dept. of Ecology, Univ. Federal de Sergipe, Av. Marechal Rondon s/n, 49100-000, São Cristóvão, Brazil.

**BOC Office**
c/o Natural History Museum at Tring,
Akeman Street, Tring, Herts. HP23 6AP, UK
E-mail: info@boc-online.org
Tel. +44 (0)208 8764728 / 07919174898

## Friends of the BOC

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

Barclays Bank
16 High Street
Holt, NR25 6BQ
Norfolk
Sort Code: 20-45-45
Account number: 53092003
Account name: The British Ornithologists' Club

Friends receive regular updates about Club events and are also eligible for discounts on the Club's Occasional Publications.

It would assist our Treasurer, Richard Malin (e-mail: rmalin21@gmail.com), if you would kindly inform him if you intend becoming a Friend of the BOC.

## The *Bulletin* and other BOC publications

From the current volume, 137 (2017), the *Bulletin* of the BOC has become an online journal, published quarterly, that is available to all readers without charge. Furthermore, it does not levy any publication charges (including for colour plates) on authors of papers and has a median publication time from receipt to publication of six months. Prospective authors are invited to contact the *Bulletin* editor, Guy Kirwan (GMKirwan@aol.com), to discuss prospective submissions or look at http://boc-online.org/bulletin/bulletin-contributions. Back numbers up to volume 131 (2011) are available via the Biodiversity Heritage Library website: www.biodiversitylibrary.org/bibliography/46639#/summary; vols. 132–136 will shortly be available on the BOC website: http://boc-online.org/

BOC Occasional Publications are available from the BOC Office or online at info@boc-online.org. Future BOC-published checklists will be available from NHBS and as advised on the BOC website.

**Trustees**

C. W. R. Storey (*Chairman*) (2016)
N. J. Redman (*Vice-Chairman*) (2016)
Dr R. P. Prŷs-Jones (*Hon. Secretary*) (2016)
R. W. Malin (*Hon. Treasurer*) (2016)
S. Chapman (2016)
Dr A. Simmons (2016)
H. M. J. Earp (2016)

**Ex-officio Members**
*Hon. Editor*: Guy M. Kirwan (1 January 2004)
*BOC Checklist Editor*: Dr D. R. Wells

Back numbers (vols. 132–136) will shortly be available on the BOC website: http://boc-online.org/. Earlier issues can be accessed via the Biodiversity Heritage Library (BHL) website: www.biodiversitylibrary.org/bibliography/46639#/summary; as its online repository, the BOC uses the British Library Online Archive (in accordance with IZCN 1999, Art. 8.5.3.1).

**Registered Charity No. 1169733**

**Bulletin of the British Ornithologists' Club**
ISSN 2513-9894 (Online)
**Edited by Guy M. Kirwan**
**Associate Editors: Frank D. Steinheimer; Robert Prŷs-Jones**
Volume 137 Number 3, pages 160–243

## CONTENTS

**EDITORIAL BOARD**
Bruce M. Beehler, Murray Bruce, R. T. Chesser, Edward C. Dickinson, Françoise Dowsett-Lemaire, Steven M. S. Gregory, José Fernando Pacheco, Robert B. Payne, Pamela C. Rasmussen, Cees Roselaar, Thomas S. Schulenberg, Lars Svensson

Registered Charity No. 1169733
**www.boc-online.org**

Published by the British Ornithologists' Club
Typeset by Eng-Li Green, New Mexico, USA