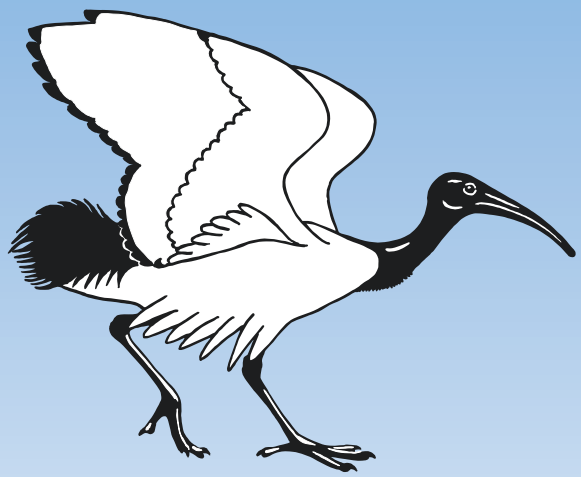
Bulletin of the British Ornithologists' Club



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CLUB ANNOUNCEMENTS

Chairman's Message

At the beginning of 2017 *Bull. Brit. Orn. Cl.* became an online open-access journal carried on the BOC website with the intention of moving in 2018 to the BioOne platform. This first number of the new volume (Vol. 138, No. 1, March 2018) and all subsequent numbers will appear on the BioOne site, where you will also find the previous volume, 137. We look forward very much to working with the BioOne team in establishing a strong web presence, for the benefit both of readers of the Bulletin and authors and potential authors. The recent Newsletter (No. 9) spells out in greater detail the service provided by BioOne. Please let us have any comments and suggestions about these new arrangements.

In addition to our online presence and Newsletters, we continue to meet regularly as a Club and during 2018 we shall have four 'Barley Mow' meetings plus a joint two-day meeting in Liverpool with the Society for the History of Natural History. I hope you will have seen the published details and will join us for what promises to be a stimulating and enjoyable event.

The Annual Review Meeting of the Club will be held in the upstairs room at the Barley Mow, 104 Horseferry Road, Westminster, London SW1P 2EE, at 5.30 pm on Monday 21 May 2018, Papers for the meeting including the financial report and accounts will be issued shortly. The Review Meeting will be followed at 6.30 pm by Dr Bård Stokke's talk on *Host selection by the Common Cuckoo*.

Chris Storey

The 988th meeting of the Club was held on Monday 6 November 2017 in the upstairs room at the Barley Mow, 104 Horseferry Road, Westminster, London SW1P 2EE.

Fifteen friends were recorded as present and three visitors. Friends attending were Miss H. Baker, Cdr. M. B. Casement, Mr S. Chapman, Mr M. Earp, Dr C. F. Mann, Mr D. J. Montier, Mr R. Langley, Mr D. Prŷs-Jones, Dr R. Prŷs-Jones, Dr P. Rudge, Dr D. G. D. Russell, Dr A. Simmons, Mr S. A. H. Statham, Mr C. W. R. Storey (*Chairman*) and Mr P. Wilkinson.

Visitors attending were Mr M. P. Adams, Mr G. de Silva and Dr C. Spottiswoode (*Speaker*).

Dr Claire Spottiswoode gave a talk entitled *Cuckoos vs. hosts: an African perspective*. She discussed 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 she had studied in the field in Zambia: cuckoos, honeyguides and parasitic finches (especially Cuckoo-finch *Anomalospiza imberbis*). First she described how co-evolution can escalate to shape sophisticated signals of identity, leading to a race between host egg 'signatures' and parasitic egg 'forgeries'. Then how co-evolution can shape ancient genetic specialisation within a single species, allowing the evolution of parasitic 'gentes'. The research she described comes from a mixture of field experiments facilitated by a large team of Zambian nest-finders, and museum work enabled by the remarkable egg collection of the late Major John Colebrook-Robjent.

OBITUARIES

Michael Patrick Stuart Irwin (1925–2017)

Michael Irwin died in Norfolk on 13 September 2017. He was well known to all with an interest in African ornithology, particularly that of the southern third of the continent. In the 1960s and 1970s in East Africa he was referred to with great reverence as 'Stuart-Irwin' or 'MPSI'.

Michael Irwin (Julia Duprée)

Of Ulster-Scottish parentage, he was born in Co. Down on 1 July 1925, and took an early interest in natural history, particularly in beetles. He joined the army, serving in the Royal Inniskilling Fusiliers in the latter half of WWII, and later in India and the Far East. He travelled to Cape Town, where he found no outlet for his interest in museum work, and in April 1949 he arrived in Southern Rhodesia (now Zimbabwe) where he had various jobs, including a spell with Rhodesia Railways. His posts had no connection with natural history but did allow him time to explore the bush

and its denizens. He began to concentrate on birds and became involved with the (now) Natural History Museum of Zimbabwe at Bulawayo. Although lacking academic qualifications, in 1959 he was appointed Assistant Keeper of Vertebrates, then Keeper (later Curator) of Birds, and from 1975 to 1983, Regional Director. During his time at the museum he built up the bird collection to become the largest in Africa.

To study birds he also travelled widely in southern Africa and as far north as Kenya. His publications, the first being a short note in 1950, are in excess of 300. These include *Birds of Zambia*, *Birds of Zimbabwe* and many species accounts in the multi-volume *Birds of Africa*. From 1983 to 2006 he was the editor of the highly respected *Honeyguide*, the journal of Zimbabwean and regional ornithology.

Although considering himself a 'social loner' many benefitted from his encouragement and friendship, and he took great care to ensure that his knowledge and ideas were understood and disseminated to those who showed interest. One friend, Julia Duprée, has written 'He was a gentleman with a big heart—totally natural, kind, caring, supportive, lively and with a lovely sense of humour. His depth of knowledge was boundless and his enthusiasm, particularly in all things to do with birds and nature, infectious.'

He was awarded the Gill Memorial Medal by the Southern African Ornithological Society in 1984 for his 'years of dedicated service to the cause of Afrotropical ornithology'.

In the mid 1970s I became involved in a three-way correspondence with Michael and Con Benson on the relationship of the 'bulbul' *Phyllastrephus orostruthus*, as I had field and in-hand experience of this species, and about 30 other species of bulbul. We concluded that it was not a member of the Pycnonotidae. In 1986 Michael and Phillip Clancey erected a new genus, *Arcanator*, to accommodate it. We later discussed its relationships with two other recalcitrant monotypic genera of which I had experience, *Modulatrix* and *Kakamega*. Today these three genera are accepted as having their own family or subfamily, Modulatrichidae / Modulatrichinae.

In the 1990s he and I overlapped for a few days at Tring. He kindly devoted much of his valuable time to discussing sunbird taxonomy with me, particularly generic placings.

In May 2012 Michael moved to Norfolk to live with relatives, and in September of that year moved to sheltered accommodation in Litcham, Norfolk, where he lived an independent life until his final fall which led to medical complications. On 5 October 2017 Michael was buried in Litcham, Norfolk, although he would have preferred to be left in a safari park for the lions!

Michael was pre-deceased by his wives Beverley, and later Nancy, and leaves one biological son, Tony, who described him as a 'great father'.

I am grateful to Michael's son Tony for various items of information, to Robert Prŷs-Jones for assistance, and to Robert Dowsett for allowing me sight of his obituary of Michael to be published in *Ibis*.

Clive Mann

Michael Patrick Walters (1942–2017)

Michael P. Walters, a curator in the Bird Group at the Natural History Museum, Tring, for more than 32 years, was born in Portrush, a small seaside town on the north coast of Co. Antrim in Ireland on 5 November 1942, the only son of Patrick & Lyndsay Walters. His father, who came from Dublin, was a sergeant in the North Irish Horse, billeted in Portrush during the war where he met and married Lyndsay MacMurray in June 1941. He was tragically killed 17 months later on active service during the Tunisian campaign in North Africa. Consequently, his mother brought Michael up alone whilst also supporting her sick aunt, Maud Macbeth. Lyndsay Walters was an active and well-known figure in Portrush, an amateur actress with the Portrush Players and the Ballywillan Drama Group, as well as being an artist and potter; this backdrop in theatre and art was undoubtedly a major influence on Michael's later life.

Michael Walters (Harry Taylor © The Trustees of the Natural History Museum, London)

Michael attended the Friends' School Lisburn as a border, and his first foray into ornithological publishing was a tongue-in-cheek article for the school magazine. This short, rather grandiose account of his visit to the now demolished old Parrot House at London Zoo, and the destruction of his pen by cockatoos, is somewhat typical of Michael's dry wit and unashamedly ostentatious take on life. The Friends' School then had a very strong natural history society, and Michael was certainly greatly influenced by Arnold Benington (1903–82). An ornithologist and enthusiastic teacher at the school between 1927 and 1967, who devoted his life to the study of birds, Bennington was the mentor of many at the school and helped establish the Copeland Bird Observatory.

On leaving school Michael took a job in the civil service as a clerk, working first in Belfast and then London. Having been interested in birds from an early age, Michael joined the British Ornithologists' Union in 1964 and the British Ornithologists' Club in 1969. It was at BOU meetings he met the pioneering ornithologist Reginald Ernest Moreau (1897–1970), who encouraged him to consider pursuing a career in ornithology despite his lack of formal qualifications. Moreau recommended Michael to David William Snow (1924–2009), then Head of the Sub-department of Ornithology at the Natural History Museum (now

NHMUK), and consequently in September 1970, at the age of 27, Michael finally achieved his long-held ambition of joining the bird staff at South Kensington. Much of his first two years at the museum was spent packing up the bird collections, which were being moved to the out-station at Tring. Colin Harrison (1926–2003), then responsible for the birds' eggs and nests in the NHMUK collection, readily delegated responsibility for their curation to Michael, and this was to become his specialism after he transferred to Tring in February 1972, slightly later than other members of staff.

Michael worked as a curator and ornithologist, mainly on the egg collections, for the majority of his career. His main personal interests were eggs and historical ornithology, but he also contributed to the curation of other areas of the ornithology collections, especially the type collection of skins. His former colleague, Alan Knox, even recalled that when a large number of frozen birds urgently needed preparation as skins, Michael, who had then never skinned a bird and wasn't all that keen on getting his hands inside the corpses, conscientiously put his head down and quietly got on with it, though he was 'all thumbs' to begin with.

Michael was not an avid birder or field ornithologist later in life, but in his younger years he did take part in Operation Seafarer (1968–71), when he counted Northern Fulmars *Fulmarus glacialis* and Black-legged Kittiwakes *Rissa tridactyla* along a stretch of coast south of Aberdeen. He was at heart a museum ornithologist and over the course of 50 years published nearly 100 papers, abstracts and notes on a wide variety of topics. These ranged from the standard ornithological, e.g. his description of eggs of Coral-billed Ground-cuckoo *Carpococcyx renauldi*, to his more idiosyncratic notes, e.g. on the curing of warts by the application of potato. Likewise his lifelong interest in cryptozoology led to him joining the editorial board for *Cryptozoology*—the interdisciplinary journal of the International Society of Cryptozoology—from 1992 to 1998. His enduring interest in extinct bird species was first piqued by Walter Rothschild's (1907) *Extinct birds* and made him a very appropriate choice to co-author, with Alan Knox, a 1994 monograph on extinct and endangered bird specimens in the NHMUK collections. His extended notes on the subject were subsequently used as a basis for the wider and very well-received 2012 monograph *Extinct birds*, co-authored with Julian P. Hume.

Michael was an impassioned and remarkably colourful character, whose detailed knowledge of eggs and the history of ornithology was equalled by his enthusiasm for theatre and world-renowned expertise on the lives and works of Gilbert & Sullivan; he was publisher and editor of his own newsletter, *Gilbertian Gossip*, for many years from 1975. He was an avid amateur performer of musical theatre and Shakespeare in Richmond, where he lived, and a somewhat biting critic. As Marc Sheppard, his co-author on the ongoing, definitive, *Variorum Gilbert & Sullivan,* wrote in his November 2017 obituary in *The Palace Peeper*, published by the Gilbert & Sullivan Society of New York, 'his blunt opinions weren't always appreciated', and this is undoubtedly equally true for his life in ornithology. His interactions with some of his colleagues were now and then tempestuous, not least because he did not easily accept criticism himself, and he tended to work in isolation; by his own admission he occasionally made curatorial decisions that, with the benefit of hindsight, he clearly regretted. There are few careers like being a museum curator for introspection—alongside the best of our efforts we inevitably leave a legacy that subsequent generations question and fault without necessarily understanding the context of decisions. Ultimately, the three decades that Michael dedicated to eggs in the NHMUK resulted in an impressively well-ordered and catalogued main collection, but also a residue of an array of important unincorporated collections he had taken on for NHMUK but had lacked time to curate. Overall, the NHMUK egg collection stands as one of the two largest in the world and the most comprehensive in terms of species richness.

I was fortunate to have the opportunity of spending valuable time learning about curation of the NHMUK egg collection from Michael before he retired in May 2003, and he continued a level of involvement with the Bird Group for nearly a decade subsequently as a Scientific Associate, initially working on type specimens supported by a Leverhulme Emeritus Fellowship. As well as his curation, Michael leaves a legacy of numerous scientific papers and much important academic research on the Victorian theatre. His ornithological books include *The complete birds of the world* (1980), the popular *Eyewitness Handbook: Birds eggs* (1994), *Extinct and Endangered birds in the collections of the Natural History Museum* (1994, co-authored with Alan Knox), *A concise history of ornithology* (2003), in which his fascination with historical ornithology and taxonomy are given full rein, and *Extinct birds* (2012, co-authored with Julian Hume).

Michael retired to the family home in Portrush he had known as a child, which sadly somewhat isolated him from the bird and theatre worlds he had previously enjoyed. Here, his life-long routine of reading, commenting and wry observation continued, despite growing ill heath, and he died peacefully in hospital on Sunday 22 October 2017 at the age of 74. He titled his short 2005 autobiography in *Zoologische Mededelingen* 'My life with eggs' and it is assuredly with eggs he will forever be associated and remembered. His funeral was held at Roselawn Crematorium, Belfast, on Friday 27 October.

I am grateful to Michael's former colleagues and friends, especially Alan Knox, Robert Prŷs-Jones, Revd. Selwyn Tillett and Arthur G. Chapman, Joanne McGaffin and colleagues at Friends' School Lisburn, and John Stanage for their help. A fuller, focused account of Michael's contribution to theatre and Gilbert & Sullivan scholarship, authored by Marc Shepherd and Selwyn Tillett, will be published in *Gilbert and Sullivan News* in 2018.

Douglas G. D. Russell

David John Pearson (1941–2017)

Ornithology, and particularly African ornithology, lost a modest giant when David John Pearson died on 20 September 2017. By profession a biochemist, David was by avocation one of the finest ornithologists of his generation; his signature contribution was the long-term investigation of a major migration route of Palearctic passerines through the Ngulia Hills of southern Kenya in midwinter, long after the species involved would have reached the tropics. His first paper on this (Pearson & Backhurst 1976) described 'very large falls' of migrants attracted to the bright lights of the Ngulia Safari Lodge, especially on rainy or misty nights. Remarkably, ringing activities at this site have continued ever since, enormously increasing knowledge of migration of Palearctic and African passerines.

David Pearson was born 26 January 1941 in Bedford, his family moving to Suffolk in 1947; David returned here after he retired and was active in local bird-ringing, as he had been when on leave throughout his time in Africa. He studied biochemistry at Cambridge (Ph.D. 1965) before moving to Uganda to teach at Makerere University College, where he published several bird papers on wintering Palearctic migrants.

From 1970 to 1990 he lectured in biochemistry at the University of Nairobi; it was there that I knew him during my time in the Zoology Department of the Chiromo campus (1976–80). David introduced me to several birding sites and to other local ornithologists, and we both contributed to the *Birds of East Africa* (Britton *et al*. 1980); at regular meetings of co-authors working on the book, David's detailed technical knowledge of the East African avifauna was delivered with calm authority.

I recall sharing only two field trips with David. On one to the Kenya coast to mist-net migrants I was introduced to many identification subtleties, notably of *Acrocephalus* species and subspecies, which demonstrated the depth of his knowledge and his eagerness to share it. His abiding interest in disentangling the taxonomic affinities of the many warblers of several genera wintering in East Africa is evident in his numerous publications in this area (e.g., Pearson & Backhurst 1988, Pearson 1989). On the other occasion, we visited a nearby sewage works at Kariobangi where he had sorted out the breeding origins of confusingly yellow-headed Yellow Wagtails *Motacilla flava* (Pearson & Backhurst 1973); we mist-netted through the morning and as he predicted, both fat scores and body mass increased detectably over a few hours as the wagtails gorged on the abundant insect fauna of a tropical sewage farm.

David published more than 150 scientific papers, the great majority on birds, and most of those from East Africa, many long after he had retired, but his regular visits home on leave, and his time at Cambridge, yielded a number on British birds too; his abiding interests in moult and Bearded Tits *Panurus biarmicus* were combined in an early paper in *Bird Study* (Pearson 1975). He also co-authored several monographs including *Reed and Bush Warblers* (2010) with Peter Kennerley, *Birds of Kenya and northern Tanzania* (1996) with Dale Zimmerman and Don Turner, and he contributed particularly extensively to vol. 8 of *The birds of Africa*.

David leaves his wife of 53 years, Maggie, two daughters, and many friends and colleagues who mourn his passing but are grateful for his enormous personal and professional contributions.

I thank Graeme Backhurst and Robert Prŷs-Jones for help in preparing this tribute.

A. W. (Tony) Diamond

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FORTHCOMING MEETINGS

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

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

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

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

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

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

Monday 21 May—6.30 pm—Dr Bård G. Stokke—*Host selection by the Common Cuckoo*

Abstract.—The Common Cuckoo *Cuculus canorus* is a generalist parasite at the species level, known to have utilised more than 100 host species in Europe alone. However, in general individual females are host specific, utilising and often mimicking the eggs of a particular host species. This talk will focus on the spatial variation in host use in Europe, and I will discuss characteristics that are important for parasite utilisation of passerine hosts. The research and results that will be described stem mostly from a thorough search for cuckoo parasitism events throughout Europe, which has so far resulted in c.65,000 cases of parasitism.

Biography.—Bård Stokke works in part as a researcher in the AfricanBioServices project at the Norwegian University of Science and Technology (NTNU), Trondheim, and also as a research professor at the Norwegian Institute for Nature Research (NINA), Trondheim. He was awarded his Ph.D. on avian brood parasitism at NTNU in 2001. Bård has studied co-evolution between brood parasites and hosts extensively both in Asia and Europe for 20 years. He is a co-author of the recently published book *The Cuckoo – the uninvited guest* (Wild Nature Press, Plymouth, 2017), which so far has appeared in Dutch, English, French and German editions.

Thursday 14 and Friday 15 June—Joint two-day meeting in Liverpool with the Society for the History of Natural History (SHNH) on the subject *Bon voyage? 250 years exploring the natural world*. Please note that there will be a registration fee for this meeting and prior booking is **essential**. Participants can register for either one or both days, and there is a discount for SHNH and BOC members and friends. A full provisional programme of 24 talks, together with a link to the booking form, can be found at: http://shnh.org.uk/news/registration-open-bon-voyage-250-years-exploring-natural-world/. Linked to the conference, a guided tour of Knowsley Hall, the ancestral home of the Stanley family (Earls of Derby), has also been arranged for Wednesday 13 June (leaving 12 noon from Liverpool city centre). If interested, prior booking and payment for this via the booking form is also **essential**.

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 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 are available on the BOC website: http://boc-online.org/

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

Range extensions for Yellow-crowned Elaenia *Myiopagis flavivertex* and Dugand's Antwren *Herpsilochmus dugandi* in eastern Colombia

by Wilmer A. Ramírez, César Arredondo, Ramón Carillo López, Andrea Lopera-Salazar & Sergio Chaparro-Herrera

Received 5 May 2017; revised 27 October 2017; published 22 March 2018

http://zoobank.org/urn:lsid:zoobank.org:pub:3BBB1B7F-849E-44E7-86BB-E9C5279A980D

Summary.—We present new records of two poorly known species in eastern Colombia. Yellow-crowned Elaenia *Myiopagis flavivertex*, previously known in Colombia from a single record in the Inírida region, was recorded in dptos. Meta and Guaviare. Dugand's Antwren *Herpsilochmus dugandi* was recorded in dpto. Guaviare, representing the species' northernmost limit in Amazonia. These records underscore the importance of further inventories of the poorly known eastern part of Colombia.

Several decades of armed conflict in Colombia have partially limited ornithological exploration of various regions, and the ecology, abundance and distributions of birds are not well known in more remote regions of the country, e.g. Guainía, Vaupés, southern Meta and Guaviare (Stiles 2010, Ruíz-Ovalle & Chaparro-Herrera 2015, Stiles & Beckers 2015). However, despite the challenges, dogged efforts by some researchers have documented new species for science (e.g., Chiribiquete Emerald *Chlorostilbon olivaresi*; Stiles 1996), new country records (e.g., Rose-breasted Chat *Granatellus pelzelni*, Yellow-crowned Elaenia *Myiopagis flavivertex*, Subtropical Pygmy Owl *Glaucidium parkeri*, Rufous-headed Woodpecker *Celeus spectabilis*; P. Flórez *in* Kirwan *et al*. 2013, Acevedo-Charry *et al*. 2015, Carantón *et al*. 2016, Flórez & Kirwan 2017) and substantial ranges extensions (Cadena *et al*. 2000, Stiles 2010, Álvarez *et al*. 2013, Stiles & Beckers 2015, Gómez-Bernal *et al*. 2016, Ramírez *et al*. in press).

As result of several expedition to eastern Colombia (southern Meta and northern Guaviare) in 2014–17 we present records of two species—*Myiopagis flavivertex* and Dugand's Antwren *Herpsilochmus dugandi*—that substantially extend their known ranges in the country.

Yellow-crowned Elaenia *Myiopagis flavivertex*

This local species is distributed in the Guianas, north-east and southern Venezuela, Amazonian Brazil, north-east Ecuador and east Peru. In Colombia it is known only from north-east Guainía, in the municipality of Inírida near the border with Venezuela (Hilty & Brown 1986, Hilty 2003, Fitzpatrick 2004b, Flórez & Kirwan 2017) (Fig. 1).

We present nine additional records in Colombia, all in the understorey of *várzea* forest. On 12 October 2014 one was observed for *c*.10 minutes moving low down (*c*.1 m above ground) near the Guaviare River (02°35'N, 72°39'W, 200 m), at Playa Nueva, municipality of Puerto Concordia, dpto. Meta (WAR), with further observations in the same area on 16 January 2016 and 22 January 2016 (WAR, CA). On 22 December 2015, two were observed for *c*.10 minutes near Laguna María (02°33'N, 72°39'W, 180 m) at Buena Vista II, municipality of San José del Guaviare (WAR, CA). On 11 January 2016, an individual was observed for

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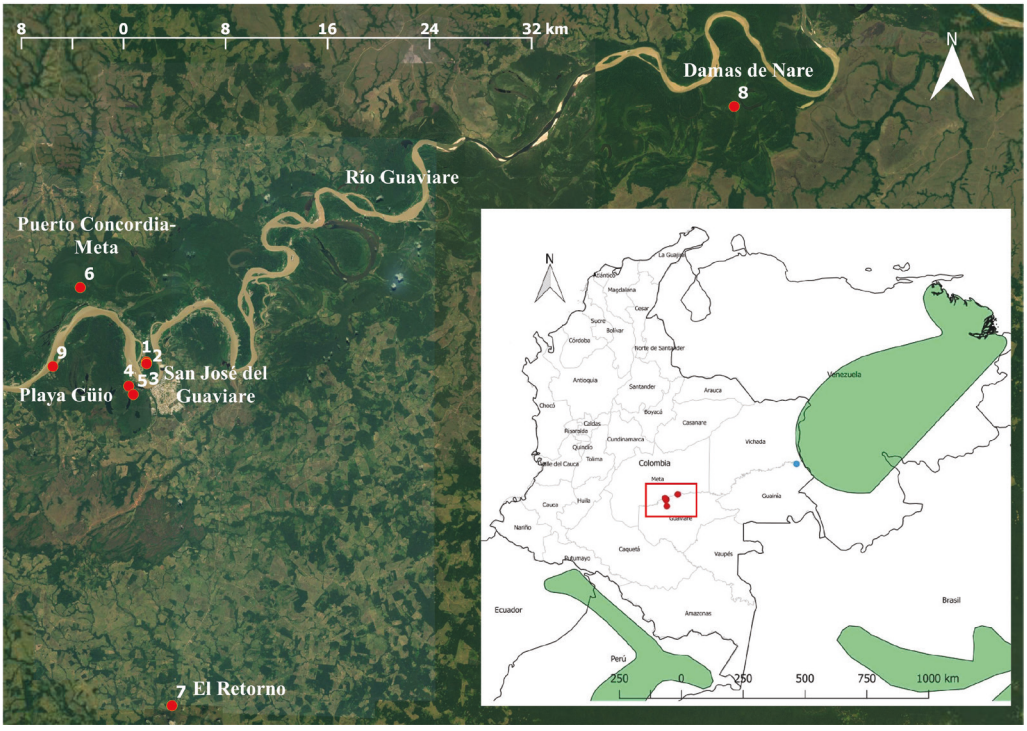

Figure 1. New records of Yellow-crowned Elaenia *Myiopagis flavivertex* in Colombia, in dptos. Guaviare and Meta (red spots), and the species' range in surrounding countries *per* BirdLife International (2017; green). Blue spot = only previous known locality in Colombia, in municipality of Inírida, dpto. Guainía. Records: 1–3 and 6: Puerto Concordia (Meta); 4–5: Buena Vista II; 7: El Retorno, 8: Damas de Nare, 9: Playa Güio.

c.5 minutes near Kioscos Lagoon, Buena Vista II, vocalising in response to playback (WAR, CA, RC). On 31 January 2016, two were observed for *c*.15 minutes beside Caño Grande at Jordán Bajo, municipality of El Retorno, dpto. Guaviare (02°20'N, 72°37'W, 200 m), and the vocalisations of one were recorded (www.xeno-canto.org/367853) (WAR, CA). On 28 December 2016, one was observed at Damas de Nare, municipality of San José del Guaviare (02°45'N, 72°14'W, 185 m) (CA). On 14 January 2017, an individual vocalised several times near the Guaviare River, at Playa Alta, municipality of Puerto Concordia, dpto. Meta (02°37'N, 72°40'W, 180 m) (WAR, CA; Fig. 2). Finally on 22 July 2017, one was observed at Playa Güio (02°34'N, 72°42'W, 180 m), near a transitional lagoon, and responded to playback by approaching the source (WAR, SCH, ALS). It was accompanied by Green-backed Trogon *Trogon viridis*, White-chinned Jacamar *Galbula tombacea*, Speckled Spinetail *Cranioleuca gutturata*, Buff-throated Woodcreeper *Xiphorhynchus guttatus* and Dugand's Antwren *Herpsilochmus dugandi*. These records extend its distribution 495 km west in Colombian Amazonia.

The species was differentiated from similar taxa in the region, such as Forest Elaenia *M. gaimardii* or Euler's Flycatcher *Lathrotriccus euleri*, mainly using vocalisations and plumage, respectively. *M. gaimardii* produces a short, upward-inflected disyllabic *pitchueeet*, typically as isolated calls or separated by intervals of 30+ seconds (Fitzpatrick 2004a), while *M. flavivertex* makes a distinctive, loud *jéw, jee-jee-jew* or *wéécheché-e-e-e* (Fitzpatrick 2004b; www.xeno-canto.org/367853, www.xeno-canto.org/365007). *L. euleri* vocalises similarly to *M. flavivertex* (www.xeno-canto.org/122356) but its plumage is quite different (see Farnsworth & Lebbin 2004).

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Figure 2. Yellow-crowned Elaenia *Myiopagis flavivertex*, Playa Alta, municipality of Puerto Concordia, dpto. Meta, Colombia, January 2017 (Wilmer A. Ramírez)

Dugand's Antwren *Herpsilochmus dugandi*

Occurs in *várzea* and *terra firme* forests in eastern Ecuador, north-east Peru (north of the Marañón River and in Amazonas) and in extreme southern Colombia, where recorded in south-west Caquetá (south-west of Florencia), western Putumayo, and at Leticia in south-east Amazonas (Ridgely & Tudor 1994, Zimmer & Isler 2003).

We present seven new records for the country, all in *várzea* forest in the municipality of San José del Guaviare, dpto. Guaviare. On 8 December 2015, two were observed close to Caño Negro at Buena Vista II (02°34'N, 72°40'W, 194 m) (WAR), with three observed there (WAR, RC, CA) and sound-recorded in response to playback (www.xeno-canto.org/367857) on 3 January 2016, and a female photographed in July 2016 (WAR; Fig. 4) within a mixed-species flock that also included Fork-tailed Woodnymph *Thalurania furcata*, *Cranioleuca gutturata*, Orange-eyed Flycatcher *Tolmomyias traylori*, Small-billed Elaenia *Elaenia parvirostris*, Blackish-grey Antshrike *Thamnophilus nigrocinereus* and Silver-beaked Tanager *Ramphocelus carbo*. On 11 January 2016, one was observed (WAR, RC, CA) calling near Kioscos Lagoon, at Buena Vista II (02°33'N, 72°39'W, 185 m) and in the same place, on 23 January 2016, one was observed (WAR) within a mixed-species flock that also included Velvet-fronted Grackle *Lampropsar tanagrinus*, White-flanked Antwren *Myrmotherula axillaris* and Black-fronted Nunbird *Monasa nigrifrons*. On 3 January 2016, at Los Cambulos, an individual was observed (WAR, RC, CA) near La Rompida Lagoon (02°38'N, 72°31'W, 190 m). Finally, on 22 July 2017, a female was observed at Playa Güio (02°34'N, 72°42'W, 180 m) (see also *M. flavivertex*) (WAR, SCH, ALS). These records extend the species' range by *c*.360 km to north-central Amazonian Colombia (Fig. 3) and are among the few records in Colombia far from the east slope of the East Andes (in addition to those at Leticia and in south-east Caquetá, which localities are 711 km and 318 km distant, respectively, from our records).

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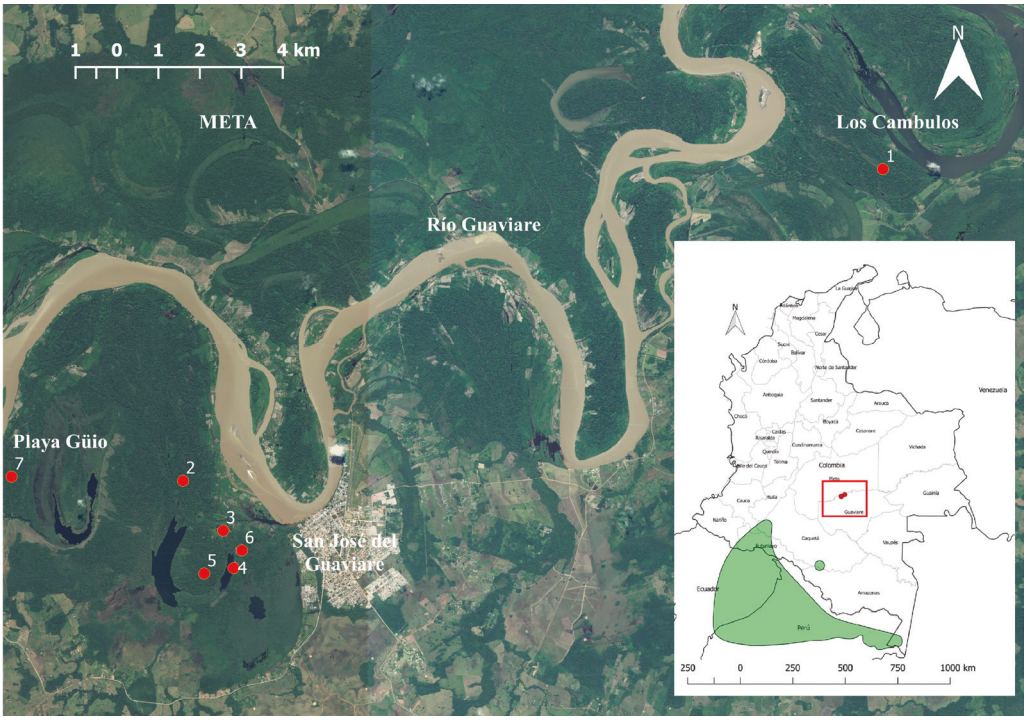

Figure 3. New records of Dugand's Antwren *Herpsilochmus dugandi* in Colombia, in dpto. Guaviare (red spots), and the species' range in surrounding countries *per* BirdLife International (2017; green). Records: 1: Los Cambulos, 2–6: Buena Vista II, 7: Playa Güio.

Figure 4. Female Dugand's Antwren *Herpsilochmus dugandi*, near Caño Negro, Buena Vista II, municipality of San José del Guaviare, dpto. Guaviare, Colombia, July 2016 (Wilmer A. Ramírez)

The species was identified by its vocalisations and plumage differences, especially in females, from Spot-backed Antwren *H. dorsimaculatus*. The latter species has similar plumage but differs vocally, and has recently been recorded in both Vaupés and Guainía

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(Stiles & Beckers 2015; www.xeno-canto.org/81761) making its presence in Guaviare plausible, and increasing the risk of possible confusion with *H. dugandi* (J. E. Avendaño pers. comm.).

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Streptopelia risoria and how Linnaeus had the last laugh

by Hein van Grouw

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Summary.—The dove known as *Streptopelia risoria* (Linnaeus, 1758) has long confused ornithologists. Linnaeus described a domestic variety of a dove whose wild form was then unknown. Its wild counterpart, African Collared Dove, was subsequently named *Streptopelia roseogrisea* (Sundevall, 1857) but that name's type series was mixed. Despite this, the name *roseogrisea* became commonly accepted and was used for both African Collared Dove and its domestic form in avian taxonomy, whilst the name *risoria* was commonly used by bird-keepers for the domestic form. In 2008 the ICZN ruled that the senior name *risoria* should have priority for both African Collared Dove and its domestic form, Barbary Dove. Although this decision was appropriate, it was based on incomplete information. Here a detailed history of the use of the name *risoria* in the ornithological literature is presented, followed by designation of a neotype for *roseogrisea* to resolve taxonomy.

'Among the Turtle-Doves—now *Streptopelia*, formerly *Turtur*—there is first of all a difficulty about the name "*risoria*"' (Hartert 1916).

The Barbary Dove, also known as Ringed Dove or Ringneck Dove, is the domestic form of African Collared Dove, until recently known as *Streptopelia roseogrisea* (Sundevall, 1857). In many other languages (Dutch, German, French, etc.), the domestic form is referred to as 'Laughing Dove' (e.g. Lachduif, Lachtaube, Tourterelle rieuse) for the typical call it makes when excited. (In contrast, Laughing Dove *S. senegalensis* does not give a laughing call at all!) Throughout this paper, the domestic bird is referred to as Barbary Dove and the wild form as African Collared Dove.

Barbary Dove was already known in the 16th century but details concerning its domestication are unclear. At that time Barbary Dove occurred in two varieties: a pale fawn-coloured form and a nearly white one (two different recessive alleles of the same gene, which is located on the sex chromosome, see Appendix). The original dark colour of the ancestral species was not then known to exist in captivity.

Long before the wild form was known to science, Barbary Dove had been described by Linnaeus (1758) as *Columba risoria* (Latin *risoris*: a laugher), presumably for its 'giggling' call. In his description, Linnaeus also listed *Turtur Indicus* of Aldrovandi (1600a), Willughby (1678), Ray (1713) and Albin (1738) in the synonymy of the same species. The dove was later transferred, via the genus *Turtur* Selby, 1835, to *Streptopelia* Bonaparte, 1855. As Donegan (2008) considered Linnaeus' name to be based on a mixed type series, he established a neotype for *risoria*, based on a pale fawn-coloured specimen from captivity whose specimen label indicated origin in India.

Although the scientific name *S. risoria* is senior to *S. roseogrisea*, the latter was commonly accepted in ornithology and used as the valid name for both African Collared Dove and its domestic form until 2008. However, in medical and bird-keeping literature, use of *risoria* for the domestic form prevailed (Pluis & Stupperich 1986, Donegan 2007). Donegan (2007) officially applied to the ICZN to conserve the junior name *roseogrisea* for the wild species but allow continued use of *risoria* for the domestic form, based on their previous approach to

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domestic mammals and their wild forms (ICZN 2003). However, the ICZN (2008) ruled that the valid name for both the wild and domestic forms is *Streptopelia risoria* (Linnaeus, 1758). This change was accepted by many authorities, e.g. the Association of European Records and Rarities Committees (Crochet *et al*. 2011). Dickinson & Remsen (2013), however, ignored the ruling, in the belief that Barbary Dove being the domestic form of African Collared Dove remains to be proven. However, in my opinion, the hypothesis that the two are the same species can no longer be denied (see Appendix).

Donegan (2007, 2008) argued that the nomenclature of *S. risoria* and *S. roseogrisea* is complicated by apparent reference to individuals of other species in the description of *Columba risoria*. This is unlikely, however, as will be demonstrated here. What is true is that many *Streptopelia* species are very similar and the name *risoria* was often used for similar-looking species, notably Eurasian Collared Dove *S. decaocto*. Here I recapitulate the history of the name *risoria* for Barbary Dove and its wild parent species in the ornithological literature (after van Grouw 1999). I offer more detail than the information presented by Donegan (2007) to the ICZN. The data herein confirm that the ICZN decision to maintain priority for *risoria* as the specific name for both African Collared Dove and its domestic form was correct. Whilst some commissioners (ICZN 2008) stated that the case of *risoria* could or should be reconsidered based on additional information, this will not be necessary based on the data and recommendations set out here.

History

Pre-Linnaeus, the name used for Barbary Dove was *Turtur indicus* which was introduced by Aldrovandi (1600a). Following Aldrovandi, Willughby (1678), Ray (1713) and Albin (1738) mentioned *Turtur Indicus*, the 'Indian Turtle' or 'the Turtle dove from the East Indies', in their works but their descriptions were based on Aldrovandi's without adding anything significant. Aldrovandi (1600a,b) mentioned that the image used in his book (Figs. 1–2) was produced 'from life' and reported that he kept a pair of Barbary Doves himself which came from Alexandria in Egypt. Donegan (2008) considered that Aldrovandi was possibly referring to two different species in his description. However, Aldrovandi stated that males are fawn-coloured and females white. On this basis, it is clear that Aldrovandi was discussing the two colour mutations of Barbary Dove (see Appendix). According to him, the species then occurred in England, Germany, Africa (in enormous cloud-like masses), 'Tartaria' (presumably the Caucasus and parts of Russia) and 'the Orient'. Despite the name *indicus*, Aldrovandi did not mention India specifically as a country of origin. Although one could argue that India formed part of 'the Orient', one might also then wonder why Aldrovandi did not name it *orientalis*. Willughby (1678) added that the species was common in captivity in England, but used a copy of Aldrovandi's plate (Fig. 3), while Albin (1738) added nothing further but did include a new plate (Fig. 4). Donegan (2008) considered it to be a Eurasian Collared Dove *Streptopelia decaocto* but in my opinion, based on the bird's colour and because Eurasian Collared Dove did not yet occur in Europe (Nowak 1965), the bird depicted is a pale, fawn-coloured Barbary Dove.

Linnaeus (1758) named the Barbary Dove *Columba risoria* and described it as 'C[olumba] supra lutescens, lunula cervicali nigraon' (dove with yellowish upperparts and black neck-ring), which is a perfect colour description of Barbary Dove. Presumably based on Aldrovandi's name *Indicus*, Linnaeus further stated that it came from India and that the bird was 'our common Turtle Dove' (nobis communis Turtur), which may suggest that it was commonly kept in Europe.

Latham's (1783) account of *Columba risoria*, 'the Collared turtle', also concerns the pale fawn mutation of Barbary Dove ('The upperparts of the head and neck, the back, and wing

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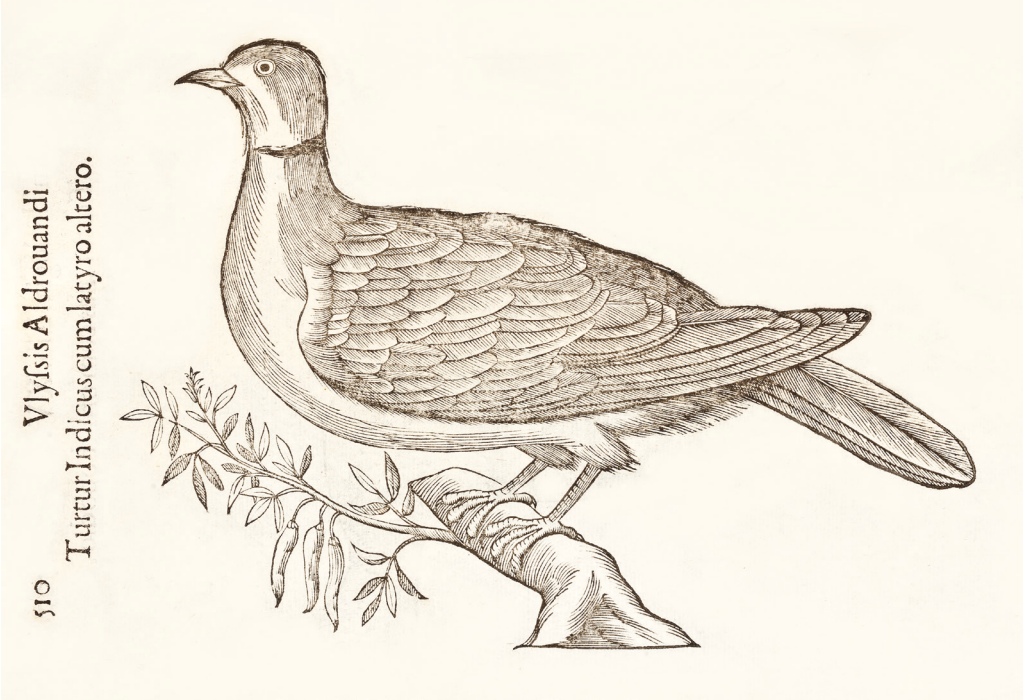

Figure 1. *Turtur Indicus* [Barbary Dove] in Aldrovandi (1600a) (Harry Taylor, © Natural History Museum, London)

Figure 2. *Turtur Indicus* [Barbary Dove] in Aldrovandi (1600b); the coloured version of Aldrovandi's work is unique (© Library of the University of Bologna)

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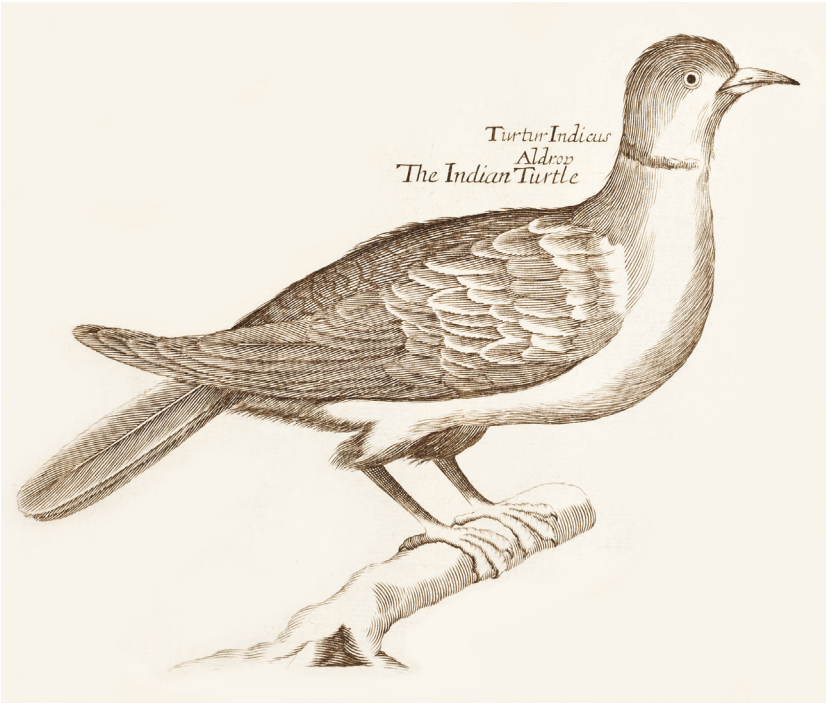

Figure 3. *Turtur Indicus*, the Indian Turtle [Barbary Dove] in Willughby (1678) (Harry Taylor, © Natural History Museum, London)

Figure 4. 'The Turtle Dove from the East Indies' [Barbary Dove], pl. 45 in Albin (1738) (Harry Taylor, © Natural History Museum, London)

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Figure 5. *La Tourterelle Blonde* [Ring-necked Dove *Streptopelia capicola damarensis*], pl. 268 in Le Vaillant (1808) (Harry Taylor, © Natural History Museum, London)

coverts, are of a rufous or reddish white, nearly cream-colour....'). According to Latham the species was common in France and elsewhere in continental Europe, although he did not 'hear of it at large in England'. Regarding mainland Europe, he remarked in a footnote: 'some think as far as Sweden, but I think Linnaeus's words do not justify this. He stated "Habitat in India, nobis communis Turtur"; by which I should think he only means, that it is everywhere in cages, as with us in England. It is not mentioned in his *Fauna Suecica*'.

Temminck (1808) knew that *Columba risoria* was a domestic form that had been kept in captivity for a very long time, and he suspected that its wild form was an African species. He referred to earlier authors like Buffon and Brisson who described 'Turtle doves with neck rings' from different parts of Africa, and specifically to *La tourterelle blonde* of Le Vaillant (1808; Fig. 5). This, in his opinion, although somewhat smaller, was the same as Barbary Dove ('....comme le type de nos Tourterelles a collier.'). He therefore called Barbary Dove 'Colombe Blonde' (Fig. 6). *La tourterelle blonde*, however, was a pale-coloured race of Ring-necked Dove *Streptopelia capicola damarensis*, which was discovered by Le Vaillant in what is now Namibia (Finsch & Hartlaub 1870, Shelley 1883). Unfortunately Le Vaillant's illustration failed to indicate the black eyeline; the artist may have missed it, possibly due to the specimen he used being poorly preserved.

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Figure 6. Colombe Blonde *Columba risoria* [Barbary Dove], pl. 44 in Temminck (1808) (Harry Taylor, © Natural History Museum, London)

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Temminck also quoted Sonnini de Manoncourt (1799) who saw Barbary Doves in Egypt where, according to Sonnini, 'the inhabitants love them very much and take special care of them'. It was unclear to Temminck, however, if Sonnini saw doves in the wild or whether they were found there in captivity, as in Europe.

Based on his observations in north-east Africa, Rüppell (1835) wrote that *Columba risoria* Linnaeus was rather common in the wild in 'Egypt', especially around Massaua (= Massawa), on the Abyssinian (now Eritrean) coast where they even occupied abandoned houses. Almost certainly, the doves that he saw were the wild ancestor of Barbary Dove, the African Collared Dove (Fig. 7). Thus, presumably unconsciously, Rüppell correctly 'linked' the wild and domestic forms as the same species. Ten years later, when he listed *Turtur risorius* Linnaeus as a common bird in north-east Africa, Rüppell (1845), like Temminck, included *La tourterelle blonde* of Le Vaillant (1808), as he too was of the opinion that Le Vaillant's dove was *Turtur risorius*.

Selby (1835; Fig. 8) was highly aware of the history of Barbary Dove and wrote of *Turtur risorius* 'From a very remote period this species appears to have been domesticated, or rather kept in that state of captivity in which it is retained at the present day; ... it is still abundant in Egypt and other parts of the East, where it is fostered and cultivated with care'. According to him, the species occurs in parts of Africa in its wild or natural state, and varies in depth and intensity of colour from the domestic variety. The specimen Selby described as the wild form came from southern Africa and had a narrow streak of black from the bill to the eyes. This specimen, however, was probably a Ring-necked Dove *Streptopelia capicola* and certainly not an African Collared Dove. Although Selby was correct as to the wild form being an African species, he picked the wrong one. Nevertheless, he was closer to the truth than many others, as Eurasian Collared Dove *S. decaocto* was then widely assumed to be the wild form of Barbary Dove.

At the time, Eurasian Collared Dove did not occur in Europe but was abundant in India and was regularly referred to as *Columba risoria*. Frivaldszky (1838), however, described and named it *Columba risoria* var. *decaocto*. Descriptions of varieties from this era are valid as species-group names. Frivaldszky was encouraged in this by J. F. Naumann, who pointed out that Eurasian Collared Dove differed in size, colour and call, and therefore was not the wild form of Barbary Dove.

Probably unaware of Frivaldszky's work, Blyth (1855) used the name *Turtur risorius* for Eurasian Collared Dove, although he too was convinced that it was a different species, as he stated while discussing Barbary Dove 'That our Indian *Turtur risorius* [*S. decaocto*] is not, as currently supposed, the wild type of this domestic breed is indicated ...'. Blyth went on to list differences in voice, size and the shape of the neck-ring. In Barbary Dove this ring, according to Blyth, is broader than in Eurasian Collared Dove, and is more comparable to that of African turtle-dove species. He admitted, however, that he was unaware of any identical African species, but he was convinced that the real species would be discovered soon.

Sundevall (1857), like Rüppell (1845), also opined that the Namibian *La tourterelle blonde* of Le Vaillant (1808) and *Turtur risorius* mentioned by Rüppell were the same species. He also thought that it was 'related' to Vinaceous Dove *Streptopelia vinacea* and he therefore proposed the name *Columba roseogrisea* for it. Both names refer to the pinkish-wine plumage.

So, African Collared Dove was correctly listed by Rüppell (1835, 1845) as *risoria*, and later renamed *roseogrisea* (Sundevall 1857). Subsequent authors, including Heuglin (1859), Hartman (1863) and Marno (1874), all continued using the name *risoria* Linnaeus for African Collared Doves in Ethiopia and Egypt. This may suggest that they considered it to be the wild form of Barbary Dove, but generally this relationship was not recognised. Dresser

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Figure 7. Adult male African Collared Dove *Streptopelia risoria* collected by Rüppell in Eritrea and the designated neotype for the junior synonym *roseogrisea* of Sundevall, SMF 22887 (Sven Tränkner, © Senckenberg Museum, Frankfurt). The species name *albiventris* on the label is a mistake by Finsch & Hartlaub (1870). They thought that the dove collected by Rüppell was the same species as *Turtur albiventris* of Gray (1844). The latter, however, is Vinaceous Dove *Streptopelia vinacea* (J. F. Gmelin, 1789). In their account of '*Turtur albiventris*' Finsch & Hartlaub used this specimen to describe the plumage characters.

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Figure 8. Collared Dove *Turtur risorius* [Barbary Dove], pl. 17 in Selby (1835) (Harry Taylor, © Natural History Museum, London)

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Figure 9. Neotype of *Streptopelia risoria*, NHMUK 2008.3.1 (Harry Taylor, © Natural History Museum, London). In connection with his application to conserve the name *S. roseogrisea* but, prior to the ICZN's final decision, Donegan (2008) assigned a neotype for *S. risoria*. The neotype designation for *S. risoria* (Linnaeus, 1758) was justified as no name-bearing specimen for *risoria* is believed to exist (and a type was necessary to define the taxon *risoria* objectively). Donegan (2008) selected a specimen of captive origin labelled 'from India' as, according to him, Linnaeus, and all other authors referred to in the latter's description, considered *risoria* to occur in India. However, as the accounts on which Linnaeus was based include more details on the species as a captive bird in Europe, which birds were also the basis of the different illustrations, a better choice might have been a captive bird from Britain, or elsewhere in Europe.

(1877), for example, who still called Eurasian Collared Dove *Turtur risorius*, thought that the species was 'the parent stock of the domestic Turtle Dove'. Shelley (1883) appears to have been first to mention the relationship with *roseogrisea*. In his discussion of *roseogrisea*, he stated 'Our common tame Turtle Dove [Barbary Dove] belongs to this species'. Nevertheless, he still used *Turtur risorius* for Eurasian Collared Dove and this name was even used for the species after 1900 by some commentators (Baker 1913). Hartert (1916) agreed with Shelley regarding the ancestry of Barbary Dove. He presented correct evidence to make his case

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and ended his account with 'We must therefore conclude that the Indian species [*S. decaocto*] cannot be the ancestor of the tame dove, while in all probability *S. roseogrisea* is the species from which our domestic birds have come'.

Conclusions and discussion

Aldrovandi's (1600a) black-and-white figure of *Turtur Indicus* (Fig. 1) could be a Barbary Dove or a Eurasian Collared Dove but, given that Aldrovandi himself kept Barbary Doves, that Eurasian Collared Dove had not yet reached Europe, and that the figure was produced 'from life', it is reasonable to assume that it depicts a Barbary Dove. The fawn colour of the only coloured copy of this figure in existence (Aldrovandi 1600b) confirms that he did indeed portray a Barbary Dove (Fig. 2). Furthermore, he stated that the species occurred in the Orient, Africa, Tartaria, Germany and England, and no explicit mention was made of India. European birds, obviously, were captive Barbary Doves while African birds could have been the wild form or any other African species with a black neck-ring. Birds from the Orient and Tartaria could have been either wild Eurasian Collared Doves or captive Barbary Doves. The further description of the species, however, certainly refers to Barbary Dove alone. Based on the species name *Indicus*, Willughby (1678) and Albin (1738) both called the species 'Indian Turtledove'. Neither author, however, recorded its provenance other than to comment that it was kept in captivity, so they too referred only to Barbary Dove. The pale, fawn-coloured dove depicted by Albin (Fig. 4) confirms this. Linnaeus (1758) described his *Columba risoria* based on the *Turtur Indicus* of Aldrovandi. Apart from the statement 'Habitat in India', the remainder of Linnaeus' brief description leaves no doubt that he was discussing Barbary Dove. Later authors including Latham (1783), Temminck (1808) and Selby (1835) all used the name *risoria* correctly for Barbary Dove.

Thereafter Rüppell (1835) used the name *Columba risoria* of Linnaeus to identify a wild species he saw in Egypt and Eritrea; these doves were actually African Collared Doves, the wild form of Barbary Dove (Fig. 7). Ten years later, Rüppell (1845) still called African Collared Dove *risoria* but was mistaken in presuming that *La tourterelle blonde* of Le Vaillant (1808) was the same species. Sundevall (1857), however, made an even bigger mistake by applying a new name, *Columba roseogrisea*, to a species of which he had only seen descriptions and a plate, but never a specimen. In fact the basis for Sundevall's name was an amalgamation of two species: Ring-necked Dove (*La tourterelle blonde* of Le Vaillant) and African Collared Dove, *Columba risoria* mentioned by Rüppell (1835, 1845)

Donegan's (2007, 2008) proposal to ICZN was designed to meet the conflict in usage between the wild form, widely referred to as *roseogrisea*, and the (introduced) domestic form, widely referred to as *risoria*. As demonstrated here, Barbary Dove is the domestic form of African Collared Dove and they are therefore the same species. In contrast to other taxonomic groups, e.g., mammals and fish (ICZN 2003), most bird species with both a domestic and a wild form have just one scientific name (Gentry *et al*. 2004), and the senior name *risoria* was given to the domestic Barbary Dove. Furthermore, as Rüppell correctly used the name *risoria* of Linnaeus for African Collared Dove, and Sundevall based his *roseogrisea* on Rüppell's information, it is in many ways unfortunate that the junior name gained traction instead of having been recognised as a synonym from the outset.

The decision of the ICZN (2008) to 're-establish' the senior name *risoria* of Linnaeus for the species, although based on less information than is presented here, is thus quite appropriate.

As a result of the above, specifically the mixed type series used by Sundevall (1857), the application of *roseogrisea* should also be clarified to avoid its synonymy with *capicola*. In his description of *La tourterelle blonde*, Le Vaillant mentioned its similarity to Buffon's *La tourterelle à collier*, which was kept in captivity in France, and he referred to a plate of the latter species

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Figure 10. *La Tourterelle à collier* [Barbary Dove], pl. 244 in Boddaert & Daubenton (1783) (Hein van Grouw, © Natural History Museum, Tring)

(Boddaert & Daubenton 1783). Buffon's bird, however, was a Barbary Dove (Fig. 10). The specimen from Namibia used for Le Vaillant's plate is believed to be no longer extant. However, Hartlaub & Finsch (1870) described *Streptopelia capicola damarensis*, designated a name-bearing type—a specimen collected on 17 February 1865 by Andersson in Namaqualand and now held in the Uebersee Museum Bremen (UMB 9477)—and listed Le Vaillant's *La tourterelle blonde* in synonymy. The information concerning *risoria* (African Collared Dove) from north-east Africa in Rüppell (1845), in which he listed Le Vaillant's *La Tourterelle* in synonymy, formed the basis

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for *roseogrisea* of Sundevall (1857). Given the conflict with *capicola*, a neotype of *roseogrisea* is assigned to clarify the taxonomic status of the junior synonym for African Collared Dove. The specimen satisfies the conditions of Art. 75.3 (ICZN 1999).

Neotype: Senckenberg Museum, Frankfurt (SMF 22887), male, undated, collected by W. P. E. S. Rüppell in 'Abyssinia'.

This results in the following sequence for these birds:
Streptopelia risoria (Linnaeus, 1758). Type specimen NHMUK 2008.3.1, based on Donegan (2008). Synonym: *Streptopelia roseogrisea* (Sundevall, 1857). Type specimen SMF 22887 (neotype designation herein).

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Appendix

Barbary Dove is widely considered to be the long-domesticated form of African Collared Dove. Shelley (1883) was probably first to recognise it as such, but thereafter many authors confirmed its ancestry based on a multitude of further evidence, e.g. sound, behaviour and colour (Hartert 1916, Goodwin 1952, 1970). Although I am unaware of any DNA results that confirm this, based on my observations over more than ten years of behaviour, sound and inheritance in Barbary, African Collared and Eurasian Collared Doves (van Grouw 1999), I consider that there can be no doubt as to the Barbary Dove's ancestry. Eurasian Collared Dove and Barbary Dove readily hybridise, their offspring are fertile (van Grouw 1999) and, in places where both species occur, e.g. North America (Romagosa 2002), hybrid characters are recorded in feral Barbary Doves. However, for many reasons, e.g. voice, behaviour, range and colour (see Fig. 11), Eurasian Collared Dove is unlikely to have contributed to the domestic Barbary Dove. Also Eurasian Collared Dove does not become tame in captivity, even after several generations, whereas wild-caught African Collared Doves quickly settle down in confinement (pers. obs.).

Apart from its ancestry, nothing appears to be known of the early history of domestic Barbary Dove. Despite old common names like Indian Turtledove and, for the 'white' colour form, Java Dove (see below), it is probable that the first domestication occurred in Egypt (Sonnini de Manoncourt 1799). Aldrovandi (1600a) received his birds from Egypt and at that time two colour mutations existed; the original dark colour of the ancestral species (Fig. 12) was not then known in Barbary Dove. These two mutations are both a form of Ino, a qualitative reduction of melanin (van Grouw 2013) in which the quantity of melanin granules in the plumage is unchanged but, due to incomplete melanin synthesis, the pigment granules themselves are lighter in colour, resulting in paler plumage. In the fawn-coloured form, the overall colour is paler, and the original blackish and greyish parts more brownish (Figs. 13–14). Due to the high concentration of melanin in the neck-ring, the change in colour in this tract is not visible to the naked eye. In the 'white' form the melanin is hardly coloured at all, resulting in a very soft, near-white plumage. Again due to the high concentration of melanin, in the 'white' form the neck-ring appears a very pale brown (Fig. 15).

The mutations are caused by two different recessive alleles of the same gene and their inheritance is known among breeders as 'sex-linked' because the gene that harbours the mutation is located on the sex chromosome. In birds, males have two sex chromosomes but females just one, so only males can be heterozygous (i.e. possess two different alleles) for a sex-linked mutation. The fawn-coloured form, also known among cagebird breeders as Blond or Pastel, is dominant in inheritance over the 'white' form, but both mutations are recessive to wild colour. Therefore, from a pair of wild-coloured doves, it is possible only to breed Blond or White offspring if the male is heterozygous for the mutation. The offspring, however, are always female (Fig. 16a). To breed a Blond or White male, it is necessary to pair a female with the mutation to a heterozygous male (Fig. 16b). From paired Blond and / or White doves, however, one can never breed

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Figure 11. Comparative ventral and dorsal views of African Collared Dove (left, NHMUK 1965-M.4710) and Eurasian Collared Dove (NHMUK 1940.12.1.2); apart from difference in size, the main difference is that in African Collared Dove (and Barbary Dove) the belly, vent and undertail-coverts are nearly white, while in Eurasian Collared Dove they are dark, bluish grey (Hein van Grouw, © Natural History Museum, Tring)

Figure 12 (left). Wild-coloured Barbary Dove, adult female (Hein van Grouw)

Figure 13 (right). Fawn-coloured Barbary Dove, adult female (Hein van Grouw)

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Figure 14. Open wings of wild-coloured and fawn-coloured Barbary Dove to compare the change in pigment colour; due to the Ino mutation the original blackish and greyish colours are paler, with a brownish hue, and the original dark brown is pale brown (Hein van Grouw)

Figure 15. Near-white adult female Barbary Dove (Hein van Grouw)

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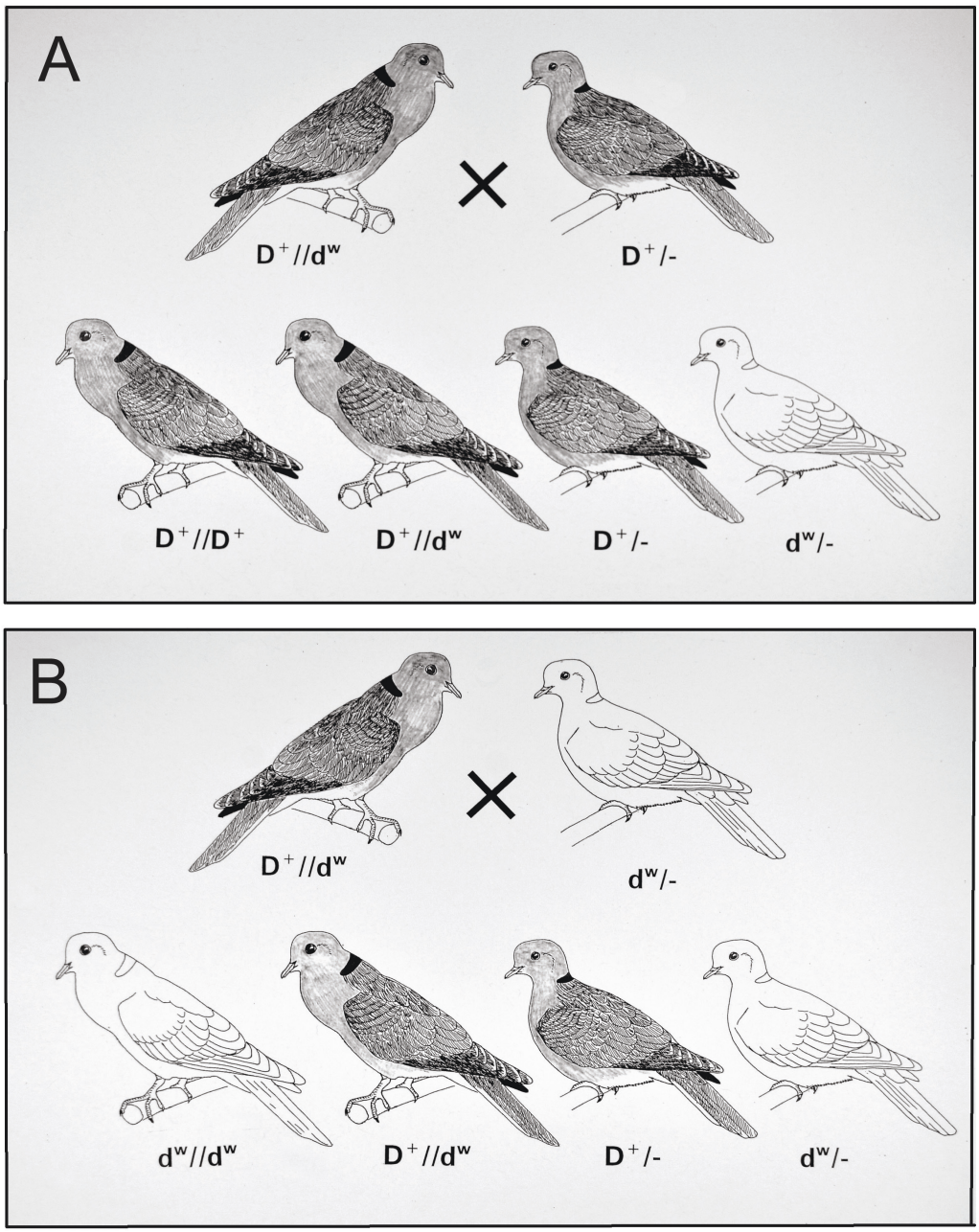

Figure 16. Crossing schemes (from van Grouw 1999) to demonstrate the inheritance of the Ino mutation in Barbary Dove. D^+ = wild colour and d^w = near-white mutation (the fawn-coloured mutation = d^B). Scheme A shows that if both parents are wild-coloured but the male is heterozygous for white ($D^+//d^w$), 25% of the offspring will be white, all of which will be females. The same applies for wild-coloured parents and fawn-coloured offspring (replace d^w for d^B). Scheme B demonstrates that to breed a white (or fawn-coloured) male, it is necessary to pair a white (or fawn-coloured) female with a heterozygous male for the mutation.

a wild-coloured bird again. This may explain why, in the past, the wild colour was lost in Barbary Dove as paler colours were probably favoured for breeding.

Both colour mutations were known in Aldrovandi's time but it was the fawn-coloured form that was described by Linnaeus (1758) as *Columba risoria*, despite the 'white' form being also widespread. Already

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Figure 17. Colombe Blanche *Columba alba* (= white form of Barbary Dove), pl. 46 in Temminck (1808) (Harry Taylor, © Natural History Museum, London)

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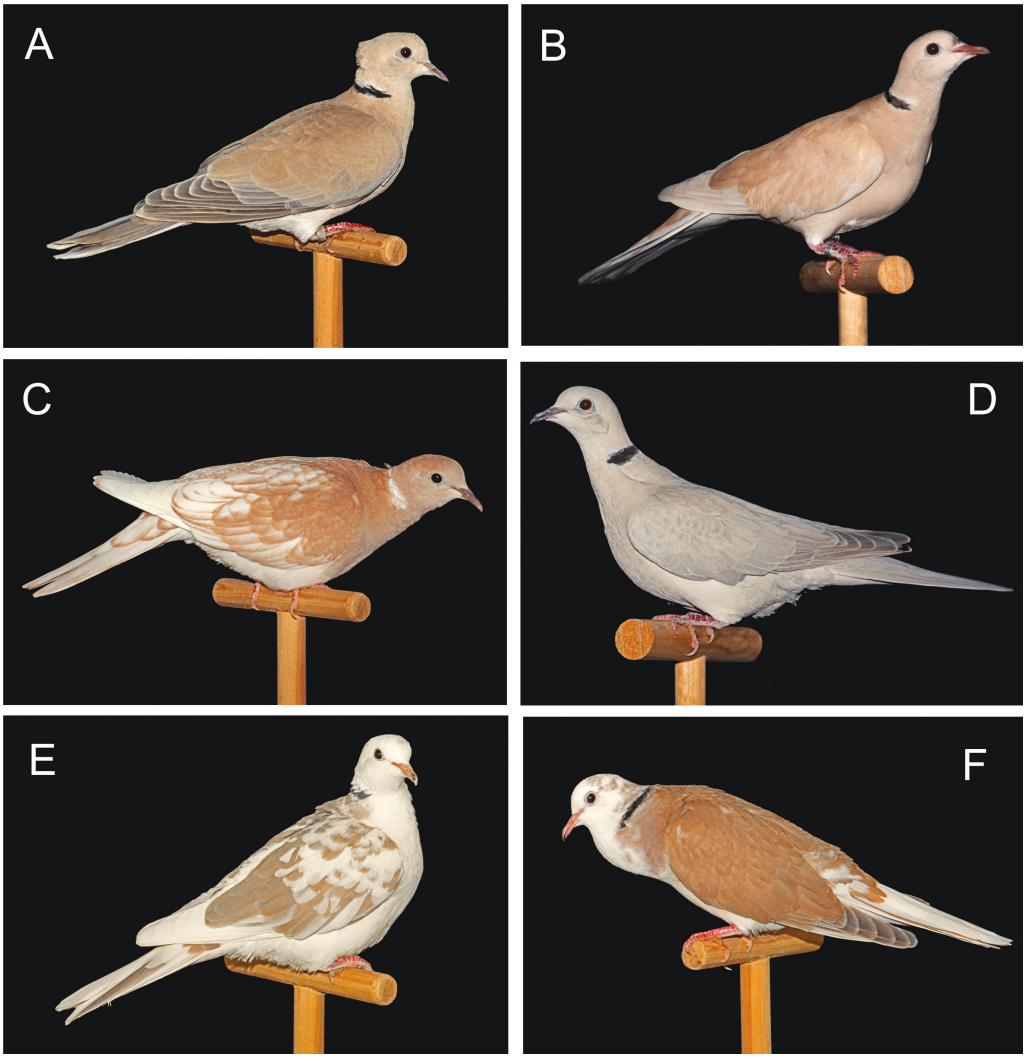

Figure 18. Different mutations of Barbary Dove. A: Crested. B: Isabel, a dilution of eumelanin alone. C: Phaeo, an absence of eumelanin alone. D: Grey, an absence of phaeomelanin alone. E and F: Pied (leucism), absence of all melanin in parts of the plumage (Hein van Grouw)

in the early 17th century the Dutch had brought them to Java and, from there, to the Pescadores (Taiwan) during the Dutch possession (1624–62) of these islands (Swinhoe 1866). In Swinhoe's era white Barbary Doves were known as 'Java Dove' or 'White Pescadore Dove' by Europeans resident in Taiwan and China. Swinhoe (1866), however, knew better, stating 'They seem to me to be simply albinos of the Domestic Dove, which is usually referred to *Turtur risorius*.' Although he was mistaken as to their being 'albinos', Swinhoe was otherwise correct. Temminck (1808) also knew that the white form was a variety of *Columba risoria*, but nevertheless gave it a separate name, Colombe Blanche *Columba alba* (Fig. 17). For centuries only these two mutations were present in Barbary Dove and it was only in the second half of the 20th century that suddenly many more occurred (Fig. 18). Currently >15 distinct mutations are known, giving rise to numerous colour varieties.

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Distribution of Pinyon Jay *Gymnorhinus cyanocephalus* in Chihuahua, Mexico: new records and environmental characterisation

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Summary.—We report new records of Pinyon Jay *Gymnorhinus cyanocephalus*) in Chihuahua, northern Mexico. All were made at Rancho Canoas, in the municipality of Gómez Farías, Chihuahua, involving more than 50 individuals between October 2014 and October 2015. Despite being considered a casual visitor to the Alta Babícora Basin, the presence of *G. cyanocephalus* may reflect the abundant *Pinus cembroides* in this region, as the species primarily inhabits forests of pine and *Juniperus*. We discuss the species' current and historical status, based on the published literature, online databases, and unpublished sightings from experienced birdwatchers. We compared the environmental parameters of available records across the species' geographic range with those in Chihuahua, and found no climatic differences between them.

Pinyon Jay *Gymnorhinus cyanocephalus* is a resident breeder from central Oregon, the mountains and arid slopes of eastern California, Nevada, Idaho, Utah, northern Arizona, Montana, Wyoming and western Oklahoma to New Mexico (Balda 2002). The species usually winters in the breeding range, but during years when the pine cone crop fails, it may reach central and south-east Arizona, and western and central Texas (Balda 2002, Lockwood & Freeman 2014). In Mexico, it is an uncommon to rare resident at 1,500–3,000 m in the Sierra San Pedro Mártir, Baja California (Howell & Webb 1995), but wanderers have been observed in Sonora (Russell & Monson 1998) and Chihuahua (Howell & Webb 1995), sometimes even in summer. The species' breeding habitat comprises pinyon–juniper woodland (*Pinus-Juniperus*) and in the non-breeding season it also occurs in scrub oak (*Quercus*), pine forest (*Pinus*), chaparral communities and sagebrush, within an altitudinal range of 1,219–2,438 m (Balda 2002). A continuum of fragmented pine–oak forests extends from the Rocky Mountains in the western USA through the Madrean Sky Islands (extreme southern Arizona and New Mexico) to the Sierra Madre Occidental (Brown 1994, Kobelkowsky-Vidrio *et al*. 2014), providing potential habitat for the species in northern Mexico.

Here, we report new records of *G. cyanocephalus* in Chihuahua, comment on its current and historical status based on the published literature, online databases and unpublished sightings made by experienced birdwatchers, and use an ecological niche modelling (ENM) approach to assess if suitable habitat conditions exist in northern Mexico to support a resident population of the species.

Materials and Methods

Field work.—The records reported here were made at Rancho Canoas, in Gómez Farías municipality, Chihuahua, Mexico (29°11'16.8"N, 107°38'11.8"W). The area is owned by the Universidad Autónoma de Chihuahua and managed by the Facultad de Zootecnia

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y Ecología. Vegetation at the study site comprises pine-oak forest (*Pinus-Quercus*), with Mexican pinyon *Pinus cembroides* and Arizona white oak *Quercus arizonica* the most important representative species (Brown 1994). Altitudinal range spans 2,231–2,426 m. Mean annual temperature is 12–18°C and mean annual precipitation 580 mm. The area forms part of the foothills west of the Sierra de Chávez, in the Sierra Madre Occidental. Birds were surveyed at Rancho Canoas between October 2014 and October 2015 as part of biological monitoring at all seasons of the year. Eight visits were made: two in 2014 (24–26 October, 12–13 December) and six in 2015 (20–21 February, 24–25 April, 22–23 May, 10–11 July, 28–29 August and 30–31 October). Three monitoring stations were established in the study area (each observation point measuring *c*.0.5 ha), separated by *c*.1 km, and three 15-minute counts were made within each point as the observer walked around the station between 06.00–11.00 h. The survey recorded all bird species seen and heard at each observation point. Bird identification was made using a field guide (Howell & Webb 1995), binoculars and camera.

Museum work.—IMC corroborated the identification of the four Pinyon Jay specimens housed at Museo de Zoología 'Alfonso L. Herrera' (MZFC), Universidad Nacional Autónoma de México, Mexico City. These specimens were collected in the Baja California Peninsula, one at the Observatorio Astronómico Nacional, Sierra San Pedro Mártir (MZFC 06518), and three at Laguna Hanson, Sierra de Juárez, Ensenada municipality (MZFC 26248, 26249, 26280).

Bibliographic review.—We conducted all searches on 10 June 2017. A literature search for published observations of *G. cyanocephalus* in Mexico was made (Miller *et al*. 1957, Phillips 1986, Howell & Webb 1995, Russell & Monson 1998). Additionally, we searched for historical and contemporary records of *G. cyanocephalus* in the Global Biodiversity Information Facility (GBIF, http://www.gbif.org), a web-based biodiversity data aggregator. The search in GBIF database was carried out with the aid of GBIF function implemented in the DISMO library (Hijmans *et al*. 2017), downloading georeferenced records alone into R 3.3.1 (R Development Core Team 2016). Supplementary confirmed locality records were gathered from unpublished observations provided by birdwatchers (see Results: Status and distribution).

Environmental characterisation and ecological niche modelling.—We followed a protocol of best practice to not over-parametrise the resulting ecological niche model (Peterson *et al*. 2011). Delimitation of the study area, crucial to create accurate ecological niche models, was based on the species' dispersal ability (Barve *et al*. 2011). The overall dataset was intersected with the ecoregions shapefile provided by Commission for Environmental Cooperation (CEC, www.cec.org/tools-and-resources/map-files/terrestrial-ecoregions-level-iii), and ecoregions selected were considered a proxy of the species' accessible area ('M' *sensu* Barve *et al*. 2011; figure available on request). We employed this approach because ecoregions are characterised by geographically distinct assemblages of natural communities, sharing similar environmental conditions and with a large majority of species critically interacting for their long-term persistence (Olson *et al*. 2001).

Researchers often sample easily accessible areas (i.e. near roads or towns and cities), leading to geographic clusters of unique locations (Boria *et al*. 2014). Further, MaxEnt tends to over-predict when employed in conjunction with biased occurrence records (Peterson *et al*. 2007). To avoid model overfitting of spatially clustered presences and inability to predict spatially independent data, the presence data were spatially rarefied. For this, we obtained an initial set of 27,884 geographical records (including GBIF, literature and unpublished records) from the years 1853 to 2017. These records were reduced to 1,875 after removing duplicates and by applying 'spatial filtering' to reduce spatial autocorrelation using

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TABLE 1
Ecological variables and their eigenvectors from the principal component analysis (PCA); and relative contributions of environmental variables to the median MaxEnt breeding-season and year-round models. The three highest loading values for each principal component are highlighted with an asterisk.

Ecological variables	PC1	PC2	% contribution (year-round)
Annual mean temperature (bio_1)	0.351*	-0.112	6.3
Mean diurnal range (bio_2)	0.149	0.066	3.7
Isothermality (bio_3)	0.074	-0.241	20.4
Temperature seasonality (bio_4)	0.045	0.358*	-
Max. temperature of warmest month (bio_5)	0.358*	0.045	-
Minimum temperature of coldest month (bio_6)	0.240	-0.277	-
Temperature annual range (bio_7)	0.119	0.331*	0.4
Mean temperature of wettest quarter (bio_8)	0.155	0.069	2.4
Mean temperature of driest quarter (bio_9)	0.150	-0.185	0.6
Mean temperature warmest quarter (bio_10)	0.353*	0.019	-
Mean temperature coldest quarter (bio_11)	0.294	-0.240	-
Annual precipitation (bio_12)	-0.221	-0.278	1.3
Precipitation of wettest month (bio_13)	-0.130	-0.330	-
Precipitation of driest month (bio_14)	-0.300	0.112*	-
Precipitation seasonality (bio_15)	0.101	-0.272	3.6
Precipitation wettest quarter (bio_16)	-0.138	-0.334	-
Precipitation driest quarter (bio_17)	-0.299	0.069	0.1
Precipitation warmest quarter (bio_18)	-0.094	-0.066	3.3
Precipitation coldest quarter (bio_19)	-0.132	-0.310	-
Elevation (h_dem)	-0.261	0.047	53.2
Slope (h_slope)	-0.120	-0.097	2.1
Topographic index (h_topoind)	0.086	0.105	2.7

SDMToolbox 1.1 (Brown 2014; http://sdmtoolbox.org/); filtered occurrence data points were >10 km apart (Boria *et al*. 2014). The final dataset consisted of 1,872 records after removing records manually. These records were removed because they fell outside clipped layers.

To characterise the environment of the potential distribution of *G. cyanocephalus* (Table 1), we used a set of 19 bioclimatic variables obtained from the WorldClim project version 2 (Fick & Hijmans 2017; http://worldclim.org/version2) and three topographic variables obtained from the Hydro1k project (https://lta.cr.usgs.gov/HYDRO1K), which added up to 22 variables. All bioclimatic and topographic layers had a spatial resolution of 30 seconds (*c*.1 km^2) with a WGS84 projection. These variables were chosen based on their potential biological relevance to Pinyon Jay (using data from Balda 2002).

It is well documented that including redundant variables with high collinearity leads to a complex model that is difficult to interpret (Peterson *et al*. 2011, Dormann *et al*. 2013). This is particularly true with layers that have been interpolated by climatic stations presenting spatial autocorrelation *per se* or by the biological properties of the modelled species (Kissling & Carl 2008). With the aim of minimising collinearity and redundancy between variables, all environmental variables were examined for cross-correlation (Pearson correlation coefficient, r) in SDMToolbox, and highly correlated variables (r >0.85) were dropped following Elith *et al*. (2010). The decision to drop or retain a variable was based on its biological relevance to Pinyon Jay, its relative predictive power, and ease of interpretation. Topographic variables were not dropped, even if there was high correlation with one or more bioclimatic variables, because of the topographic variables' greater direct

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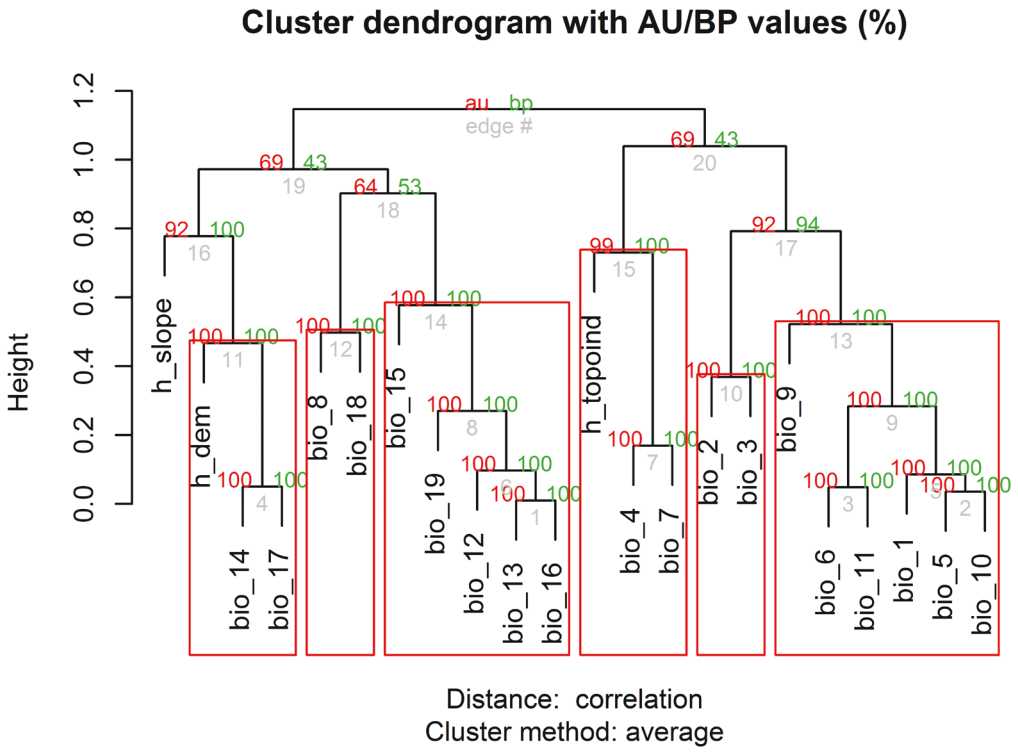

Figure 1. Cluster analysis showing correlation between bioclimatic and topographic layers supported by AU (approximately unbiased) P-value (left) and bootstrap values (right).

influence on the species' distribution (Balda 2002). Thus, the total number of variables considered in the MaxEnt model was reduced to 13. To visualise correlation between variables we performed a cluster analysis (Fig. 1). First, we extracted the pixel values of the bioclimatic and topographic layers using the above-mentioned spatially rarefied records. Then we plotted a UPGMA cluster of the entire set of variables, and a bootstrap analysis (1,000 randomisations) to obtain statistical support in each group or cluster detected using the *pvclust* function implemented in the *pvclust* library (Suzuki & Shimodaira 2015).

A bias surface file for the MaxEnt model was generated using SDMToolbox to account for potential sampling bias in the occurrence data, because such bias can negatively affect niche models' performance (Phillips 2008, Syfert *et al*. 2013). This bias file was elaborated using the Gaussian kernel density of sampling localities tool, using as input the spatially rarefied records with an extrapolation of 0.25 degrees, producing a bias grid that preferentially selects data points with fewer neighbours throughout the geographic landscape (Brown 2014). Output bias values of 1 reflect no sampling bias, whereas higher values represent increased bias (Fig. 2).

To determine the relevance of the new Chihuahuan locality under an ecological niche modelling approach, we modelled the Pinyon Jay's potential distribution employing a correlative maximum entropy-based model or MaxEnt version 3.4.1 (Phillips *et al*. 2017). The MaxEnt program also identifies areas possessing conditions most similar to the species' current known range and ranks them from 0 (unsuitable or most dissimilar) to 1 (most suitable or most similar). We employed the final dataset (n = 1,872 records), the 13 retained variables, and the above-mentioned sampling bias shape as input files in the MaxEnt model.

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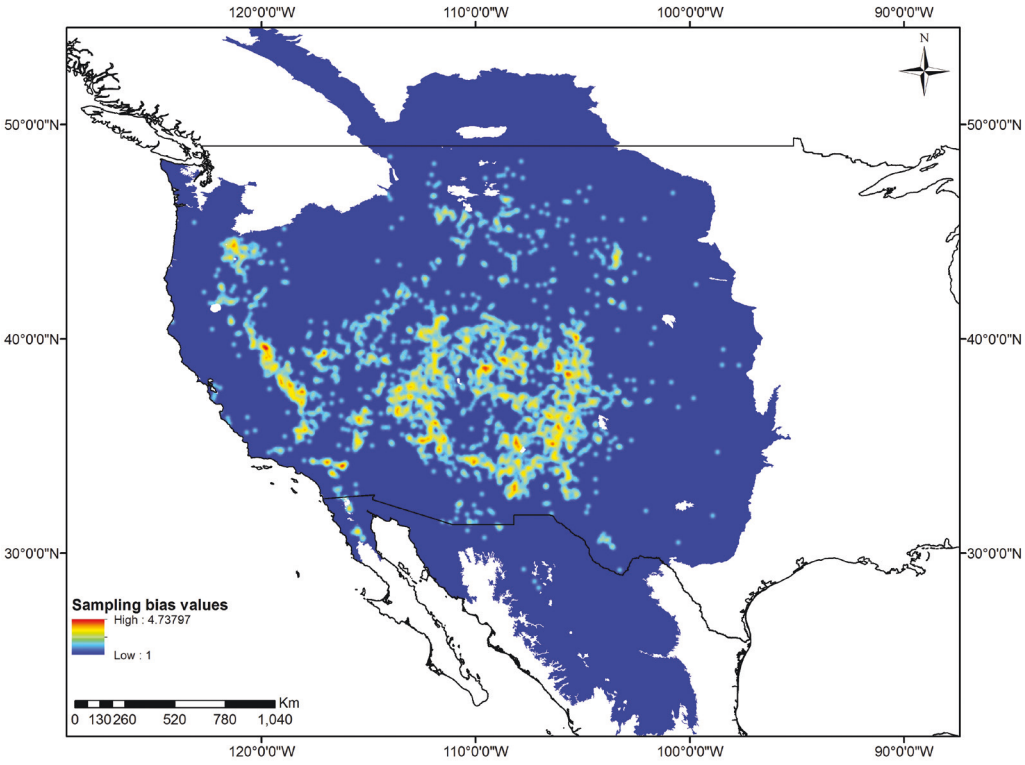

Figure 2. Sampling bias file generated using the Gaussian kernel density of sampling localities tool (spatially rarefied records as input).

We ran cross-validation whereby the occurrence data were randomly partitioned into subsamples, with each of the partitioned groups being withheld once to be used as validation data. This ensured that all of the occurrence points were used in both training and validation. Cross-validation was run ten times. These results were then averaged to produce a single suitability model. We used predetermined settings in the programme, although we chose 5,000 iterations to permit adequate sampling for convergence, while the options 'Do clamping' and 'extrapolate' were disabled to eliminate artificial extrapolations for the most extreme values among the ecological variables (Owens *et al*. 2013). Habitat suitability values from the median MaxEnt model output were mapped along with the occurrence records employed in the modelling and the new Chihuahuan records using ArcGIS 10.2 (Environmental Systems Research Institute, Redlands, CA). We chose the MaxEnt model because it is a presence background model, making it most suitable for our Pinyon Jay occurrence data; absence data at a global scale for the species were not available. The MaxEnt median model for *G. cyanocephalus* is available in GitHub (https://github.com/Israelornis).

We used a jackknife analysis to evaluate the importance of habitat variables in explaining habitat suitability for *G. cyanocephalus*. A receiver operating characteristic (ROC) plot and the associated area under the curve (AUC) were used to assess the accuracy of the output models (Phillips *et al*. 2017), a statistical technique that has become predominant in evaluating the accuracy of models predicting species' distributions. AUC values vary from 0 to 1. Models with an AUC value of 0.5 reveal model performance no better than random;

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values <0.5 worse than random; 0.5–0.7 indicate poor performance; 0.7–0.9 reasonable or moderate performance; and 0.9 high performance (Peterson *et al*. 2011).

We also modelled performance using the partial AUC approach implemented by Peterson *et al*. (2008), avoiding recent criticisms of traditional ROC for evaluating statistical robustness in ecological niche modelling (Lobo *et al*. 2008). This procedure permitted us to evaluate performance of the median model compared to random expectations, as well as to compare performance across scales and modelling methods. Partial AUC approaches limit analysis to portions of the ROC curve relevant to the question (i.e., within omission error tolerances); by calculating the ratio between the area below the curve for observed values against the area under the line of random discrimination, AUC ratios are expected to depart upwards of one if model performance is better than random (Peterson *et al*. 2008).

The main advantage of this procedure was that the comparison covered only the range of values that each algorithm predicted, thereby avoiding problems caused by using an equal scale of values not applicable to all comparisons. We used an acceptable omission error threshold of $E = 0.05$, given that raw data were obtained from GBIF and may be subject to georeferencing or identification errors, and 1,000 replicates with 50% bootstrap re-samplings of the spatially rarefied dataset to establish if the ROC AUC (area below the curve) ratio exceeded 1.0. Partial ROCs were computed using the ENMGadgets library (Barve & Barve 2016) in R. Significance of partial ROCs was assessed by direct counts of the proportion of replicate analyses with an AUC ratio ≤1.0.

For the environmental characterisation, we constrained our examination of ecological parameters to the area accessible to the species, which included all ecoregions intersecting with all spatially rarefied records employed in the year-round model, plus the new Chihuahuan record. Then, we summarised ecological variation across the distribution of *G. cyanocephalus* by performing a principal component analysis (PCA) on the values of the 22 previously normalised ecological variables from the sites of georeferenced *G. cyanocephalus* occurrence records using PRIMER v7 (Clarke *et al*. 2014). This reduced the multi-dimensionality of the 22 ecological variables. We then associated all of the records of *G. cyanocephalus* with the PCA output, obtained PCA values for each locality, and plotted PC1 and PC2 for each *G. cyanocephalus* record.

Finally, for Pinyon Jay, we extracted the point values of the MaxEnt median model and elevation employing ArcGIS 10.2. Subsequently, we analysed the environmental suitability index (ESI) generated by the niche model regress against elevation to evaluate its effects on distributional trends and possible influence on its niche. A generalised additive model (GAM) with a Gaussian distribution and identity link was used to investigate this relationship. A GAM was chosen for its ability to describe non-linear data (Wood 2006). Models were constructed using the *gam* function in the mgcv package in R. The GAM regression was plotted in ggplot2 (Wickham 2009).

Results

Field work.—Between four and ten Pinyon Jays were observed seven times at Rancho Canoas, Gómez Farías municipality (eight and six individuals on 24–25 April 2015 respectively; four and nine individuals on 22–23 May 2015; eight and ten on 10–11 July 2015; and eight on 30 October 2015). Most individuals were recorded in the study area in summer 2015. The birds were clearly identified by their relatively long pointed bill, relatively short tail, overall greyish-blue plumage and whitish-streaked throat. The observed individuals moved in small flocks of 8–10 individuals, constantly emitting contact calls, even in flight. They were seen interacting in the ground while feeding with Canyon Towhees *Melozone*

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fusca and Western Meadowlarks *Sturnella neglecta*. We did not observe any evidence of breeding behaviour.

Status and distribution.—We consider Pinyon Jay to be a rare and irregular visitor (not expected annually) in western Chihuahua at all seasons of the year, with records at six localities. In addition to our records at Rancho Canoas, one was collected at Babícora Hills, Gómez Farías municipality, on 4 December 1936 (Miller *et al*. 1957, Phillips 1986) and another was collected at Rancho La Ciénaga, 27 km east La Junta, Guerrero municipality, on 10 June 1949 (Miller *et al*. 1957, Phillips 1986). More recently, 20–30 individuals were seen at both Siete Hermanos on 22 May 2011 and near Bachíniva on 1 November 2011 (eBird), and an adult was seen along Highway 2 'Janos–Agua Prieta', Sierra San Luis, Janos municipality, on 11 September 2015 (M. Jurado pers. comm.). Thus, together with our records, the species has been recorded in Chihuahua in every month between April and December, except August. Chihuahuan records were all made at elevations between 1,963 and 2,497 m.

Environmental characterisation and ecological niche modelling.—The first two principal components of the 22 bioclimatic and topographic variables explained 56.5% of the cumulative ecological variance for the species. Those variables with higher eigenvectors for component 1 were mainly associated with temperature, whereas those for component 2 were primarily associated with temperature and precipitation (Table 1). Values of the environmental variables pertaining to Chihuahuan localities fell within the variation of those variables at Pinyon Jay sites in the USA and Baja California, Mexico (figure available on request).

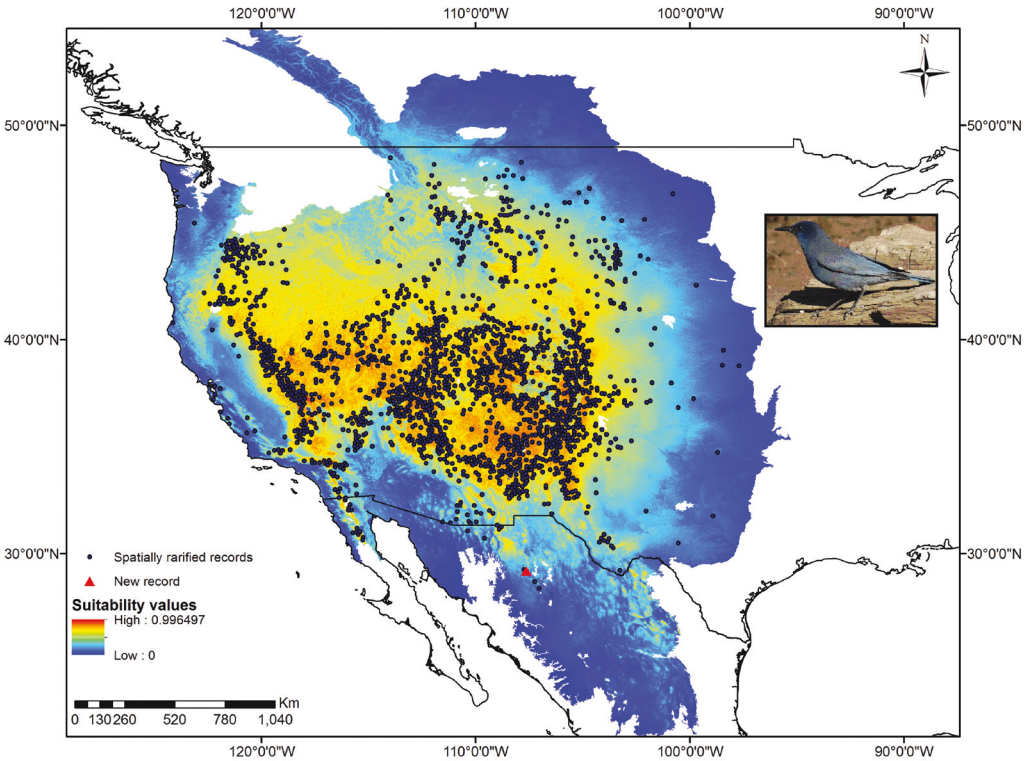

Figure 3. Tenfold cross-validation MaxEnt 'year-round' distribution model in a scale of maximum–minimum values showing the potential distribution for Pinyon Jay *Gymnorhinus cyanocephalus* in our study area and plotting the spatially rarefied records and the new Chihuahuan record.

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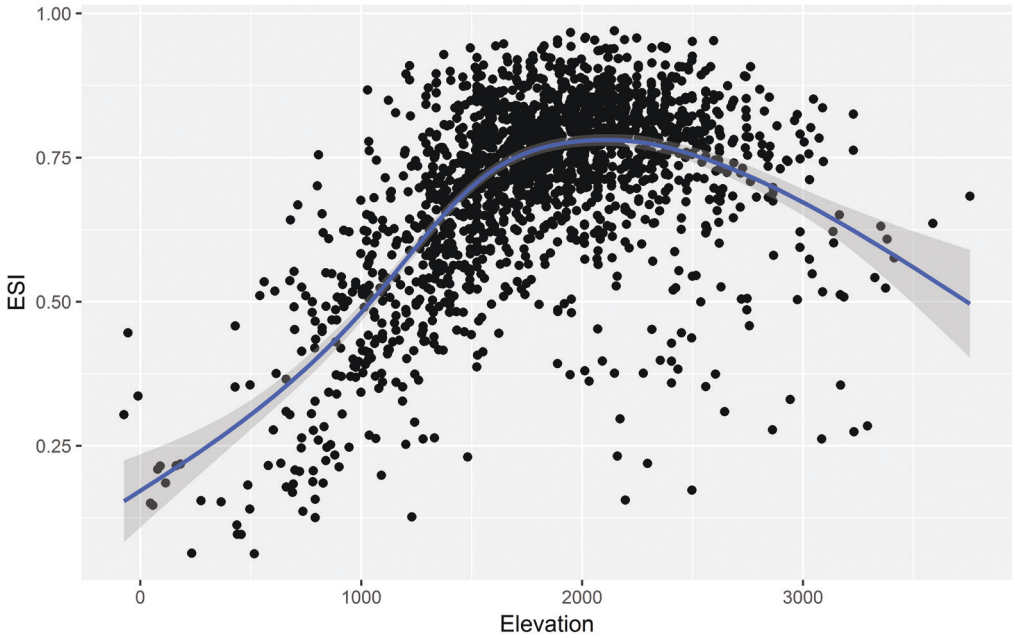

Figure 4. GAM regression showing relationship between environmental suitability index (ESI) against elevation (m).

We chose the median MaxEnt model of the tenfold cross-validation in the analysis. The year-round median model had an AUC value of 0.793 (SD ± 0.014). On the other hand, the partial ROC mean = 1.68 (SD = 0.010, P <0.05), which indicates the suitability of the model. According to our model, the suitability value of the new locality (Rancho Canoas) was 0.21, while the other Chihuahuan localities ranged between 0.15 and 0.88 (Fig. 3). The highest suitability value in the year-round model was 0.99, notably the pixel with highest suitability value in Chihuahua was 0.88.

The environmental variables that contributed most to species distribution in this model were elevation (53.2%), isothermality (20.4%) and annual mean temperature (6.3%; Table 1). As expected, the GAM regression explained 23% of the variation, showing that elevation is a significant and positive variable on the environmental suitability index (ESI) generated by the niche model (R = 0.238, P <0.0005, n = 1,872; Fig. 4).

Discussion

Some range maps (Navarro & Peterson 2007, BirdLife International & NatureServe 2014) have included the Baja California Peninsula as the only part of Mexico where Pinyon Jay occurs. The maps in Howell & Webb (1995) and Russell & Monson (1998) indicated that the species is also a sporadic visitor to Chihuahua and Sonora. It is probable that it is more common than previous Mexican records indicate, especially in Chihuahua. Given that this jay disperses from its core range and typical habitat in winter, in response to food requirements (Balda 2002) and when other Nearctic bird species occur as rare visitors or vagrants to Chihuahua and elsewhere in northern Mexico (Moreno-Contreras *et al*. 2015, Torres-Vivanco *et al*. 2015), one could hypothesise that Mexican records reflect winter dispersal. However, none was detected in the December visit to Rancho Canoas, where the species was observed in spring to autumn. However, no juveniles were observed in our

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study, so there is no proof of breeding in Chihuahua. Nevertheless, the number of recent sightings of Pinyon Jay in Chihuahua could suggest a shift in the species' distribution, possibly due to habitat change or degradation. Additional field work might reveal a resident and breeding population of Pinyon Jay, as has been reported for several other species with no prior evidence of nesting in the Chihuahuan desert of New Mexico, USA (Kozma & Mathews 1997).

Our model clearly predicted Pinyon Jay presence in western Chihuahua. According to the median model, the species may reach montane habitats in the Sierra Madre Occidental (at least during irruptions). Given that environmental conditions in Chihuahua are similar to those in its main breeding range, we believe that the species may breed in Chihuahua sporadically, especially around the Chihuahua / New Mexico border, specifically in the Sierra de San Luis area and the Animas Mountains.

We cannot rule out that Pinyon Jay is being to some extent overlooked in Chihuahua as a result of low numbers of birders and field ornithologists, and has thus gone undetected in previous years (Moreno-Contreras *et al*. 2015). In Sonora it has been reported several times (see Russell & Monson 1998) and is probably a casual visitor. This is supported by recent extensive field work in the Madrean Sky Islands and adjacent ranges in Sonora that failed to find the species (Flesch 2014). More systematic surveys of the Sierra Madre Occidental in Sonora and Chihuahua are needed to confirm presence in suitable habitats and seasonality.

Pinyon Jay is considered Vulnerable (www.iucnredlist.org/details/full/22705608/0) due to destruction of its major habitat type, pinyon-juniper woodland. Taking as a basis the vegetation types where the species has been observed in Chihuahua (pine–oak forest, pine forests), its major habitat appears to be well protected within the Chihuahua reserve network. A previous study (Moreno-Contreras *et al*. 2017) found that 26.13% (*c*.4,088 km^2) of pine–oak forest and 13.69% (*c*.2,143 km^2) of pine forest are included in this network. Nonetheless, the primary threats to these vegetation types are continued logging of large trees, catastrophic wildfires and, in some areas, agriculture and livestock grazing, even within protected areas (Martínez-Meyer *et al*. 2014). Although the species has been well studied in northern Arizona and central New Mexico, its demography, foraging preferences and other ecological aspects are virtually unstudied in its Mexican range. Based on the available records, the area of suitable habitat in Chihuahua and our modelling results, it is possible that a breeding population of Pinyon Jay exists in Chihuahua.

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First record of a four-egg clutch of Collared Forest Falcon *Micrastur semitorquatus*, with notes on a nest in a building in southern Brazil

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http://zoobank.org/urn:lsid:zoobank.org:pub:5F0DAAF9-E508-4B47-BB7D-91A42BF4071B

Summary.—Collared Forest Falcon *Micrastur semitorquatus* ranges from northern Mexico to southern Brazil. This species is known to lay 1–3 eggs. We describe the first four-egg clutch for *M. semitorquatus* from observations made in southern Brazil, in the state of Santa Catarina. We also describe the nest site, nestling diet and assess sex ratio and mass gain of the nestlings.

Collared Forest Falcon *Micrastur semitorquatus* is a widespread bird of prey distributed from northern Mexico to southern Brazil (Ferguson-Lees & Christie 2001). The species inhabits a wide range of tropical forest habitats, including primary to secondary lowland rainforests, semi-deciduous and deciduous forests (Sick 1997). Its breeding biology is well known compared to other species of *Micrastur* (Thorstrom *et al*. 2000). Several studies, from Guatemala and Brazil, suggest the species prefers to nest in cavities, lays 1–3 eggs, which are incubated 46–48 days, and feeds the nestlings until they can fly and feed themselves (Thorstrom *et al*. 2000, Carrara *et al*. 2007). The breeding season varies geographically: February–August in the humid forests of Guatemala (Thorstrom 2000), August–November in the Brazilian Pantanal (Carrara *et al*. 2007) and the late spring and austral summer in the Atlantic Forest of southern Brazil (Carvalho-Filho *et al*. 1998, Vallejos *et al*. 2008, Marreis *et al*. 2010, Viana *et al*. 2010). Although the species typically nests within natural cavities in forests, three records of breeding in man-made structures have been reported in Brazil, where nests with eggs were found in an abandoned building (Carvalho-Filho *et al*. 1998), a barbecue pit (Marreis *et al*. 2010) and a house under construction (Viana *et al*. 2010). However, use of such structures by the species remains little studied and is restricted to descriptions of the nests and eggs. Here, we provide data on a pair of Collared Forest Falcons that nested inside a building in southern Brazil, including the first record of a four-egg clutch. We describe the nest site, diet of the nestlings and assess sex ratio and mass gain of the young.

Study site and Methods

On 7 September 2014 we were shown a nest of *M. semitorquatus* in a building at the edge of a patch of lowland Atlantic Forest (28°42′51.55″S, 49°24′40.80″W; *c*.50 m) in the municipality of Criciúma, Santa Catarina, southern Brazil. The surrounding landscape (within 1 km of the nest) mainly comprised anthropogenic areas (53.8%; 190.0 ha) including buildings, roads, artificial lakes, crops and pastures; native lowland dense ombrophilous forest (32.7%; 102.6 ha); and exotic plantations of pine (*Pinus* spp.) and eucalyptus (*Eucalyptus* spp.) (13.5%; 42.5 ha). An overall description of the area was provided by Viana *et al*. (2010) including documentation of a nest of the species in the same place in 2010.

We started monitoring mass gain and food brought to the nest 52 days after incubation began (the date of hatching is unknown). From 3 November to 8 December 2014, we

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observed the nest at intervals of 2–3 days per week, totalling 15 hours of field work. To identify each nestling individually, we marked them with coloured rings. To measure body mass, we placed the nestlings in cotton bags and weighed them with Pesola balances of 100 g and 1,000 g. In order to identify their sex we obtained blood samples from the brachial vein and performed Polymerase Chain Reaction (PCR) tests applying the dried blood spot technique.

Results

Nest and eggs.—The nest was sited in a room (4.0 m × 4.4 m, 4.0 m high) with four windows of *c*.0.45m² on the third floor (15 m above ground) of the building, which was under construction during the observation period. Four dark reddish-brown eggs with beige and black spots had been laid on the concrete floor, but were placed in a wooden box with palm leaves by the builders (Fig. 1).

Diet.—During the entire observation period we apparently observed only a single cream-coloured adult at the nest. We identified a total of 11 food items of eight species at the nest (Table 1). Birds were the commonest prey (78%), followed by bats and lizards (11% each). Adult Scaled Chachalacas *Ortalis squamata* were the most frequent prey, representing 27% of all items. Body mass of prey ranged from 66 g (a bat *Artibeus lituratus*) to 1,100 g (a domestic chicken *Gallus gallus domesticus*).

Nestling sex ratio and growth.—The sex ratio of the nestlings was 1:1. One female nestling had a body mass of 140 g on day 7 after hatching, whereas the other female weighed 71 g, and the two males were 114 and 116 g, respectively, on the same day. Mass

Figure 1. Nest and nestlings of Collared Forest-Falcon *Micrastur semitorquatus* in a man-made structure in Criciúma, Santa Catarina, southern Brazil, September 2014 (Rafael Spilere Romagna)

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TABLE 1
Diet of Collared Forest-Falcon *Micrastur semitorquatus* nestlings in a man-made structure, Criciúma, Santa Catarina, southern Brazil. a = adult, j = juvenile.

Taxon	**No. of individuals**
Squamata	
Salvator merianae (j)	1
Aves	
Domestic chicken *Gallus gallus domesticus* (a)	1
Scaled Chachalaca *Ortalis squamata* (a, j)	3, 1
Roadside Hawk *Rupornis magnirostris* (j)	1
Squirrel Cuckoo *Piaya cayana* (a)	1
Guira Cuckoo *Guira guira* (j)	1
Blond-crested Woodpecker *Celeus flavescens* (a)	1
Chiroptera	
Artibeus lituratus (a)	1

gain was greatest for all nestlings between days 14 and 35 after hatching. Mean mass gain per day was 34 g and 36 g for the males, 38.5 g for the smaller female and 43.5 g for the other female. At the end of the sampling period, on 8 December, the females weighed 750 g and 610 g, and the males weighed 620 g and 590 g.

Discussion

Our observations represent the first record of a four-egg clutch for *M. semitorquatus* (see Wetmore 1974, Guedes 1993, Thorstrom *et al*. 1990, 2000, Carvalho-Filho *et al*. 1998, Carrara *et al*. 2007, Vallejos *et al*. 2008, Marreis *et al*. 2009, Viana *et al*. 2010). Clutch-size data for congenerics are available only for Barred Forest Falcon *M. ruficollis*, which lays 1–3 eggs (Thorstrom *et al*. 1990, 2000).

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Preliminary assessment of community composition and phylogeographic relationships of the birds of the Meratus Mountains, south-east Borneo, Indonesia

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Summary.—The Meratus Mountains of south-east Borneo are biogeographically interesting due to their isolation and potential endemicity. However, Meratus' birds have never been quantitatively surveyed or collected, so we know little of their community structure or taxonomy. In May 2017, we visited Mt. Besar in the Meratus range to assess its avifauna and collect specimens for phylogeographic study. Here, we report on Mt. Besar's avifauna and provide preliminary ND2-sequence assessments of their relationships. We recorded 89 species, of which we collected 68 species; 17 represented distributional extensions. Mt. Besar's avian community is depauperate compared to Borneo's main mountains, and several of its species exhibit unusual elevational abundance patterns. We attribute these findings to the range's small area, low elevation, isolation from other mountains, depleted surrounding native lowland forest, and exploitation for food and pet-trading. ND2 comparisons indicate that at least 12 Meratus species exhibit population structure that merits additional phylogeographic study.

The island of Borneo is well known for its impressive avian diversity, which includes at least 373 breeding landbird and 52 endemic species, depending on classification (Dickinson & Remsen 2013, Dickinson & Christidis 2014, Sheldon *et al*. 2015, Eaton *et al*. 2016c, Clements *et al*. 2017). This remarkable diversity hinges on the island's wide range of habitats, from low-elevation mixed-dipterocarp, peatswamp and kerangas forests to montane moss forests and ericaceous heath. Although most of Borneo's avian diversity inhabits the lowlands, the island's montane forests are particularly important in terms of biogeographic history, not only of the island itself but the Greater Sundas as a whole (de Bruyn *et al*. 2014, Sheldon *et al*. 2015). Borneo's mountains include the main central range, which runs north-east to south-west across most of the island and features several peaks above 2,000 m in elevation, one of which, Mt. Kinabalu, reaches 4,095 m (Fig. 1). There are also numerous smaller ranges and peaks that are isolated from the main range by areas of low elevation. As a group, Borneo's mountains—especially those on the eastern side of the island—are thought to have played a key role in fomenting and preserving much of South-East Asia's avian diversity (de Bruyn *et al*. 2014, Sheldon *et al*. 2015). The mountains supported rainforest continuously during dramatic climatic changes in the Oligocene, Pliocene and Pleistocene, when colder temperatures extirpated rainforest over much of the rest of Sundaland in favour of seasonal forest and even grasslands (Bird *et al*. 2005, Morley 2012, Sheldon *et al*. 2015). However, despite the biogeographic importance of Borneo's mountains, remarkably little is known concerning the evolution and ecology of birds there, especially those occurring in mountains outside the Malaysian states of Sarawak and Sabah. This is particularly true of birds in the Meratus range of south-east Borneo. These mountains have rarely been visited by ornithologists or birdwatchers (Davison 1997, Eaton *et al*. 2016a), and their birds have

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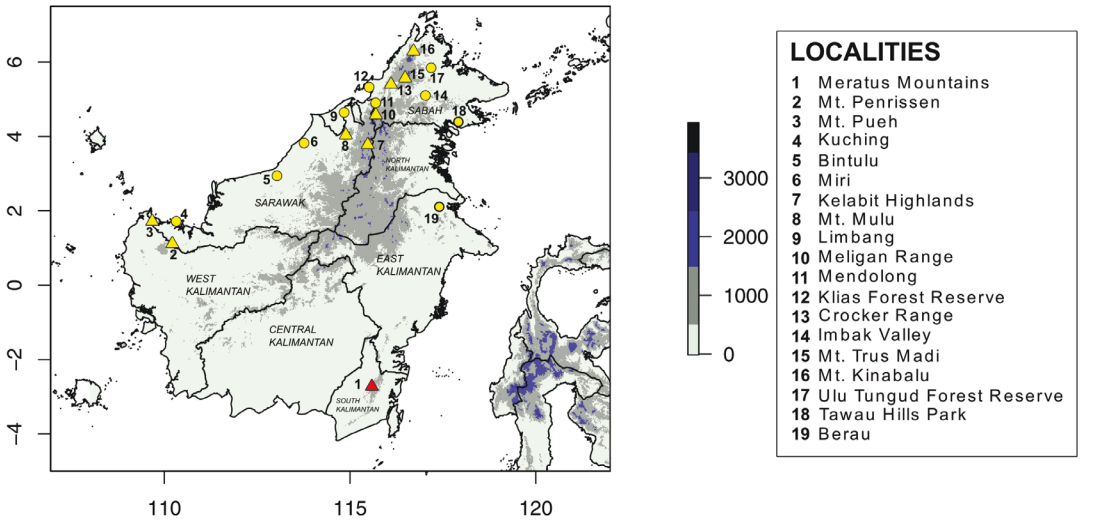

Figure 1. Map of Borneo showing the location of the Meratus and other mountain ranges.

never been surveyed quantitatively or collected for taxonomic study. As a result, we know little concerning the biogeographic relationships or community composition of the Meratus avifauna.

The Meratus Mountains are a low-elevation range skirting the south-east corner of Borneo in the Indonesian province of South Kalimantan (Fig. 1). They run north-northeast and are *c*.300 km in length and 65 km wide (Witts *et al*. 2012), with a highest point at Mt. Besar (1,901 m). The mountains consist mainly of an early Cretaceous volcanic arc and ophiolite sequence (Moss & Wilson 1998) but, like Mt. Kinabalu, they are relatively young, having arisen in the middle to late Miocene as a result of collision and subduction of continental plates on Borneo's south-eastern side (Witts *et al*. 2012). Their potential as a Pleistocene refugium and area of high endemicity has long been appreciated (MacKinnon *et al*. 1996, Gathorne-Hardy *et al*. 2002, Quek *et al*. 2007, Raes *et al*. 2009). Most forest in the Meratus Mountains is intact compared to the surrounding lowlands, but it is largely unprotected from logging and development, except the southern section, which lies within the Martapura-Pleihari Reserve (Holmes & Burton 1987, Davison 1997).

To date, only two surveys of Meratus birds have been published. Davison (1997) visited these mountains between 30 September and 10 October 1996. He identified 80 species above 800 m, expanding the known range of 21 montane specialists (*sensu* Wells 1985). Eaton *et al*. (2016a) visited the mountains on 7–10 July 2016. They observed, audio-recorded and photographed birds, identified 91 species, expanded the known range of several species, and discovered what they believed to be new species of *Cyornis* and *Zosterops*. Both expeditions approached the range from the west via Loksado (*c*.200 m) and the village of Kadayang (*c*.500 m). Davison (1997) reached close to the top of Mt. Karokangan (1,686 m), while Eaton *et al*. (2016a) reached the peak of Mt. Besar (1,901 m). Both noted that forest was heavily disturbed below 900 m, where rugged limestone outcrops appear (Davison 1997), and mildly disturbed above this elevation. The discoveries made by these two expeditions highlight the potential importance of the Meratus Mountains to understanding the evolution of avian diversity on Borneo.

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Louisiana State University Museum of Natural Science (LSUMNS) and the Museum Zoologicum Bogoriense, Indonesian Institute of Sciences (MZB), conducted a joint expedition to Mt. Besar on 1–19 May 2017. The primary purpose was to obtain molecular and morphological specimens for use in ongoing studies of Sundaic avian biogeography (e.g., Lim *et al*. 2011, Lim & Sheldon 2011, Chua *et al*. 2017, Lim *et al*. 2017, Moyle *et al*. 2017). We were also interested in the elevational distribution of birds in the Meratus Mountains, and how this distribution compares with montane communities examined elsewhere on Borneo (e.g., Harris *et al*. 2012, Burner *et al*. 2016). Here, we report on the expedition, approximate distribution of birds in the Mt. Besar region, and findings of preliminary molecular phylogeographic comparisons.

Methods

Expedition.—Our team comprised three researchers from LSUMNS (SBS, RCB, FHS), a researcher (TH) and field technician from MZB (Suparno), and a variety of local guides and porters. Like Davison (1997) and Eaton *et al*. (2016a), we approached Mt. Besar from Loksado in the Hulu Sungai Selatan regency of South Kalimantan province. We travelled from Loksado to the village of Kadayang (02°44′47″S, 115°33′20″E; 500 m), where we mist-netted birds on 1–6 May 2017. Near Kadayang, virtually all forest had been converted to (mostly overgrown) rubber, plots of hill rice, and gardens. On 6 May, we established camp on the Mt. Besar summit trail at a site known locally as 'Matupa' (02°43′30″S, 115°35′11″E; 1,150 m). We remained at this site until 19 May, setting mist-nets along the main ridge at 1,100–1,200 m and along another ridge at 1,350 m (02°43′22″S, 115°35′35″E). As noted by earlier expeditions, rubber plantation and shifting cultivation gave way to less disturbed forest at *c*.900–1,000 m. The forest above 1,000 m was largely intact, although there were some cleared areas of varying age, and footpaths were heavily trafficked by hunters armed with air guns (pellet guns) and persons seeking forest products.

Elevational records.—Avian species were sampled using mist-nets and by opportunistic observation based on visual and aural detections. Team members noted all species heard or seen during the trip, but most of our effort was directed towards mist-netting and specimen preparation.

Comparative analysis.—For morphometric comparisons we measured bill length, width and depth (all at the rear of the nares), as well as tail length, diagonal tarsus and flat wing-chord length.

We compared mitochondrial ND2 sequences of 41 species from Mt. Besar with sequences from populations in other parts of South-East Asia as available (Appendices 1–2). ND2 was used because it is the most commonly sequenced avian gene and numerous sequences were available in GenBank. When possible, we compared two individuals from each population, and included outgroups for perspective. Total genomic DNA from preserved tissues was extracted using DNEasy® Blood and Tissue Kit (Qiagen) following the manufacturers' protocol. PCR amplifications were performed in 25 µl reactions using Taq DNA Polymerase (New England BioLabs Inc.) and ND2 primers L5215 (Hackett 1996) and HTrpC (STRI). Amplification consisted of 34 cycles at a denaturing temperature of 95°C, an annealing temperature of 54°C and an extension temperature of 72°C. We visualised the PCR products in 1.5% agarose gel stained with SYBR® Safe DNA Gel Stain (Invitrogen). Samples were sequenced at Macrogen USA (Rockville, MD). The ND2 sequences were assembled in Geneious 8.1.9 (Biomatters) and aligned using MUSCLE (Edgar 2004) implemented in Geneious. We generated mitochondrial gene trees using the maximum likelihood (ML) framework in RAxML 8 (Stamatakis 2014), with 1,000 bootstrap replicates, through the CIPRES Science Gateway (Miller *et al*. 2010).

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Results

Expedition.—We recorded 89 species on Mt. Besar (Appendix 1), of which 68 were collected. Of the species recorded, 17 were new for the Meratus Mountains (marked with double asterisks in Appendix 1). Most notable among these was Bornean Spiderhunter *Arachnothera everetti*, the first record of this species outside Borneo's main mountain chain (Mann 2008, Brickle *et al*. 2010, Burner *et al*. 2016, Moyle *et al*. 2017). Its occurrence in the Meratus Mountains mirrors Bornean Leafbird *Chloropsis kinabaluensis*, which until it was discovered in the Meratus Mountains by Eaton *et al*. (2016a) was also thought to be restricted to Borneo's main mountain chain (Mann 2008, Moyle *et al*. 2011, 2017). Two of our 'new' Meratus records, Black-backed Dwarf Kingfisher *Ceyx erithaca* and Pin-tailed Parrotfinch *Erythrura prasina*, were anticipated by Davison (1997) from discussions with villagers. Some usually easily detected species recorded by Davison (1997) were not found by us or by Eaton *et al.* (2016a), most notably Helmeted Hornbill *Buceros vigil*, Oriental Magpie-Robin *Copsychus saularis*, White-rumped Shama *C. malabaricus* and Grey-cheeked Bulbul *Alophoixus bres.* These species are highly sought by hunters and pet traders (Eaton *et al*. 2016b), and probably have been extirpated from the area we visited.

Elevational records.—Elevational ranges of most species detected on Mt. Besar were within the limits known from other parts of Borneo. However, some patterns of species occurrence appeared unusual. Several species that are common at the same elevations in similar forest in other parts of Borneo were absent or found in low numbers on Mt. Besar. These include species that are generally common and conspicuous at 500 m, such as Grey-bellied Bulbul *Pycnonotus cyaniventris*, Spectacled Bulbul *P. erythropthalmos*, Yellow-bellied Bulbul *Alophoixus phaeocephalus*, Fluffy-backed Tit-Babbler *Macronus ptilosus*, Rufous-fronted Babbler *Cyanoderma rufifrons*, Rufous-crowned Babbler *Malacopteron magnum* and Short-tailed Babbler *Pellorneum malaccense*. Other 'missing' species were Rufous-winged Philentoma *Philentoma pyrhoptera*, Green Iora *Aegithina viridissima*, Blyth's Paradise Flycatcher *Terpsiphone affinis* and Pale Blue Flycatcher *Cyornis unicolor*. Another unusual feature of the bird community at 500–1,200 m was that its commonest species (based on capture and incidental observations) was Hill Blue Flycatcher *Cyornis banyumas*, which is generally uncommon and restricted to a narrow submontane elevational band in other parts of Borneo. Other slope specialists that are principally montane elsewhere in Borneo but occurred in unusually large numbers at 500 m on Mt. Besar were Grey-throated Babbler *Stachyris nigriceps* and Temminck's Babbler *Pellorneum pyrrogenys.* Their abundance near Kadayang was remarkable. At higher elevation, *c*.1,300–1,400 m, some usually scarce species were remarkably common, e.g., Bornean Stubtail *Urosphena whiteheadi*. In contrast, a species that is generally common and easy to mist-net in the main Bornean mountain range, Chestnut-hooded Laughingthrush *Ianthocincla treacheri*, was rarely seen and only occasionally heard (see Discussion).

Genetic and morphological comparisons.—Of the 41 Meratus species whose ND2 we compared, 23 were not obviously distinct from populations sampled elsewhere on Borneo, i.e., their phylogeographic trees had little branching structure, and their ND2 divergence values averaged less than 1%: Plaintive Cuckoo *Cacomantis merulinus*, Rufous Piculet *Sasia abnormis*, Malaysian Pied Fantail *Rhipidura javanica*, White-throated Fantail *R. albicollis*, Spotted Fantail *R. perlata*, Ashy Drongo *Dicrurus leucophaeus*, Bornean Treepie *Dendrocitta cinerascens*, Ashy Bulbul *Hemixos flavala*, Mountain Leaf Warbler *Phylloscopus trivirgatus*, Yellow-breasted Warbler *Seicercus montis*, Rufous-tailed Tailorbird *Orthotomus sericeus*, Scaly-crowned Babbler *Malacopteron cinereum*, Brown Fulvetta *Alcippe brunneicauda*, *Pellorneum pyrrogenys*, *Ianthocincla treacheri*, Rufous-chested Flycatcher *Ficedula dumetoria*,

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Little Pied Flycatcher *F. westermanni*, Eyebrowed Jungle Flycatcher *Vauriella gularis*, *Chloropsis kinabaluensis*, Chestnut-crested Yuhina *Yuhina everetti*, *Arachnothera everetti*, Little Spiderhunter *A. longirostra* and Purple-naped Spiderhunter *A. hypogrammicum.* In six cases, we did not possess an adequate number of specimens or sequences to speculate on patterns of population structure: Bornean Barbet *Psilopogon eximius*, Grey-chinned Minivet *Pericrocotus solaris*, Blyth's Shrike-Babbler *Pteruthius aeralatus*, *Urosphena whiteheadi*, Mountain Tailorbird *Phyllergates cucullatus* and Indigo Flycatcher *Eumyias indigo*. However, the remaining 12 species exhibited phylogeographic patterns worthy of further work. We depict these patterns in Fig. 2 and describe them briefly below, but caution that population genetic parameters have not been examined in detail. Also, note that mitochondrial trees sometimes indicate incorrect population structure (see Bornean examples in Lim *et al*. 2017, Manthey *et al*. 2017). The rooted trees in Fig. 2, therefore, are intended only as preliminary guides for future investigation.

Bornean Whistler *Pachycephala hypoxantha*.—Meratus individuals form a clade separate from other Bornean individuals, but divergence between the populations is not large (*c*.1%).

Ochraceous Bulbul *Alophoixus ochraceus*.—The Meratus population differs by 4.5% from both *A. o. ruficrissus* (Sabah specimens) and *A. o. fowleri* (Sarawak specimens), which are also distinct genetically from each other (Chua *et al*. 2017). All three populations differ in plumage (Table 1). The Sabah and Sarawak populations lack yellow pigment in their plumage, causing them to appear distinct from other populations of *A. ochraceus*. Indeed, the Meratus individuals look more like Sumatran than northern Bornean birds, raising the possibility of multiple invasions of Borneo. Confusion is also wrought by paraphyly of *A. ochraceus* and Grey-cheeked Bulbul *A. bres* as traditionally constituted; *A. ochraceus* of Sabah is sister to *A. bres* of Java (Fuchs *et al*. 2015, Collar 2017). *A. ochraceus* and *A. bres* populations among all of the Greater Sundas and the Malay Peninsula should be compared before their scientific names are revised.

Lemon-bellied White-eye *Zosterops chloris*.—This is one of the taxa identified as a new species by Eaton *et al*. (2016a). ND2 comparisons with 45 other species of white-eyes, including the genera *Zosterops*, *Lophozosterops*, *Speirops* and *Chlorocharis* (mostly from Moyle *et al*. 2009), reveal the Meratus population to be most closely related to *Z. chloris* (ND2 divergence 2.69%). This finding makes general biogeographic sense, because *Z. chloris* occurs from Wallacea west across some islands of the Java Sea to Karimata and Belitung (van Balen 2017). The occupied islands include Kalambau and Solombo Besar near the south-east corner of Borneo (Clements *et al*. 2017). However, *Z. chloris* generally occurs at low elevations and in coastal habitats, whereas the Meratus population is montane. As such, the Meratus population appears to fill a potential ecological gap left by the absence of montane white-eye species that occupy mountains in other parts of Borneo: Black-capped White-eye *Z. atricapilla*, Mountain Black-eye *Chlorocharis emiliae* and Pygmy White-eye *Oculocincta squamifrons*. None of these species seems to occur in the Meratus range, leaving the high-elevation forest open for invasion and occupation by *Z. chloris*. We have not yet performed a morphological analysis for lack of specimens from other populations, but plumage of the Meratus birds appears much like that in photographs of other populations (Fig. 3). Given the large number of *Z. chloris* populations across the Java Sea and Wallacea, extensive study will be required to determine more precise phylogeographic relationships of the Meratus birds.

Bold-striped Tit-Babbler *Mixornis bornensis*.—Genetic comparisons of the Meratus population indicate it is closest to individuals from Sarawak and western Sabah (Meligan range) (ND2 divergence 0.55%) than to those in the rest of Sabah and mid-eastern Kalimantan (Berau) (ND2 divergence 3.33%). However, this species displays greater mtDNA

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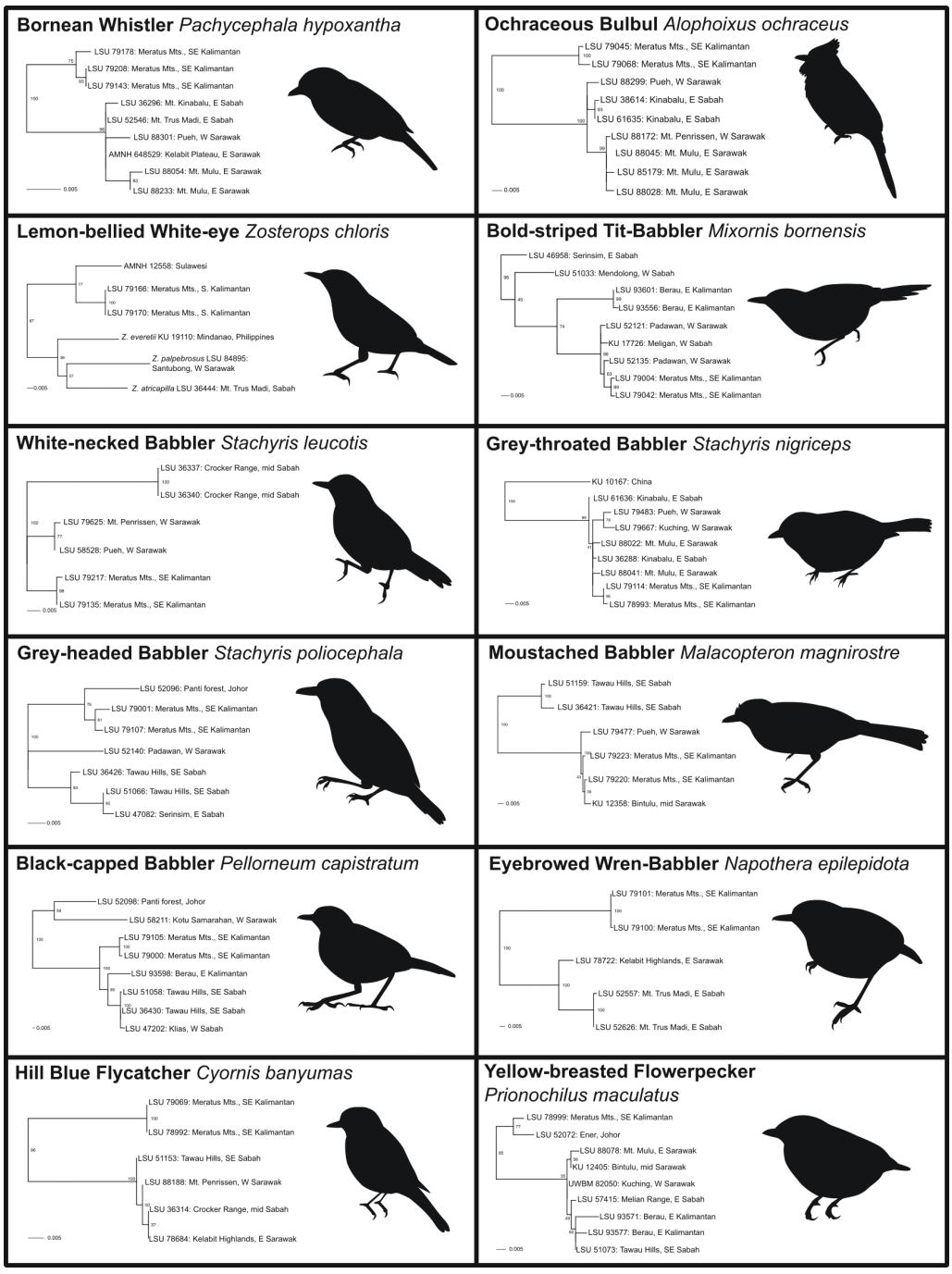

Figure 2. Rooted maximum likelihood trees indicating mtDNA-ND2 relationships between Meratus and other populations (in some cases species) for 12 species exhibiting marked genetic patterns. Bootstrap values are reported next to respective nodes.

than nuclear DNA structure on Borneo (Lim *et al*. 2017). It also has complex relationships with Pin-striped Tit-Babbler *M. gularis* (Cros & Rheindt 2017), its closest relative outside of

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TABLE 1
Plumage colour variation in Ochraceous Bulbul *Alophoixus ochraceus* and Grey-cheeked Bulbul *A. bres* from the Meratus Mountains and other parts of Borneo.

Plumage tract	***A. ochraceus* (Meratus)**	***A. ochraceus ruficrissus*/ *fowleri* (Sabah and Sarawak)**	***Alophoixus bres* (Sabah and Sarawak)**
Crown and nape	Grey	Greyish brown	Rufous-brown
Back and rump	Olive-green	Olive-brown	Olive-green
Tail	Dark reddish brown	Dark reddish brown	Dark reddish brown
Wings	Brown with green edges	Dark reddish brown	Dark reddish brown
Throat	White	White	White
Breast and flanks	Bright olive-green	Greyish brown	Pinkish brown
Belly	Lemon-yellow	Pale yellowish brown	Pale yellow
Vent	Yellowish brown	Rufous	Yellowish brown

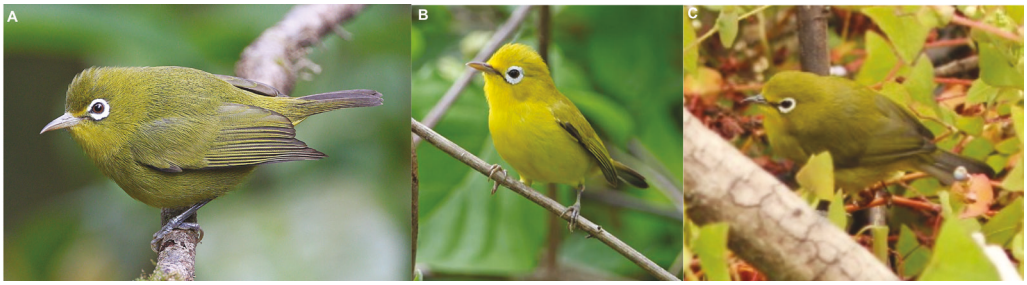

Figure 3. Lemon-bellied White-eyes *Zosterops chloris* from: (A) the Meratus Mountains (J. C. Eaton); (B) Tukangbesi Islands, south-east Sulawesi, *Z. c. flavissimus* (J. C. Eaton); and (C) Lore Lindu National Park, central Sulawesi, *Z. c. mentalis* (D. Beadle)

Borneo, decreasing the reliability of conclusions based on a few mtDNA comparisons of a limited sample of specimens.

White-necked Babbler *Stachyris leucotis*.—The Meratus, Sarawak and Sabah populations appear to form distinct clades. ND2 distances are: Meratus–Sarawak 1%, Meratus–Sabah 3% and Sabah–Sarawak 3%. The substantial divergence separating Sabah's population from the others is consistent with many other species (Lim *et al*. 2010, 2011, Lim & Sheldon 2011, Lim *et al*. 2017).

Grey-throated Babbler *Stachyris nigriceps*.—The Meratus population appears distinct from western Sarawak and north-eastern populations (ND2 divergence 4%; also see Chua *et al*. 2017).

Grey-headed Babbler *Stachyris poliocephala*.—Like White-necked Babbler *S. leucotis*, this lowland species exhibits marked divergence among Meratus, Sarawak and Sabah populations (ND2 divergence 2.3%) (Lim *et al*. 2011).

Moustached Babbler *Malacopteron magnirostre*.—The population-genetic structure of Borneo's *Malacopteron* species has never been assessed. Meratus and Sarawak populations appear to be closely related and quite distinct from birds in eastern Sabah (ND2 divergence 5.81%). The pattern in this species suggests a connection between western and southern Bornean populations and, again, a distinct history for the north-east population (Lim *et al*. 2010, 2011, Lim & Sheldon 2011, Lim *et al*. 2017).

Black-capped Babbler *Pellorneum capistratum*.—The Meratus population is distinct from others in Borneo (average ND2 divergence 7.2%), and Sabah and Sarawak populations are distinct from one another as well (ND2 divergence 11.2%) (Lim *et al*. 2011).

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Eyebrowed Wren-Babbler *Napothera epilepidota*.—Few tissues of this species are available for genetic assessment. However, the three Bornean populations we compared are remarkably different from one another genetically, in the order of 7%. We did not obtain sufficient specimen material to judge morphological differences.

Hill Blue Flycatcher *Cyornis banyumas*.—This taxon is one of two possibly new species mentioned by Eaton *et al*. (2016a). ND2 comparisons indicate that the Meratus population is monophyletic with *C. banyumas* and divergent by 3.27% from other Bornean populations that have been sampled (i.e., in Sabah and on Mt. Mulu in eastern Sarawak). Morphometric comparisons indicate that Meratus individuals are larger overall in size and have larger bills than those from Borneo's central mountain chain (Table 2). The orange breast of Meratus males also grades into a whiter belly and their black chin is much reduced compared to male *C. banyumas* from Mt. Mulu and Sabah. As with *Z. chloris*, thorough phylogeographic comparisons across the entirety of Sundaland will be required to establish the phylogeographic position of the Meratus population.

Yellow-breasted Flowerpecker *Prionochilus maculatus*.—Our single Meratus specimen is relatively distinct genetically from other Bornean populations and closer to a Peninsular Malaysian bird. Better sampling will be required to tell if this unexpected relationship is well supported and what it implies for Bornean populations.

Discussion

Avifaunal characteristics.—Compared to Borneo's central mountain chain, the Meratus forest bird community has distinctive features. At 500 m, some common lowland species are absent (e.g., *Pycnonotus erythropthalmos*, *Macronus ptilosus* and *Pellorneum malaccense*), whereas species normally uncommon at this elevation are abundant (e.g., *Stachyris nigriceps*, *Pellorneum pyrrogenys* and *Cyornis banyumas*). At higher elevations, 1,100–1,400 m, some species that are usually common are uncommon (e.g., *Ianthocincla treacheri*), and others that are typically uncommon are remarkably common (e.g., *C. banyumas*, *Urosphena whiteheadi*). Moreover, at this higher elevation, many montane species are completely absent, including numerous Bornean endemics such as Whitehead's Trogon *Harpactes whiteheadi*, Whitehead's Broadbill *Calyptomena whiteheadi* and Whitehead's Spiderhunter *Arachnothera juliae*.

Several interacting factors probably contribute to these patterns. First, the Meratus range is relatively small in area, low in elevation and isolated from other mountain ranges. Simply as a function of size, elevation and location, i.e., by the expectations of island biogeography, the Meratus Mountains should lack a complete montane avifauna. Second,

TABLE 2
Size comparison between six specimens of Meratus and five specimens of Sabah and Sarawak populations of Hill Blue Flycatcher *Cyornis banyumas*, including males and females. T-test values show significance of differences between the two groups. All measurements in mm.

Population	Culmen length	Culmen width	Culmen depth	Tail	Tarsus	Wing
Meratus (mean)	10.63	5.87	4.53	64.78	20.48	78.83
Meratus (s.d.)	0.37	0.25	0.35	2.86	1.24	2.19
Sabah and Sarawak (mean)	9.68	5.48	3.86	61.20	17.98	72.80
Sabah and Sarawak (s.d.)	0.22	0.31	0.14	1.43	1.32	1.60
T-test *P* value	0.001	0.038	0.003	0.024	0.009	0.001

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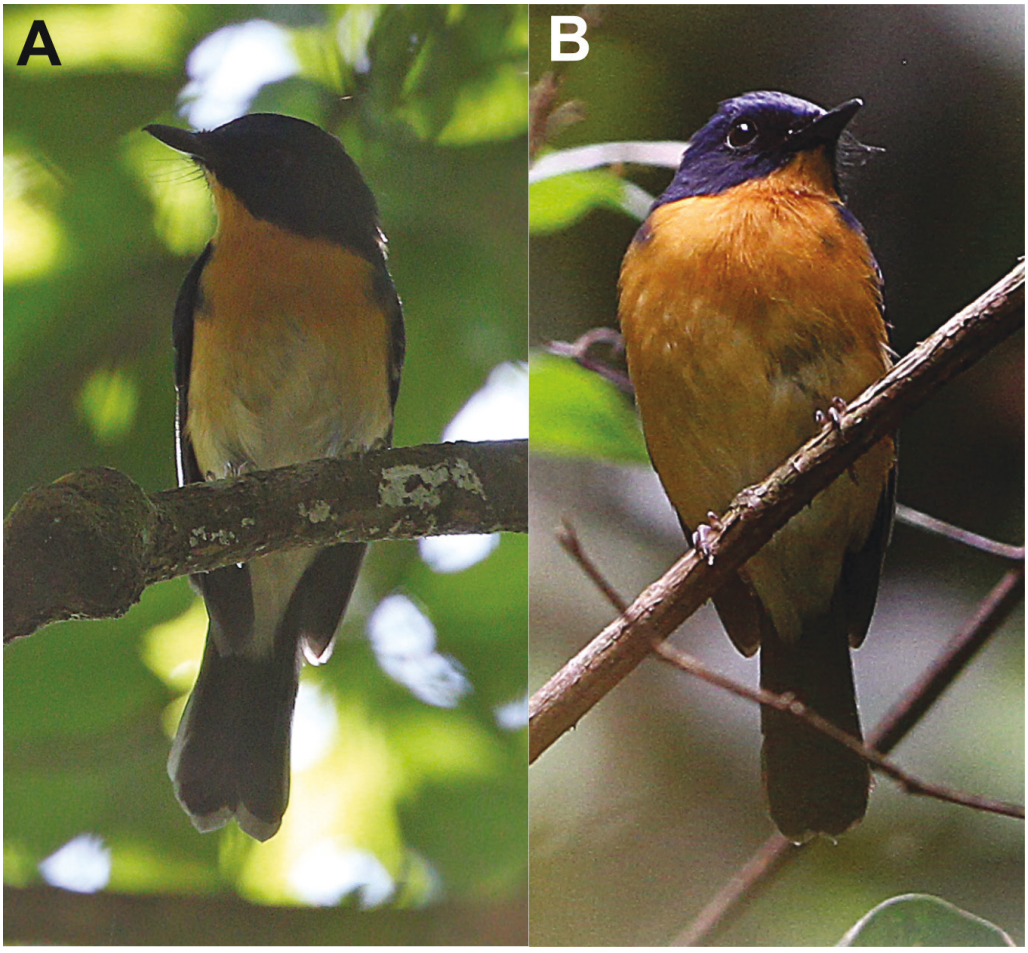

Figure 4. Male Hill Blue Flycatchers (*Cyornis banyumas*) from: (A) the Meratus Mountains (J. C. Eaton) and (B) Poring, Sabah, *C. b. montanus* (J. C. Eaton)

native lowland forest surrounding the Meratus Mountains has been replaced mostly by plantations: oil palm at low elevation, rubber and mixed-use forest at higher elevation (up to 900 m). Thus, the lowland forest avifauna that would normally contribute to the Meratus community at 500 m and above has largely been depleted. Montane species such as *Stachyris nigriceps* and *Cyornis banyumas* may be filling this low-elevation species void. There may also be a Massenerhebung effect driving montane species to lower elevation (Bruijnzeel *et al*. 1993). Third, the local human population appears to depend heavily on small birds for protein. Virtually every villager we encountered in the forest was carrying an air gun (pellet gun) and was shooting small birds and mammals for food. Unlike shotgun ammunition, air gun ammunition is inexpensive and, thus, these guns can be used economically to hunt animals that individually yield small amounts of food. The guns are also quiet when fired, and do not disturb wildlife. We observed hunters climbing fruiting fig trees and shooting numerous barbets at a sitting. This type of hunting pressure might explain the paucity of pigeons, trogons, laughingthrushes, drongos, *Alophoixus* bulbuls and other mid-sized species in the area we visited. Finally, hornbill-ivory hunters and pet traders appear to have extirpated *Buceros vigil*, *Copsychus saularis*, *C. malabaricus* and *Alophoixus bres* in the

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Kadayang area, and may be influencing numbers of other popular cagebird species (e.g., laughingthrushes and leafbirds).

Biogeographic issues.—Knowledge of Sundaic rainforest bird phylogeography is confined mainly to studies of populations in Malaysian Borneo (Sabah and Sarawak). Although restricted geographically, these studies provide hypotheses against which to judge the results of our preliminary genetic comparisons of Meratus bird populations. Studies in Malaysian Borneo indicate that lowland populations of birds in Sarawak are often more closely related to those in western Sundaland (Malay Peninsula and Sumatra) than to populations in Sabah (Sheldon *et al*. 2009, Lim *et al*. 2010, 2011, Lim & Sheldon 2011, Lim *et al*. 2017). This pattern, combined with molecular estimates of divergence dates, suggests that Sabah's lowland birds were isolated (one or more times) from populations in western Sundaland, probably in rainforest refugia during global glacial events early in the Pleistocene (e.g., 1–2 million years ago) when most of central Sundaland was subaerial and covered by dry or seasonal forest (Sheldon *et al*. 2015). Similarly, studies suggest that Bornean populations of montane taxa, such as *Chloropsis kinabaluensis*, Bornean Forktail *Enicurus leschenaulti borneensis* and *Arachnothera everetti*, were isolated in rainforest refuges in north-east Borneo from congeneric populations in western Sundaland early in the Pleistocene (Moyle *et al*. 2005, 2011, 2017). During the more recent Pleistocene, glaciation events apparently had a different effect on Sundaic habitats; instead of reducing rainforest cover in Sundaland, they increased it, causing greater habitat connectivity among islands and the mainland (Cannon *et al*. 2009, Raes *et al*. 2014). Genetic comparisons suggest that, concomitant with this recent increase in rainforest coverage, several western Sundaic bird populations invaded Borneo and occupied the western lowlands, pushing or restricting endemic Bornean populations to the east or into the mountains. These dynamics caused the marked parapatry witnessed today between populations in the lowlands of Sarawak and Sabah (e.g., between White-rumped Shama *Copsychus malabaricus suavis* in Sarawak and White-crowned Shama *C. m. stricklandii* in Sabah) and between populations in the lowlands and mountains of Borneo (e.g., White-crowned Forktail *Enicurus leschenaulti frontalis* in the lowlands and Bornean Forktail *E. l. borneensis* at higher elevation) (Sheldon *et al*. 2015, Moyle *et al*. 2017). Using these biogeographic scenarios as a foundation, we can put our preliminary phylogeographic comparisons of Meratus birds into context and identify the requirements of future investigations.

One of the most interesting discoveries of this study is the occurrence of *Chloropsis kinabaluensis* and *Arachnothera everetti* in the Meratus Mountains (also see Eaton *et al*. 2016a). Previously these species were known only from north-eastern portions of the main Bornean mountain range, e.g., Mulu, Crocker Range and Menyapa Mountains (Mann 2008, Brickle *et al*. 2010, Burner *et al*. 2016, Moyle *et al*. 2017). Their presence in the Meratus Mountains suggests that early Bornean Pleistocene rainforest refuges occurred not just in Sabah (Sheldon 2016) but also in mountains and adjacent lowlands near the coast across much of eastern Borneo. This hypothesis is supported by paleo-habitat data (Morley 2012), paleo-habitat modelling (Cannon *et al*. 2009, Lim *et al*. 2011, Manthey *et al*. 2017) and phylogeographic studies (Quek *et al*. 2007, Chua *et al*. 2015).

Some of our preliminary ND2 comparisons suggest that lowland species in the Meratus Mountains are more closely related to western Sarawak or even western Sundaic populations than to north-east Bornean populations (e.g., *Malacopteron magnirostre*, *Stachyris leucotis* and *Prionochilus maculatus*). This pattern could result from the same phenomenon causing similarity between Sarawak and western Sundaic populations: invasion of Borneo from the west during recent global glacial events when the islands and mainland were connected by suitable habitat. Recent invasion of Borneo might also explain the genetic

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difference between montane birds in the Meratus Mountains and those in northern Borneo (e.g., *Alophoixus ochraceus*, *Pellorneum pyrrogenys*, *Napothera epilepidota* and *Cyornis banyumas*). Invasion from Sumatra is possible for all four of these species; the last three could have arrived from Java. A faunal connection between Java and south-east Borneo is especially likely, given proximity. Several open- or dry-habitat taxa are shared between Java and Borneo, e.g., Red-breasted Parakeet *Psittacula alexandri*, Savanna Nightjar *Caprimulgus affinis*, *Copsychus saularis* and Scarlet-headed Flowerpecker *Dicaeum trochileum* (e.g., Mees 1996, Phillipps & Phillipps 2014). More importantly for Meratus populations, preliminary genetic comparisons of some taxa from Borneo's central mountain chain, e.g., swiftlets (*Collocalia*), spiderhunters (*Arachnothera*) and forktails (*Enicurus*), suggest they are closest to Javan populations (Moyle *et al*. 2005, 2008, 2011). Thus, it is reasonable to expect that some birds in the Meratus Mountains will have at least as much, or greater, affinity with Javan populations than with other Bornean populations.

Overall, understanding the biogeographic significance of genetic and morphological divergence in both lowland and montane populations of the Meratus Mountains will require phylogeographic comparisons with populations of Java, Sumatra and even Peninsular Malaysia, as well as the rest of Borneo. For *Zosterops chloris*, it will require comparisons with populations across the Java Sea and Wallacea.

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Appendix 1: List of bird species recorded in the Meratus Mountains

Scientific name[a]	English name[a]	Elevation, this study[b]			Davison (1997)[c]	Eaton *et al.* (2017)
		500 m	1,150 m	1,350 m		
Rollulus rouloul	Crested Partridge					x
Spilornis cheela	Crested Serpent Eagle	x			x	x
Nisaetus alboniger	Blyth's Hawk-Eagle					x
Lophotriorchis kienerii	Rufous-bellied Eagle					x
Macropygia ruficeps	Little Cuckoo-Dove		x		x	x
Chalcophaps indica	Asian Emerald Dove	x			x	
*Treron olax***	Little Green Pigeon		x			
Ducula badia	Mountain Imperial Pigeon				x	
Centropus sinensis	Greater Coucal	x			x	
Centropus bengalensis	Lesser Coucal				x	
Phaenicophaeus curvirostris	Chestnut-breasted Malkoha	s				
*Cacomantis merulinus**	Plaintive Cuckoo	s			x	
Cacomantis variolosus	Brush Cuckoo					x

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Scientific name[a]	English name[a]	Elevation, this study[b]			Davison (1997)[c]	Eaton *et al.* (2017)
		500 m	1,150 m	1,350 m		
Surniculus lugubris	Square-tailed Drongo-Cuckoo		x		x	
Cuculus micropterus	Indian Cuckoo		x		x	
Cuculus lepidus	Sunda Cuckoo		x	s	x	x
Otus spilocephalus	Mountain Scops Owl					x
Bubo sumatranus	Barred Eagle-Owl					x
Glaucidium brodiei	Collared Owlet		s			x
Batrachostomus poliolophus	Short-tailed Frogmouth				x	x
Lyncornis temminckii	Malaysian Nightjar				x	
Rhaphidura leucopygialis	Silver-rumped Needletail				x	
Collocalia affinis	Plume-toed Swiftlet				x	
Aerodramus sp.	swiftlet sp.	x			x	x
Cypsiurus balasiensis	Asian Palm Swift	x				x
Harpactes diardii	Diard's Trogon	s				x
*Harpactes oreskios***	Orange-breasted Trogon		s			
*Berenicornis comatus***	White-crowned Hornbill		x			
Buceros vigil	Helmeted Hornbill				x	
Buceros rhinoceros	Rhinoceros Hornbill		x		x	x
Anorrhinus galeritus	Bushy-crested Hornbill		x		x	x
Rhyticeros undulatus	Wreathed Hornbill		x		x	x
*Alcedo euryzona***	Blue-banded Kingfisher	s				
*Ceyx erithaca***	Black-backed Dwarf Kingfisher	s				
Lacedo pulchella	Banded Kingfisher				x	x
Actenoides concretus	Rufous-collared Kingfisher				x	
Nyctyornis amictus	Red-bearded Bee-eater	s			x	
Merops viridis	Blue-throated Bee-eater				x	
Psilopogon duvaucelii	Blue-eared Barbet				x	x
Psilopogon eximius	Bornean Barbet		s			x
Psilopogon mystacophanos	Red-throated Barbet	s			x	
Psilopogon monticola	Mountain Barbet		s	x	x	x
Psilopogon chrysopogon	Gold-whiskered Barbet				x	x
*Sasia abnormis**	Rufous Piculet	s	s	x	x	x
Dendrocopos moluccensis	Sunda Woodpecker				x	
Dendrocopos canicapillus	Grey-capped Woodpecker				x	x
Picus miniaceus	Banded Woodpecker					x
Picus puniceus	Crimson-winged Woodpecker					x
Picus mentalis	Checker-throated Woodpecker		s			x
*Meiglyptes tristis***	Buff-rumped Woodpecker		s			
Blythipicus rubiginosus	Maroon Woodpecker		s		x	x
Loriculus galgulus	Blue-crowned Hanging Parrot					x
Calyptomena viridis	Green Broadbill		x		x	x
*Psarisomus dalhousiae***	Long-tailed Broadbill		s			
Eurylaimus javanicus	Banded Broadbill		x		x	
Eurylaimus ochromalus	Black-and-yellow Broadbill	x			x	x
Hydrornis schwaneri	Bornean Banded Pitta				x	x
Gerygone sulphurea	Golden-bellied Gerygone	x			x	x
Hemipus picatus	Bar-winged Flycatcher-Shrike				x	x
*Pericrocotus solaris**	Grey-chinned Minivet		s			x
*Pachycephala hypoxantha**	Bornean Whistler		s	s		x
*Pteruthius aeralatus**	Blyth's Shrike-Babbler		s	s	x	x

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Scientific name[a]	English name[a]	Elevation, this study[b]			Davison (1997)[c]	Eaton *et al.* (2017)
		500 m	1,150 m	1,350 m		
Erpornis zantholeuca	White-bellied Erpornis					x
*Dicrurus leucophaeus**	Ashy Drongo		s	s		x
*Rhipidura perlata**	Spotted Fantail		s		x	x
*Rhipidura javanica** **	Malaysian Pied Fantail	s				
*Rhipidura albicollis**	White-throated Fantail		s	s	x	x
Hypothymis azurea	Black-naped Monarch					x
Platylophus galericulatus	Crested Jay		x		x	x
*Dendrocitta cinerascens**	Bornean Treepie		s	x		x
Corvus enca	Slender-billed Crow				x	
Hirundo tahitica	Pacific Swallow				x	
Culicicapa ceylonensis	Grey-headed Canary-Flycatcher		s			x
Sitta frontalis	Velvet-fronted Nuthatch			s		x
Pycnonotus atriceps	Black-headed Bulbul	x			x	x
Pycnonotus squamatus	Scaly-breasted Bulbul				x	x
Pycnonotus goiavier	Yellow-vented Bulbul	s			x	
Pycnonotus brunneus	Red-eyed Bulbul				x	
*Alophoixus ochraceus**	Ochraceous Bulbul	s	s		x	x
Alophoixus bres	Grey-cheeked Bulbul				x	
*Hemixos flavala**	Ashy Bulbul		x	s	x	x
Ixos malaccensis	Streaked Bulbul					x
*Urosphena whiteheadi**	Bornean Stubtail			s		x
Abroscopus superciliaris	Yellow-bellied Warbler	s	s		x	x
*Phyllergates cucullatus**	Mountain Tailorbird			s	x	x
*Phylloscopus trivirgatus**	Mountain Leaf Warbler			s	x	x
*Seicercus montis**	Yellow-breasted Warbler		x	s	x	x
Orthotomus atrogularis	Dark-necked Tailorbird					x
Orthotomus ruficeps	Ashy Tailorbird	s			x	x
*Orthotomus sericeus**	Rufous-tailed Tailorbird	s			x	x
Prinia flaviventris	Yellow-bellied Prinia	s			x	
*Yuhina everetti**	Chestnut-crested Yuhina		s	s		x
Zosterops palpebrosus	Oriental White-eye					x
Zosterops everetti	Everett's White-eye				x[d]	
*Zosterops chloris**	Meratus White-eye			s	x[e]	x
*Mixornis bornensis**	Bold-striped Tit-Babbler	s			x	x
*Cyanoderma erythropterum***	Chestnut-winged Babbler		x			
Pomatorhinus montanus	Chestnut-backed Scimitar Babbler	s	s	s	x	x
*Stachyris nigriceps**	Grey-throated Babbler	s	s	x	x	x
*Stachyris poliocephala**	Grey-headed Babbler	s			x	
*Stachyris leucotis** **	White-necked Babbler			s		
*Malacopteron magnirostre**	Moustached Babbler	s				x
*Malacopteron cinereum** **	Scaly-crowned Babbler	s				
*Pellorneum capistratum** **	Black-capped Babbler	s				
*Pellorneum pyrrogenys**	Temminck's Babbler	s	s	x	x	x
*Napothera epilepidota** **	Eyebrowed Wren-Babbler		s			
*Alcippe brunneicauda**	Brown Fulvetta		s			x
*Ianthocincla treacheri**	Chestnut-hooded Laughingthrush		s		x	x
Irena puella	Asian Fairy Bluebird		s		x	x
Copsychus saularis	Oriental Magpie-Robin				x	
Copsychus malabaricus	White-rumped Shama				x	

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Scientific name[a]	English name[a]	Elevation, this study[b]			Davison (1997)[c]	Eaton *et al.* (2017)
		500 m	1,150 m	1,350 m		
*Cyornis banyumas**	Meratus Flycatcher	s	s	x	x	x
Cyornis superbus	Bornean Blue Flycatcher					x
*Eumyias indigo**	Indigo Flycatcher		s			x
Eumyias thalassinus	Verditer Flycatcher					x
*Vauriella gularis**	Eyebrowed Jungle Flycatcher		s	s	x	x
Brachypteryx montana	White-browed Shortwing					x
Enicurus leschenaulti	White-crowned Forktail	x			x	
Enicurus ruficapillus	Chestnut-naped Forktail				x	
*Ficedula westermanni**	Little Pied Flycatcher		s		x	x
*Ficedula dumetoria** **	Rufous-chested Flycatcher		s			
Chlamydochaera jefferyi	Fruit-hunter					x
Gracula religiosa	Common Hill Myna				x	
*Chloropsis kinabaluensis**	Bornean Leafbird		s			x
*Prionochilus maculatus**	Yellow-breasted Flowerpecker	s				x
Prionochilus xanthopygius	Yellow-rumped Flowerpecker					x
Dicaeum trigonostigma	Orange-bellied Flowerpecker	s			x	x
Dicaeum monticolum	Black-sided Flowerpecker				x	x
Chalcoparia singalensis	Ruby-cheeked Sunbird					x
Anthreptes malacensis	Plain-throated Sunbird				x	x
Leptocoma brasiliana	Van Hasselt's Sunbird					x
Aethopyga temminckii	Temminck's Sunbird		s	s	x	x
Aethopyga siparaja	Crimson Sunbird				x	
*Arachnothera longirostra**	Little Spiderhunter	s			x	x
*Arachnothera hypogrammicum**	Purple-naped Spiderhunter	s				x
*Arachnothera flavigaster***	Spectacled Spiderhunter			s		
Arachnothera modesta	Grey-breasted Spiderhunter					x
*Arachnothera everetti** **	Bornean Spiderhunter	s	s	x		
*Erythrura prasina***	Pin-tailed Parrotfinch	s				
Lonchura fuscans	Dusky Munia	s			x	x

[a] = Classification follows Clements *et al*. (2017).
[b] = s: specimen records, x: other records.
[c] = Migrants recorded by Davison (1997) have been omitted.
[d] = Identified as *Zosterops everetti* or perhaps *Z. palpebrosa* by Davison (1997)
[e] = Identified as *Z. atricapilla* by Davison (1997).
* = Species for which ND2 was sequenced in this study.
** = New records for the Meratus Mountains.

Appendix 2: List of ND2 sequence-samples compared for this study, classified according to Clements *et al*. (2017).

Tissue No.*	Genus	Species	Locality	GenBank No.
LSUMNS B-51117 / AMNH DOT 15123	*Cacomantis*	*sonneratii*	Tawau Hills Park, Sabah	KJ455342
LSUMNS B-79648	*Cacomantis*	*sonneratii*	Kuching, Sarawak	MG546353
LSUMNS B-47009	*Cacomantis*	*merulinus*	Mt. Kinabalu, Sabah	MG546349
LSUMNS B-47049	*Cacomantis*	*merulinus*	Mt. Kinabalu, Sabah	MG546350
LSUMNS B-58630	*Cacomantis*	*merulinus*	Mt. Pueh, Sarawak	MG546351
LSUMNS B-79020	*Cacomantis*	*merulinus*	Meratus Mountains, South Kalimantan	MG546352
UWBM 67474	*Cacomantis*	*merulinus*	Sumatra, Indonesia	KJ455341
LSUMNS B-51190	*Psilopogon*	*eximius*	Tawau Hills Park, Sabah	MG546418
LSUMNS B-79082	*Psilopogon*	*eximius*	Meratus Mountains, South Kalimantan	MG546419

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Tissue No.*	Genus	Species	Locality	GenBank No.
LSUMNS B-79194	*Psilopogon*	*eximius*	Meratus Mountains, South Kalimantan	MG546420
LSUMNS B-36374	*Sasia*	*abnormis*	Tawau Hills Park, Sabah	MG546474
LSUMNS B-36380	*Sasia*	*abnormis*	Tawau Hills Park, Sabah	DQ479158
LSUMNS B-36428	*Sasia*	*abnormis*	Tawau Hills Park, Sabah	DQ188163
LSUMNS B-52131	*Sasia*	*abnormis*	Padawan, Sarawak	MG546475
LSUMNS B-58509	*Sasia*	*abnormis*	Mt. Pueh, Sarawak	MG546476
LSUMNS B-79019	*Sasia*	*abnormis*	Meratus Mountains, South Kalimantan	MG546477
LSUMNS B-79061	*Sasia*	*abnormis*	Meratus Mountains, South Kalimantan	MG546478
LSUMNS B-88097	*Sasia*	*abnormis*	Mt. Mulu, Sarawak	MG546479
LSUMNS B-88107	*Sasia*	*abnormis*	Mt. Mulu, Sarawak	MG546480
LSUMNS B-93562	*Sasia*	*abnormis*	Berau, East Kalimantan	MG546481
LSUMNS B-93600	*Sasia*	*abnormis*	Berau, East Kalimantan	MG546482
LSUMNS B-51210	*Pericrocotus*	*solaris*	Guangdong, China	JQ864472
LSUMNS B-52683	*Pericrocotus*	*solaris*	Mt. Trus Madi, Sabah	MG590020
LSUMNS B-79096	*Pericrocotus*	*solaris*	Meratus Mountains, South Kalimantan	MG590021
LSUMNS B-79142	*Pericrocotus*	*solaris*	Meratus Mountains, South Kalimantan	MG590022
AMNH 648529	*Pachycephala*	*hypoxantha*	Kelabit Highlands, Sarawak	GQ494105
LSUMNS B-36296	*Pachycephala*	*hypoxantha*	Mt. Kinabalu, Sabah	MG546431
LSUMNS B-52546	*Pachycephala*	*hypoxantha*	Mt. Trus Madi, Sabah	MG546432
LSUMNS B-79143	*Pachycephala*	*hypoxantha*	Meratus Mountains, South Kalimantan	MG546433
LSUMNS B-79178	*Pachycephala*	*hypoxantha*	Meratus Mountains, South Kalimantan	MG546434
LSUMNS B-79208	*Pachycephala*	*hypoxantha*	Meratus Mountains, South Kalimantan	MG546435
LSUMNS B-88054	*Pachycephala*	*hypoxantha*	Mt. Mulu, Sarawak	MG546436
LSUMNS B-88233	*Pachycephala*	*hypoxantha*	Mt. Mulu, Sarawak	MG546437
LSUMNS B-88301	*Pachycephala*	*hypoxantha*	Mt. Pueh, Sarawak	MG546438
LSUMNS B-52675	*Pteruthius*	*aeralatus*	Mt. Trus Madi, Sabah	MG546454
LSUMNS B-79081	*Pteruthius*	*aeralatus*	Meratus Mountains, South Kalimantan	MG546455
LSUMNS B-79214	*Pteruthius*	*aeralatus*	Meratus Mountains, South Kalimantan	MG546456
LSUMNS B-36475	*Dicrurus*	*leucophaeus*	Mt. Trus Madi, Sabah	MG546371
LSUMNS B-52560	*Dicrurus*	*leucophaeus*	Mt. Trus Madi, Sabah	MG546372
LSUMNS B-79080	*Dicrurus*	*leucophaeus*	Meratus Mountains, South Kalimantan	MG546373
LSUMNS B-79134	*Dicrurus*	*leucophaeus*	Meratus Mountains, South Kalimantan	MG546374
LSUMNS B-79564	*Dicrurus*	*leucophaeus*	Kuching, Sarawak	MG546375
LSUMNS B-88044	*Dicrurus*	*leucophaeus*	Mt. Mulu, Sarawak	MG546376
LSUMNS B-88295	*Dicrurus*	*leucophaeus*	Mt. Pueh, Sarawak	MG546377
LSUMNS B-38596	*Rhipidura*	*perlata*	Imbak Valley, Sabah	MG546468
LSUMNS B-57451	*Rhipidura*	*perlata*	Ulu Tungud Forest Reserve, Sabah	GQ145409
LSUMNS B-74749	*Rhipidura*	*perlata*	Mt. Mulu, Sarawak	MG546469
LSUMNS B-79054	*Rhipidura*	*perlata*	Meratus Mountains, South Kalimantan	MG546470
LSUMNS B-79070	*Rhipidura*	*perlata*	Meratus Mountains, South Kalimantan	MG546471
LSUMNS B-79480	*Rhipidura*	*perlata*	Kuching, Sarawak	MG546472
LSUMNS B-88071	*Rhipidura*	*perlata*	Mt. Mulu, Sarawak	MG546473
KU 17717	*Rhipidura*	*javanica*	Padas Damit, Sabah	JN546011
LSUMNS B-46972	*Rhipidura*	*javanica*	Mt. Kinabalu, Sabah	GQ145404
LSUMNS B-58663	*Rhipidura*	*javanica*	Mt. Pueh, Sarawak	MG546463
LSUMNS B-79018	*Rhipidura*	*javanica*	Meratus Mountains, South Kalimantan	MG546464
LSUMNS B-79254	*Rhipidura*	*javanica*	Limbang, Sarawak	MG546465
LSUMNS B-93595	*Rhipidura*	*javanica*	Berau, East Kalimantan	MG546466
LSUMNS B-93602	*Rhipidura*	*javanica*	Berau, East Kalimantan	MG546467
KU 13977	*Rhipidura*	*nigritorquis*	Camiguin, Philippines	JN546013

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Tissue No.*	Genus	Species	Locality	GenBank No.
KU 10230	*Rhipidura*	*albicollis*	Guangxi, China	GQ145386
LSUMNS B-36474	*Rhipidura*	*albicollis*	Mt. Trus Madi, Sabah	GQ145387
LSUMNS B-52563	*Rhipidura*	*albicollis*	Mt. Trus Madi, Sabah	MG546457
LSUMNS B-79050	*Rhipidura*	*albicollis*	Meratus Mountains, South Kalimantan	MG546458
LSUMNS B-79098	*Rhipidura*	*albicollis*	Meratus Mountains, South Kalimantan	MG546459
LSUMNS B-88121	*Rhipidura*	*albicollis*	Mt. Pueh, Sarawak	MG546460
LSUMNS B-88230	*Rhipidura*	*albicollis*	Mt. Mulu, Sarawak	MG546461
LSUMNS B-88238	*Rhipidura*	*albicollis*	Mt. Mulu, Sarawak	MG546462
LSUMNS B-38662	*Dendrocitta*	*cinerascens*	Mt. Kinabalu, Sabah	MG546364
LSUMNS B-61577	*Dendrocitta*	*cinerascens*	Meligan Range, Sabah	MG546365
LSUMNS B-78702	*Dendrocitta*	*cinerascens*	Kelabit Highlands, Sarawak	MG546366
LSUMNS B-79092	*Dendrocitta*	*cinerascens*	Meratus Mountains, South Kalimantan	MG546367
LSUMNS B-79129	*Dendrocitta*	*cinerascens*	Meratus Mountains, South Kalimantan	MG546368
LSUMNS B-88039	*Dendrocitta*	*cinerascens*	Mt. Mulu, Sarawak	MG546369
LSUMNS B-88245	*Dendrocitta*	*cinerascens*	Mt. Mulu, Sarawak	MG546370
LSUMNS B-38614	*Alophoixus*	*ochraceus*	Mt. Kinabalu, Sabah	DQ402229
LSUMNS B-61635	*Alophoixus*	*ochraceus*	Mt. Kinabalu, Sabah	KY547863
LSUMNS B-79045	*Alophoixus*	*ochraceus*	Meratus Mountains, South Kalimantan	MG546336
LSUMNS B-79068	*Alophoixus*	*ochraceus*	Meratus Mountains, South Kalimantan	MG546337
LSUMNS B-85179	*Alophoixus*	*ochraceus*	Mt. Mulu, Sarawak	KY547847
LSUMNS B-88028	*Alophoixus*	*ochraceus*	Mt. Mulu, Sarawak	KY547848
LSUMNS B-88045	*Alophoixus*	*ochraceus*	Mt. Mulu, Sarawak	KY547844
LSUMNS B-88172	*Alophoixus*	*ochraceus*	Mt. Penrissen, Sarawak	KY547868
LSUMNS B-88299	*Alophoixus*	*ochraceus*	Mt. Pueh, Sarawak	MG546338
KU 15140	*Hemixos*	*flavala*	Kyi Tan, Myanmar	GU112648
LSUMNS B-38649	*Hemixos*	*flavala*	Mt. Kinabalu, Sabah	KY547905
LSUMNS B-38659	*Hemixos*	*flavala*	Mt. Kinabalu, Sabah	DQ402224
LSUMNS B-79173	*Hemixos*	*flavala*	Meratus Mountains, South Kalimantan	MG546392
LSUMNS B-79203	*Hemixos*	*flavala*	Meratus Mountains, South Kalimantan	MG546393
LSUMNS B-88173	*Hemixos*	*flavala*	Mt. Penrissen, Sarawak	KY547908
LSUMNS B-88235	*Hemixos*	*flavala*	Mt. Mulu, Sarawak	MG546394
LSUMNS B-88254	*Hemixos*	*flavala*	Mt. Mulu, Sarawak	MG546395
LSUMNS B-88289	*Hemixos*	*flavala*	Mt. Pueh, Sarawak	MG546396
LSUMNS B-88303	*Hemixos*	*flavala*	Mt. Pueh, Sarawak	MG546397
KU 17730	*Urosphena*	*whiteheadi*	Meligan Range, Sabah	MG546498
LSUMNS B-61550	*Urosphena*	*whiteheadi*	Meligan Range, Sabah	MG546499
LSUMNS B-79133	*Urosphena*	*whiteheadi*	Meratus Mountains, South Kalimantan	MG546500
LSUMNS B-79200	*Urosphena*	*whiteheadi*	Meratus Mountains, South Kalimantan	MG546501
KU 21046	*Phyllergates*	*cucullatus*	Luzon, Philippines	JX006118
LSUMNS B-52577	*Phyllergates*	*cucullatus*	Mt. Trus Madi, Sabah	JX006119
LSUMNS B-79210	*Phyllergates*	*cucullatus*	Meratus Mountains, South Kalimantan	MG546445
LSUMNS B-52702	*Phylloscopus*	*trivirgatus*	Mt. Kinabalu, Sabah	MG546446
LSUMNS B-61581	*Phylloscopus*	*trivirgatus*	Meligan Range, Sabah	MG546447
LSUMNS B-79165	*Phylloscopus*	*trivirgatus*	Meratus Mountains, South Kalimantan	MG546448
LSUMNS B-79167	*Phylloscopus*	*trivirgatus*	Meratus Mountains, South Kalimantan	MG546449
429247	*Phylloscopus*	*trivirgatus*	Philippines	FJ173457
LSUMNS B-36278	*Seicercus*	*montis*	Mt. Kinabalu, Sabah	MG546483
LSUMNS B-52597	*Seicercus*	*montis*	Mt. Trus Madi, Sabah	KY547975
LSUMNS B-61549	*Seicercus*	*montis*	Meligan Range, Sabah	MG546484
LSUMNS B-79159	*Seicercus*	*montis*	Meratus Mountains, South Kalimantan	MG546485

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Tissue No.*	Genus	Species	Locality	GenBank No.
LSUMNS B-79216	*Seicercus*	*montis*	Meratus Mountains, South Kalimantan	MG546486
LSUMNS B-88115	*Seicercus*	*montis*	Mt. Pueh, Sarawak	KY547972
LSUMNS B-88278	*Seicercus*	*montis*	Mt. Pueh, Sarawak	MG546487
LSUMNS B-88300	*Seicercus*	*montis*	Mt. Pueh, Sarawak	MG546488
KU 17792	*Orthotomus*	*sericeus*	Crocker Range, Sabah	JN826602
LSUMNS B-36370	*Orthotomus*	*sericeus*	Crocker Range, Sabah	KJ865188
LSUMNS B-51034	*Orthotomus*	*sericeus*	Mendolong, Sabah	KJ865189
LSUMNS B-58160	*Orthotomus*	*sericeus*	Miri, Sarawak	KJ865180
LSUMNS B-58183	*Orthotomus*	*sericeus*	Miri, Sarawak	KJ865179
LSUMNS B-74736	*Orthotomus*	*sericeus*	Mt. Mulu, Sarawak	MG546425
LSUMNS B-74766	*Orthotomus*	*sericeus*	Mt. Mulu, Sarawak	MG546426
LSUMNS B-79005	*Orthotomus*	*sericeus*	Meratus Mountains, South Kalimantan	MG546427
LSUMNS B-79109	*Orthotomus*	*sericeus*	Meratus Mountains, South Kalimantan	MG546428
LSUMNS B-93551	*Orthotomus*	*sericeus*	Berau, East Kalimantan	MG546429
LSUMNS B-93604	*Orthotomus*	*sericeus*	Berau, East Kalimantan	MG546430
KU 17756	*Yuhina*	*everetti*	Meligan Range, Sabah	JN826709
LSUMNS B-36290	*Yuhina*	*everetti*	Mt. Kinabalu, Sabah	FJ460779
LSUMNS B-79163	*Yuhina*	*everetti*	Meratus Mountains, South Kalimantan	MG546507
LSUMNS B-79193	*Yuhina*	*everetti*	Meratus Mountains, South Kalimantan	MG546508
LSUMNS B-88025	*Yuhina*	*everetti*	Mt. Mulu, Sarawak	KY548027
LSUMNS B-88190	*Yuhina*	*everetti*	Mt. Penrissen, Sarawak	KY548030
LSUMNS B-88237	*Yuhina*	*everetti*	Mt. Mulu, Sarawak	MG546509
LSUMNS B-88279	*Yuhina*	*everetti*	Mt. Pueh, Sarawak	MG546510
LSUMNS B-84895	*Zosterops*	*palpebrosus*	Santubong, Sarawak	MG546511
LSUMNS B-36444	*Zosterops*	*atricapilla*	Mt. Trus Madi, Sabah	FJ460802
KU 19110	*Zosterops*	*everetti*	Mindanao, Philippines	MG546512
LSUMNS B-79166	*Zosterops*	*chloris*	Meratus Mountains, South Kalimantan	MG546513
LSUMNS B-79170	*Zosterops*	*chloris*	Meratus Mountains, South Kalimantan	MG546514
AMNH 12558	*Zosterops*	*chloris*	Sulawesi Selatan, Sulawesi	FJ460798
KU 17726	*Mixornis*	*bornensis*	Meligan Range, Sabah	JN826571
LSUMNS B-46958	*Mixornis*	*bornensis*	Mt. Kinabalu, Sabah	HQ011004
LSUMNS B-51033	*Mixornis*	*bornensis*	Mendolong, Sabah	HQ011001
LSUMNS B-52121	*Mixornis*	*bornensis*	Kuching, Sarawak	HQ011018
LSUMNS B-52135	*Mixornis*	*bornensis*	Kuching, Sarawak	HQ011017
LSUMNS B-79004	*Mixornis*	*bornensis*	Meratus Mountains, South Kalimantan	MG546404
LSUMNS B-79042	*Mixornis*	*bornensis*	Meratus Mountains, South Kalimantan	MG546405
LSUMNS B-93556	*Mixornis*	*bornensis*	Berau, East Kalimantan	MG546406
LSUMNS B-93601	*Mixornis*	*bornensis*	Berau, East Kalimantan	MG546407
KU 10167	*Stachyris*	*nigriceps*	Guangxi, China	JN826673
LSUMNS B-36288	*Stachyris*	*nigriceps*	Mt. Kinabalu, Sabah	JN826674
LSUMNS B-61636	*Stachyris*	*nigriceps*	Mt. Kinabalu, Sabah	KY547978
LSUMNS B-78993	*Stachyris*	*nigriceps*	Meratus Mountains, South Kalimantan	MG546494
LSUMNS B-79114	*Stachyris*	*nigriceps*	Meratus Mountains, South Kalimantan	MG546495
LSUMNS B-79483	*Stachyris*	*nigriceps*	Mt. Pueh, Sarawak	KY548009
LSUMNS B-79667	*Stachyris*	*nigriceps*	Mt. Penrissen, Sarawak	KY547999
LSUMNS B-88022	*Stachyris*	*nigriceps*	Mt. Mulu, Sarawak	KY547993
LSUMNS B-88041	*Stachyris*	*nigriceps*	Mt. Mulu, Sarawak	KY547996
LSUMNS B-36426	*Stachyris*	*poliocephala*	Tawau Hills Park, Sabah	HQ011178
LSUMNS B-47082	*Stachyris*	*poliocephala*	Mt. Kinabalu, Sabah	HQ011180
LSUMNS B-51066	*Stachyris*	*poliocephala*	Tawau Hills Park, Sabah	HQ011182

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LSUMNS B-52096	*Stachyris*	*poliocephala*	Panti Forest, West Malaysia	HQ011192
LSUMNS B-52140	*Stachyris*	*poliocephala*	Kuching, Sarawak	HQ011186
LSUMNS B-79001	*Stachyris*	*poliocephala*	Meratus Mountains, South Kalimantan	MG546496
LSUMNS B-79107	*Stachyris*	*poliocephala*	Meratus Mountains, South Kalimantan	MG546497
LSUMNS B-36337	*Stachyris*	*leucotis*	Crocker Range, Sabah	MG546489
LSUMNS B-36340	*Stachyris*	*leucotis*	Crocker Range, Sabah	JN826671
LSUMNS B-58528	*Stachyris*	*leucotis*	Mt. Pueh, Sarawak	MG546490
LSUMNS B-79135	*Stachyris*	*leucotis*	Meratus Mountains, South Kalimantan	MG546491
LSUMNS B-79217	*Stachyris*	*leucotis*	Meratus Mountains, South Kalimantan	MG546492
LSUMNS B-79625	*Stachyris*	*leucotis*	Kuching, Sarawak	MG546493
KU 12358	*Malacopteron*	*magnirostre*	Samarakan, Sarawak	JN826585
LSUMNS B-36421	*Malacopteron*	*magnirostre*	Tawau Hills Park, Sabah	FJ460778
LSUMNS B-51159	*Malacopteron*	*magnirostre*	Tawau Hills Park, Sabah	MG546414
LSUMNS B-79220	*Malacopteron*	*magnirostre*	Meratus Mountains, South Kalimantan	MG546415
LSUMNS B-79223	*Malacopteron*	*magnirostre*	Meratus Mountains, South Kalimantan	MG546416
LSUMNS B-79477	*Malacopteron*	*magnirostre*	Mt. Pueh, Sarawak	MG546417
KU 12320	*Malacopteron*	*cinereum*	Samarakan, Sarawak	JN826583
LSUMNS B-38552	*Malacopteron*	*cinereum*	Tawau Hills Park, Sabah	MG546408
LSUMNS B-51118	*Malacopteron*	*cinereum*	Tawau Hills Park, Sabah	MG546409
LSUMNS B-74719	*Malacopteron*	*cinereum*	Mt. Mulu, Sarawak	MG546410
LSUMNS B-79077	*Malacopteron*	*cinereum*	Meratus Mountains, South Kalimantan	MG546411
LSUMNS B-79492	*Malacopteron*	*cinereum*	Kuching, Sarawak	MG546412
LSUMNS B-88095	*Malacopteron*	*cinereum*	Mt. Mulu, Sarawak	MG546413
LSUMNS B-36430	*Pellorneum*	*capistratum*	Tawau Hills Park, Sabah	FJ460772
LSUMNS B-47202	*Pellorneum*	*capistratum*	Klias Forest Reserve, Sabah	HQ011068
LSUMNS B-51058	*Pellorneum*	*capistratum*	Tawau Hills Park, Sabah	HQ011069
LSUMNS B-52098	*Pellorneum*	*capistratum*	Panti Forest, West Malaysia	HQ011077
LSUMNS B-58211	*Pellorneum*	*capistratum*	Kota Samarahan, Sabah	HQ011074
LSUMNS B-79000	*Pellorneum*	*capistratum*	Meratus Mountains, South Kalimantan	MG546439
LSUMNS B-79105	*Pellorneum*	*capistratum*	Meratus Mountains, South Kalimantan	MG546440
LSUMNS B-93598	*Pellorneum*	*capistratum*	Berau, East Kalimantan	MG546441
KU 17798	*Pellorneum*	*pyrrogenys*	Mt. Kinabalu, Sabah	JN826614
LSUMNS B-36316	*Pellorneum*	*pyrrogenys*	Crocker Range, Sabah	KY547936
LSUMNS B-78985	*Pellorneum*	*pyrrogenys*	Meratus Mountains, South Kalimantan	MG546442
LSUMNS B-79106	*Pellorneum*	*pyrrogenys*	Meratus Mountains, South Kalimantan	MG546443
LSUMNS B-88033	*Pellorneum*	*pyrrogenys*	Mt. Mulu, Sarawak	KY547943
LSUMNS B-88042	*Pellorneum*	*pyrrogenys*	Mt. Mulu, Sarawak	KY547944
LSUMNS B-88132	*Pellorneum*	*pyrrogenys*	Mt. Penrissen, Sarawak	KY547937
LSUMNS B-88166	*Pellorneum*	*pyrrogenys*	Mt. Penrissen, Sarawak	KY547949
LSUMNS B-88294	*Pellorneum*	*pyrrogenys*	Mt. Pueh, Sarawak	MG546444
LSUMNS B-52557	*Napothera*	*epilepidota*	Mt. Trus Madi, Sabah	JN826601
LSUMNS B-52626	*Napothera*	*epilepidota*	Mt. Trus Madi, Sabah	MG546421
LSUMNS B-78722	*Napothera*	*epilepidota*	Kelabit Highlands, Sarawak	MG546422
LSUMNS B-79100	*Napothera*	*epilepidota*	Meratus Mountains, South Kalimantan	MG546423
LSUMNS B-79101	*Napothera*	*epilepidota*	Meratus Mountains, South Kalimantan	MG546424
KU 17766	*Alcippe*	*brunneicauda*	Crocker Range, Sabah	JN826469
LSUMNS B-36359	*Alcippe*	*brunneicauda*	Crocker Range, Sabah	FJ460770
LSUMNS B-78700	*Alcippe*	*brunneicauda*	Kelabit Highlands, Sarawak	MG546332
LSUMNS B-79053	*Alcippe*	*brunneicauda*	Meratus Mountains, South Kalimantan	MG546333
LSUMNS B-79221	*Alcippe*	*brunneicauda*	Meratus Mountains, South Kalimantan	MG546334

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LSUMNS B-88287	*Alcippe*	*brunneicauda*	Mt. Pueh, Sarawak	MG546335
LSUMNS B-69904	*Ianthocincla*	*mitrata*	Sumatra, Indonesia	MG546390
KU 17728	*Ianthocincla*	*treacheri*	Meligan Range, Sabah	JN826518
LSUMNS B-36460	*Ianthocincla*	*treacheri*	Mt. Trus Madi, Sabah	FJ460776
LSUMNS B-78696	*Ianthocincla*	*treacheri*	Kelabit Highlands, Sarawak	KY547901
LSUMNS B-79099	*Ianthocincla*	*treacheri*	Meratus Mountains, South Kalimantan	MG546391
LSUMNS B-85203	*Ianthocincla*	*treacheri*	Mt. Mulu, Sarawak	KY547902
LSUMNS B-88040	*Ianthocincla*	*treacheri*	Mt. Mulu, Sarawak	KY547903
LSUMNS B-36314	*Cyornis*	*banyumas*	Crocker Range, Sabah	MG546358
LSUMNS B-51153	*Cyornis*	*banyumas*	Tawau Hills Park, Sabah	MG546359
LSUMNS B-78684	*Cyornis*	*banyumas*	Kelabit Highlands, Sarawak	MG546360
LSUMNS B-78992	*Cyornis*	*banyumas*	Meratus Mountains, South Kalimantan	MG546361
LSUMNS B-79069	*Cyornis*	*banyumas*	Meratus Mountains, South Kalimantan	MG546362
LSUMNS B-88188	*Cyornis*	*banyumas*	Mt. Penrissen, Sarawak	MG546363
KU 17741	*Eumyias*	*indigo*	Meligan Range, Sabah	MG546378
LSUMNS B-79169	*Eumyias*	*indigo*	Meratus Mountains, South Kalimantan	MG546379
LSUMNS B-88243	*Eumyias*	*indigo*	Mt. Mulu, Sarawak	MG546380
LSUMNS B-36275	*Vauriella*	*gularis*	Mt. Kinabalu, Sabah	MG546502
LSUMNS B-79067	*Vauriella*	*gularis*	Meratus Mountains, South Kalimantan	MG546503
LSUMNS B-79175	*Vauriella*	*gularis*	Meratus Mountains, South Kalimantan	MG546504
LSUMNS B-88049	*Vauriella*	*gularis*	Mt. Mulu, Sarawak	MG546505
LSUMNS B-88050	*Vauriella*	*gularis*	Mt. Mulu, Sarawak	MG546506
FMNH 357529	*Ficedula*	*westermanni*	Mindanao, Philippines	DQ674452
LSUMNS B-79089	*Ficedula*	*westermanni*	Meratus Mountains, South Kalimantan	MG546386
LSUMNS B-79196	*Ficedula*	*westermanni*	Meratus Mountains, South Kalimantan	MG546387
LSUMNS B-88117	*Ficedula*	*westermanni*	Mt. Pueh, Sarawak	MG546388
LSUMNS B-88226	*Ficedula*	*westermanni*	Mt. Mulu, Sarawak	MG546389
ANSP 1133	*Ficedula*	*dumetoria*	Kg. Makanitan, Sabah	DQ674458
LSUMNS B-36298	*Ficedula*	*dumetoria*	Crocker Range, Sabah	MG546381
LSUMNS B-58559	*Ficedula*	*dumetoria*	Mt. Pueh, Sarawak	MG546382
LSUMNS B-79076	*Ficedula*	*dumetoria*	Meratus Mountains, South Kalimantan	MG546383
LSUMNS B-88199	*Ficedula*	*dumetoria*	Mt. Penrissen, Sarawak	MG546384
LSUMNS B-88276	*Ficedula*	*dumetoria*	Mt. Mulu, Sarawak	MG546385
LSUMNS B-51149	*Chloropsis*	*kinabaluensis*	Tawau Hills Park, Sabah	MG546354
LSUMNS B-52618	*Chloropsis*	*kinabaluensis*	Mt. Trus Madi, Sabah	MG546355
LSUMNS B-79071	*Chloropsis*	*kinabaluensis*	Meratus Mountains, South Kalimantan	MG546356
LSUMNS B-79195	*Chloropsis*	*kinabaluensis*	Meratus Mountains, South Kalimantan	MG546357
KU 12405	*Prionochilus*	*maculatus*	Samarakan, Sarawak	GQ145275
LSUMNS B-51073	*Prionochilus*	*maculatus*	Tawau Hills Park, Sabah	HQ011104
LSUMNS B-52072	*Prionochilus*	*maculatus*	Sedenak Forest Reserve, West Malaysia	HQ011115
LSUMNS B-57415	*Prionochilus*	*maculatus*	Ulu Tungud Forest Reserve, Sabah	HQ011112
LSUMNS B-78999	*Prionochilus*	*maculatus*	Meratus Mountains, South Kalimantan	MG546450
LSUMNS B-88078	*Prionochilus*	*maculatus*	Mt. Mulu, Sarawak	MG546451
LSUMNS B-93571	*Prionochilus*	*maculatus*	Berau, East Kalimantan	MG546452
LSUMNS B-93577	*Prionochilus*	*maculatus*	Berau, East Kalimantan	MG546453
UWBM 82050	*Prionochilus*	*maculatus*	Sarawak	HQ011114
LSUMNS B-36306	*Arachnothera*	*longirostra*	Crocker Range, Sabah	JN126640
LSUMNS B-38546	*Arachnothera*	*longirostra*	Tawau Hills Park, Sabah	JN126643
LSUMNS B-46985	*Arachnothera*	*longirostra*	Mt. Kinabalu, Sabah	MG546343
LSUMNS B-52237	*Arachnothera*	*longirostra*	Miri, Sarawak	JN126685

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LSUMNS B-57069	*Arachnothera*	*longirostra*	Bintulu, Sarawak	JN126684
LSUMNS B-74742	*Arachnothera*	*longirostra*	Mt. Mulu, Sarawak	MG546344
LSUMNS B-78987	*Arachnothera*	*longirostra*	Meratus Mountains, South Kalimantan	MG546345
LSUMNS B-79043	*Arachnothera*	*longirostra*	Meratus Mountains, South Kalimantan	MG546346
LSUMNS B-93535	*Arachnothera*	*longirostra*	Berau, East Kalimantan	MG546347
LSUMNS B-93538	*Arachnothera*	*longirostra*	Berau, East Kalimantan	MG546348
LSUMNS B-38549	*Arachnothera*	*hypogrammicum*	Tawau Hills Park, Sabah	JF956935
LSUMNS B-47081	*Arachnothera*	*hypogrammicum*	Mt. Kinabalu, Sabah	HQ010965
LSUMNS B-51127	*Arachnothera*	*hypogrammicum*	Tawau Hills Park, Sabah	HQ010972
LSUMNS B-52085	*Arachnothera*	*hypogrammicum*	Bukit Hanta Forest Reserve, West Malaysia	HQ010989
LSUMNS B-74741	*Arachnothera*	*hypogrammicum*	Mt. Mulu, Sarawak	MG546398
LSUMNS B-78991	*Arachnothera*	*hypogrammicum*	Meratus Mountains, South Kalimantan	MG546399
LSUMNS B-79046	*Arachnothera*	*hypogrammicum*	Meratus Mountains, South Kalimantan	MG546400
LSUMNS B-88102	*Arachnothera*	*hypogrammicum*	Mt. Mulu, Sarawak	MG546401
LSUMNS B-93541	*Arachnothera*	*hypogrammicum*	Berau, East Kalimantan	MG546402
LSUMNS B-93547	*Arachnothera*	*hypogrammicum*	Berau, East Kalimantan	MG546403
UWBM 81984	*Arachnothera*	*hypogrammicum*	Kubah National Park, Sarawak	HQ010983
AMNH 648559	*Arachnothera*	*everetti*	Sarawak	JF956980
LSUMNS B-36309	*Arachnothera*	*everetti*	Crocker Range, Sabah	JF956951
LSUMNS B-36402	*Arachnothera*	*everetti*	Tawau Hills Park, Sabah	JF956974
LSUMNS B-78752	*Arachnothera*	*everetti*	Kelabit Highlands, Sarawak	MG546339
LSUMNS B-79021	*Arachnothera*	*everetti*	Meratus Mountains, South Kalimantan	MG546340
LSUMNS B-79213	*Arachnothera*	*everetti*	Meratus Mountains, South Kalimantan	MG546341
LSUMNS B-88259	*Arachnothera*	*everetti*	Mt. Mulu, Sarawak	MG546342
KU 17801	*Arachnothera*	*everetti*	Mt. Kinabalu, Sabah	JF956920

* AMNH = American Museum of Natural History, New York; FMNH = Field Museum of Natural History, Chicago; KU = University of Kansas Museum of Natural History, Lawrence; LSUMNS = Louisiana State University Museum of Natural Science, Baton Rouge; and UWBM = University of Washington Burke Museum, Seattle.

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