

Bulletin of the British Ornithologists' Club

ISSN 2513-9894 (Online)

Edited by Guy M. Kirwan

Associate Editors: Robert Prŷs-Jones; Lincoln Fishpool; Bruce M. Beehler; Christopher J. Sharpe

Volume 142 Number 1, pages 1–152

CONTENTS

Club Announcements.....	1
GOURAUD, C. Note on the nomenclature of <i>Myrmothera guttata</i> Vieillot, 1824 (Passeriformes, Thamnophilidae).....	5
SUÁREZ, W. Catalogue of Cuban fossil and subfossil birds	10
DICKINSON, E. C., KAMMINGA, P. & VAN DER MIJE, S. Temminck's new bird names introduced in the early parts of the <i>Nouveau recueil de planches coloriées d'oiseaux</i> in 1820–22.....	75
DIAMOND, J. & BISHOP, K. D. Why may the same species have different elevational ranges at different sites in New Guinea?	92
BRETAGNOLLE, V., FLOOD, R. L., GABA, S. & SHIRIHAI, H. <i>Fregetta lineata</i> (Peale, 1848) is a valid extant species endemic to New Caledonia	111
WILSON, J.-J., FISHER, C. T., SENFELD, T., SHANNON, T. J. & COLLINSON, J. M. The tangled nomenclatural history of <i>Haploelia forbesi</i> Salvadori, 1904: were Forbes and Robinson right all along?	131
IQBAL, M., AMEY, T., KUSUMA, I., ALIM, S. S. & HUSNI, A. Novel ecological information for Silvery Pigeon <i>Columba argentina</i> , with first description of the chick	138
BARREIROS, M. H. M., TOLENTINO, M. & LEITE, G. A. Breeding ecology of Rufous Potoo <i>Nyctibius bracteatus</i> in central Amazonian Brazil	145

BOC Office

c/o Natural History Museum at Tring,
Akeman Street, Tring, Herts. HP23 6AP, UK

E-mail: info@boc-online.org

Tel. +44 (0)208 8764728 / 07919174898

Registered Charity No. 1169733

www.boc-online.org

Bulletin of the BRITISH ORNITHOLOGISTS' CLUB

Vol. 142 No. 1

Published 11 March 2022

CLUB ANNOUNCEMENTS

FORTHCOMING MEETINGS

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

The next meeting (21 March) will be held online only via Zoom. Although free, you need to pre-register your intention to attend (<https://www.eventbrite.co.uk/e/the-importation-of-the-plumage-prohibition-act-of-1921-tickets-256779342927>). The 16 May meeting will be held in person and be available to watch online. For more details, keep an eye on the Club's website (<https://voc-online.org/meetings>) or Twitter account (https://twitter.com/online_BOC).

Monday 21 March 2022 – 6.30 pm – Kathryn Rooke – *The Importation of the Plumage (Prohibition) Act of 1921, as told through the Natural History Museums Archive collections.*

Abstract: In the Victorian and Edwardian period, a demand for bird feathers in fashionable millinery led to the most luxurious of plumes being worth, quite literally, their weight in diamonds. Demand for feathers of egrets, birds of paradise, hummingbirds, grebes and more were pushing bird populations across the world to the brink of extinction. In this talk, I share records from the Natural History Museums archives that document the museums contribution to a lengthy campaign, led by the Royal Society for the Protection of Birds, to end the importation of bird feathers from across the then British Empire, which eventually resulted in the passing of the Importation of Plumage (Prohibition) Act in 1921.

Biography: Kathryn Rooke is the Assistant Archivist at the Natural History Museum, London, and Archivist at the former Rothschild property, now local history museum, Gunnersbury Park. She is a history graduate and Archives and Records Management post-graduate who has previously worked for Lancashire Archives, The Clothworkers Company, The Barber-Surgeons' Company and The School for Oriental and African Studies. After a brief three-year stint in Taiwan, she is now London-based with her family, and enjoying the opportunities NHMUK has brought to revisit a childhood of birdwatching and bug-collecting.

Monday 16 May 2022 – 6.30 pm – Martin Stervander – *The evolutionary history of a remarkable radiation of South Atlantic finches.*

This meeting will be held in person in the upstairs room at the Barley Mow, 104 Horseferry Road, London SW1P 2EE, but will also be available to watch via Zoom. Details concerning registration should be available shortly. Please follow the Club on Twitter (@online_BOC) to keep abreast.

Abstract: Ask anyone interested in birds for an example of adaptive radiations, and they will probably mention Darwin's Finches, the evolutionary 'rock stars' of the Galápagos Islands. But did you know about *Nesospiza* finches, endemic to Tristan da Cunha in the South Atlantic? Tristan is a small and very isolated archipelago comprising three main islands, the two smaller of which are each home to both a small-bodied and small-billed generalist finch, and a large-bodied and large-billed specialist finch that feeds exclusively on the seeds of an endemic island tree. But how are these four taxa related, and how did they evolve? And where do the extinct small-billed finches of the third, larger island fit into the picture? I will take you on a trip to the South Atlantic, to see what ecology and a whole lot of DNA detective work can reveal about this remarkable radiation.

Biography: Martin Stervander is a Marie Skłodowska Curie Fellow at the Natural History Museum, Tring, where he currently is researching the genomic architecture of convergent evolution in flight loss among island rails (including the Inaccessible Island Rail *Laterallus [Atlantisia] rogersi*, neighbour to the *Nesospiza* finches). Martin did his Ph.D. on speciation in birds at Lund Univ. (Sweden), followed by a postdoc at the Univ. of Oregon (USA). While his main research is focused on understanding the evolutionary mechanisms

of speciation and radiation as well as phenotypic convergence, his interests also comprise phylogenetics, taxonomy, and phylogeography. Martin is an Associate Editor of *Ibis* and Managing Editor of BirdLife Sweden's ornithological journal *Ornis Svecica*, which—like *Bull. Brit. Orn. Club*—is available online, at <https://os.birdlife.se>.

BOOK REVIEWS

Milsom, T. 2020. *Henry Seebohm's ornithology: his collecting, field observations, publications and evolutionary theories*. Self-published in a limited edition of 125 copies. 371 pp, 16 colour and 35 black-and-white illustrations. £40 (via Wildside Books, Eastbourne, e-mail: wildsidebooks@hotmail.com).

Henry Seebohm (1832–95), who was a founder member of the British Ornithologists' Club in 1892, certainly deserves a biography of this calibre and thoroughness, the only shame being the very short print run which may leave many bereft of a copy (only a few were left when I ordered mine). Tim Milsom has spent many years researching Seebohm's life story and his book is a wealth of careful research, and includes much of interest about Seebohm's contemporaries and the relationships he had with them.

Seebohm was an industrialist from Yorkshire, and as such an 'amateur', but he maintained close ties with the natural history departments of the British Museum and was much more than just a collector, having advanced ideas about evolutionary processes, bird breeding and their habitats. In the half century after his death, recognition of Seebohm's significance as an ornithological thinker declined, to the extent that Milsom flags up that almost his 'lone support' among British ornithologists in the period following WWII came from James Fisher, who considered Seebohm to be years before his time in his scientific thinking. For many years the Sheffield steel master was considered rather obscure and unimportant, but Milsom demonstrates the opposite is true, despite having had to rely on the fragmentary nature of Seebohm's archive, with his notebooks, annotated books and letters much dispersed or destroyed. However, the author has enjoyed the hunt for source material, which 'has been as absorbing as the writing of the book'. To emphasise the importance of writings on paper, Milsom quotes David Allen as saying: 'Manuscripts are the historian's bread, the basic source of sustenance without which his subject can scarcely exist'. It would be good to remember this; in this ever-more online world manuscripts and annotations are increasingly treated with cavalier abandon.

However, Seebohm's huge collection of well-labelled birds have fared better, most now residing in the Natural History Museum's out station at Tring, complete with a huge register which is devoted to the Yorkshireman's material and that of the Chiswick-based Edward Hargitt. Other Seebohm birds can be found elsewhere, such as in National Museum Liverpool, which has 130 of Seebohm's own specimens and others (including types) which he had acquired. Just as important to natural science are the several volumes of Seebohm's manuscript catalogue of the eggs in what was then the British Museum (Natural History), the hundreds of pages filled with Seebohm's careful sloping writing.

Milsom has carefully grouped his chapters, not necessarily in chronological order, as he is aware that many readers may only be interested in one particular aspect of Seebohm's life. We learn about Henry Seebohm's early life—the 'black sheep', whose male siblings did well in business. Henry took many years to make any money and vastly preferred to be out collecting birds and their eggs. He led an extraordinary ornithological life, in so many ways. His *History of British birds* (re-issued in 1896) is still widely consulted, even if it is over 120 years old. It is full of interesting field observations and erudite thought. Seebohm's contribution to the many volumed *Catalogue of the birds in the British Museum* (vol. 5, 1881: warblers and thrushes) is the classic record of the synonymy of the Turdidae, as well as having long and meticulous details of plumage. He travelled widely in his search for birds, especially in Siberia, the basis of his books (now considered classics) published in 1880, 1882 and 1901. Seebohm collected thousands of eggs but was just as diligent in recording their details for posterity and was the first to discover the nesting places of many rarities. He named many new species of birds, and many were named for him. Perhaps most importantly, Seebohm was among the first to seriously treat bird species as ever-changing and evolving, with geography playing a large part in this, and to champion the use of trinomials (subspecies) to indicate such development.

At 63 Seebohm died far too young, but (in addition to his election to ornithological societies) with the distinguished Society letters FLS, FZS and FRGS attached to his name, a stalwart and fully accepted part of the fabric of the British Museum (Natural History) and a man more than capable of standing his ground against the few who saw the blunt Yorkshireman as an upstart (yes, we particularly mean you, Alfred Newton). Seebohm had been on the British Ornithologists' Union Committee that led to the BOC being set up; he attended its inaugural meeting in October 1892 and eight of the nine subsequent meetings that took place in its first year of existence. He continued to attend meetings until to October 1895, the month before his death.

Clemency Fisher

Wiley, J. W. 2021. *The birds of St Vincent, The Grenadines and Grenada: an annotated checklist*. BOC Checklist Series 27. British Ornithologists' Club, Tring. 384 pp, 32 plates with 78 colour photos and 1 colour map. ISBN 978-0-9522886-8-8. £37.50.

The West Indies has been fortunate to have been the subject of half a dozen previous BOC (and BOU) checklists. The series is known for publishing detailed summaries of the status of every bird species recorded in a particular country or region, together with background information about the resultant avifauna. These checklists generally set rigorous standards for the evaluation and acceptance of published and unpublished records, and by weeding out doubtful or inadequately supported claims, they tend to be adopted as a firm baseline for further study.

The islands of St Vincent, the Grenadines and Grenada are arguably the corner of this region that was most in need of a thorough ornithological revision. Not only has there been confusion over the geographic assignment of records, caused by discrepancies between biogeographic and political names (the southern Grenadines are part of Grenada, rather than the country of St Vincent and the Grenadines), but a succession of previous checklists has admitted numerous records without the degree of evidence typically required by, for example, a national records committee. Furthermore, none of the previous checklists is readily available. The current work does much to bring clarity to this confusion by dividing the islands into three natural geological units, the largest islands of St Vincent and Grenada, and the Grenadines that run along the Grenada Bank between them; a map on p. 14 illustrates the relevant boundaries. The author removes 85 species for which occurrence in the islands is inadequately documented, relegating these unconfirmed species to 17 pages at the back of the book. They range from evident mistakes (Red-necked Grebe *Podiceps grisegena*), to claims lacking any documentation, to intriguing records like the Lack's famous 1971 Common Swift *Apus apus* that Bond concluded was erroneous, notwithstanding the observers' unrivalled experience with the species, and which now seems decidedly less outlandish in the light of a bird photographed in Puerto Rico in 2015. The threshold of evidence required for inclusion in the main checklist rather than this appendix is not entirely clear, as other published sight records have been accepted. Several species that likely occur and have been included in previous checklists—notably migrant shorebirds and parulid warblers—have been relegated to the appendix pending concrete evidence of their occurrence. On the other hand, Wiley resurrects species whose occurrence had been overlooked by previous checklists and some regional field guides, like White-necked Jacobin *Florisuga mellivora* for which a 1904 specimen exists. Genuinely new records include anticipated additions like Antillean Nighthawk *Chordeiles gundlachi* and Great Shearwater *Ardenna gravis*, both having been confirmed since the author's death, as well as vagrants like Bar-tailed Godwit *Limosa lapponica*.

The main text accounts broadly follow the layout of previous BOC checklists. The 200 species recorded with certainty are treated under sections on global distribution, status within the present region, breeding data, and a discussion of any pertinent taxonomic issues. The distinction between the three biogeographical subunits is maintained. The author located more than 5,000 specimens across 27 museums, and these are listed at the end of each account. Species accounts are highly informative and provide unique insights into the endemic taxa of the Lesser Antilles. Wiley gives little hope for the continued survival of the only West Indian population of Euler's Flycatcher *Lathrotriccus euleri flaviventris* on Grenada (of which there are no records since the 1950s), or the Grenada Scaly-breasted Thrasher *Allenia fusca 'fusca'*. A section of colour plates illustrates habitats as well as some of the more representative taxa. It is hard to believe on the basis of these photographs (as well as voice) that the two House Wren taxa, *musicus* and *grenadensis*, are the same species.

The introductory chapters provide a reliable overview of geology, vegetation, climate, human colonisation, conservation and so forth—information that is not easy to find elsewhere. A ten-page reference history of ornithology helps put the names of contributors into context as they appear in the main text. A further 23 pages are devoted to biogeography, and include an overview table summarising at a glance the status of each species in the subregions of St Vincent, the Grenadines, Grenada, and the region as a whole.

This is a worthy addition to the BOC checklist series as well as to the author's already impressive body of literature on the West Indies. A key piece in the jigsaw of West Indian ornithology, it becomes the standard account of the avifauna of St Vincent, the Grenadines and Grenada. The editors and the authors' collaborators are to be congratulated on seeing this valuable work through to completion.

Christopher J. Sharpe

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

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

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

Note on the nomenclature of *Myrmothera guttata* Vieillot, 1824 (Passeriformes, Thamnophilidae)

by Christophe Gouraud

Received 30 April 2021; revised 13 January 2022; published 11 March 2022

<http://zoobank.org/urn:lsid:zoobank.org:pub:4483DE96-5705-4821-AD85-22219740B22D>

SUMMARY.—Work on the publication date of Bonnaterre & Vieillot's *Tableau encyclopédique et méthodique* calls into question the priority of some names in use today. Among these *Myrmothera guttata* Vieillot, 1824, proves to be a junior synonym of a name introduced earlier. The possible reversal of precedence is studied here in compliance with the International Code of Zoological Nomenclature.

The Principle of Priority (Art. 23) is one of the pillars of the *International code of zoological nomenclature* (hereafter the Code) whose scope is 'to promote stability and universality in the scientific names of animals and to ensure that the name of each taxon is unique and distinct' (ICZN 1999). For more than a decade, the publication dates of several important 19th-century ornithological works, in which many new species were described, have been studied and corrected, as a result sometimes questioning the priority of names currently in use (e.g., Dickinson & Lebossé 2018, Dickinson *et al.* 2019). The relevant work to the case discussed herein is Bonnaterre & Vieillot's *Tableau encyclopédique et méthodique des trois règnes de la nature* (1790–1823, hereafter *Tableau encyclopédique*), whose publication date was clarified by Dickinson (2011). Based on his work and during my ongoing search for type material in the Baillon Collection of the Musée George Sand et de la Vallée Noire, La Châtre, France (hereafter MLC; see Gouraud 2015), I came across a valid name—*Myrmothera tessellata* Vieillot, 1822—which was published before that currently in use: *Myrmothera guttata* Vieillot, 1824. The former name is therefore senior synonym of the latter. I have investigated the implications of the rediscovery of this name, introduced by Vieillot in 1822, for the nomenclature of what is currently known as Rufous-bellied Antwren *Iseria guttata* (Vieillot, 1824).

Although the Principle of Priority is fundamental to the stability of nomenclature, it should not 'upset a long-accepted name in its accustomed meaning by the introduction of a name that is its senior synonym' (Art. 23.2). Art. 23.9.1.1 ('the senior synonym...has not been used as a valid name after 1899') and Art. 23.9.1.2 ('the junior synonym...has been used for a particular taxon, as its presumed valid name, in at least 25 works, published by at least 10 authors in the immediately preceding 50 years and encompassing a span of not less than 10 years') are intended to ensure this, and both must be met to prevent a reversal of precedence and the continued use of the junior synonym. After having addressed the possible reversal of precedence, I will address the whereabouts of the type specimens.

Myrmothera tessellata Vieillot, 1822

Full reference.—*M[yrmothera] Tessellata* Vieillot in Bonnaterre & Vieillot, 1822: 683–684, livraison 91 (July 1822).

M. tessellata was introduced by Vieillot in 1822 in the *Tableau encyclopédique*. The section *Ornithologie* in which this taxon was described comprises eight livraisons, the dates of which were detailed by Dickinson (2011: 78, and references therein). Livraison 91, which contains pp. 529–848 and concerns us here, appeared in July 1822. The bird described by



Figure 1. Plate 155 of the *Galerie des oiseaux*: 'Le Fourmilier Moucheté (*Myrmothera guttata*)' (© Ernst Mayr Library, Museum of Comparative Zoology, Harvard University, Cambridge, via Biodiversity Heritage Library: <https://www.biodiversitylibrary.org>)



Figure 2A: Specimen MLC.2011.0.1526, holotype of *Myrmothera tessellata* Vieillot, 1822. B: the original pedestal inscriptions read: ‘Myrmothera / tessellata V[ieillot] / fourmilier / marqueté Vieill[ot] / Encycl[opédie] / Cayenne / M. Bécœur’. The red label to indicate type status will be added as soon as possible (© Christophe Gouraud / Musée George Sand et de la Vallée Noire, La Châtre)

Vieillot is a good match for a female Rufous-bellied Antwren *Iseria guttata* (Vieillot, 1824) whose description, of a male, appeared two years later in Vieillot & Oudart’s *La galerie des oiseaux, dédiée à son Altesse Royale Madame, Duchesse du Berri* (1820–26, hereafter *Galerie des oiseaux*) under the name *Myrmothera guttata*. More precisely, the text appeared on the first page of livraison 44 (p. 251) and the plate (155; see Fig. 1) was the last of livraison 45 (A. Lebossé *in litt.* 2020). Both livraisons were dated 1824 by Lebossé & Dickinson (2015: 51). Thus, *Myrmothera tessellata* Vieillot, 1822, is a senior synonym of *Myrmothera guttata* Vieillot, 1824, the name currently in use.

Reversal of precedence.—Both conditions of Art. 23.9.1 are met and therefore the younger name (*Myrmothera guttata*) is valid. The conditions of Art. 23.9.1.2 are met (see list of works in Appendix). To my knowledge, the condition in Art. 23.9.1.1 applies. Thus, the younger name has precedence. Applying Art. 23.9.2, the younger but valid name *Myrmothera guttata* Vieillot, 1824, is a *nomen protectum* and the older name *Myrmothera tessellata* Vieillot, 1822, is a *nomen oblitum*.

Types.—Although the *Galerie des oiseaux* aimed to describe and figure at least one species of each genus in the Muséum national d’Histoire naturelle, Paris (MNHN) collections, Vieillot’s protologue for *M. guttata* is based on a bird from Cayenne (French Guiana) originally owned by the Comte de Riocour, most of whose collection was acquired by Adolphe Boucard in 1889 (Renshaw 1905: 422). The Boucard collection was subsequently dispersed among several museums, especially MNHN (25,000 specimens), the National Museum of Natural History, Smithsonian Institution, Washington DC (10,000 duplicates) and those in Madrid and Lisbon¹, which acquired 8,000 birds (Mearns & Mearns 1998: 286, 302). The holotype could not be found at MNHN (P. Boussès *in litt.* 2021). It is also not in Washington (not listed by Deignan 1961; confirmed by C. Milensky *in litt.* 2021) and Philadelphia (N. H. Rice *in litt.* 2021), where some specimens ended up. The Natural History Museum, Tring, also possesses some Boucard specimens, but the type was not listed by Warren & Harrison (1971) or in the online NHMUK database (<https://data.nhm.ac.uk/search>). Finally, it has not been found in the Museo Nacional de Ciencias Naturales, Madrid

¹ The entire collection was destroyed by fire in March 1978 (Roselaar 2003: 275).

(J. Barreiro Rodríguez *in litt.* 2021). In summary the whereabouts of the type specimen is unknown.

With respect to *Myrmothera tessellata*, Vieillot's description clearly indicates that the individual described was in the Baillon Collection and came from Cayenne. The holotype has been found (MLC.2011.0.1526; Fig. 2a) and it matches Vieillot's protologue. The pedestal inscriptions also state that the bird is from Cayenne (Fig. 2b) in accordance with the given type locality.

Acknowledgements

I am grateful to Josefina Barreiro Rodríguez (Museo Nacional de Ciencias Naturales, Madrid), Patrick Boussès (Muséum national d'Histoire naturelle, Paris), Christopher Milensky (National Museum of Natural History, Smithsonian Institution, Washington DC) and Nate Rice (Academy of Natural Sciences of Drexel University, Philadelphia) for their help in searching for the type of *M. guttata*. Without the Biodiversity Heritage Library (<https://www.biodiversitylibrary.org>), where the plate for Fig. 1 of the *Galerie des oiseaux* was found, work such as this would be far more difficult and time-consuming. Laurent Chevrier provided useful information on the collection of the Count de Riocour, Guy Kirwan helped with the search for synonyms, and Alain Lebossé provided additional information on publication dates of the texts and plates of the *Galerie des oiseaux*. Finally, I thank Vítor de Q. Piacentini and an anonymous referee for their comments.

References:

- Bonnaterre [Abbé] & Vieillot, L. P. 1790–1823. *Tableau encyclopédique et méthodique des trois règnes de la nature. Ornithologie*. 2ème édition. Panckoucke, Paris.
- Deignan, H. G. 1961. Type specimens of birds in the United States National Museum. *Bull. US Natl. Mus.* 221: 1–718.
- Dickinson, E. C. 2011. Bonnaterre, L'Abbé & L. P. Vieillot (1790-1823). *Tableau encyclopédique et méthodique des trois règnes de la nature*. 2^{ème} édition. *Ornithologie*. P. 78 in Dickinson, E. C., Overstreet, L. K., Dowsett, R. J. & Bruce, M. D. (eds.) *Priority! The dating of scientific names in ornithology*. Aves Press, Northampton.
- Dickinson, E. C. & Lebossé, A. 2018. A study of d'Orbigny's "Voyage dans l'Amérique Meridionale" IV. New avian names deriving from d'Orbigny's expedition with evidence for their first introduction and necessary corrections to authorship, dates and citations. *Zool. Bibliogr.* 5: 49–274.
- Dickinson, E. C., Stopiglia, R., Fuchs, J., Boussès, P., Trimble, J. & Gouraud, C. 2019. A study of d'Orbigny's "Voyage dans l'Amérique Meridionale" VI. Type specimens based on plate captions: bibliographic evidence applied. *Zool. Bibliogr.* 5: 293–388.
- Gouraud, C. 2015. List of type specimens of birds in the Baillon Collection (La Châtre, France). Part 1. Non-Passerines. *Bull. Brit. Orn. Cl.* 135: 131–153.
- International Commission on Zoological Nomenclature (ICZN). 1999. *International code of zoological nomenclature*. Fourth edn. International Trust for Zoological Nomenclature, London.
- Lebossé, A. & Dickinson, E. C. 2015. Fresh information relevant to the make-up of the livraisons of the "Galerie des Oiseaux" by Vieillot (1748-1831) & Oudart (1796-1860). *Zool. Bibliogr.* 3: 25–58.
- Mearns, B. & Mearns, R. 1998. *The bird collectors*. Academic Press, London.
- Renshaw, G. 1905. The Réunion Starling. *The Zoologist* (4)9: 418–422.
- Roselaar, C. S. 2003. An inventory of major European bird collections. Pp. 253–337 in Collar, N. J., Fisher, C. & Feare, C. J. (eds.) *Why museums matter: avian archives in an age of extinction*. *Bull. Brit. Orn. Cl. Suppl.* 123A.
- Vieillot, L. P. & Oudart, P. L. 1820–26. *La galerie des oiseaux, dédiée à son Altesse Royale Madame, Duchesse du Berry*, 2 vols. Constant-Chantpie, Paris.
- Warren, R. L. M. & Harrison, C. J. O. 1971. *Type-specimens of birds in the British Museum (Natural History)*, vol. 2. Trustees of the Brit. Mus. (Nat. Hist.), London.

Address: Christophe Gouraud, Musée George Sand et de la Vallée Noire (Collection Baillon), Hôtel de Villaines, 36400 La Châtre, France. Present address: Franz Baumannweg 22/39, 6020 Innsbruck, Austria, e-mail: ornithocoll@gmail.com

Appendix

Sample of 25 works, published by at least ten authors in the immediately preceding 50 years and encompassing a span of not less than ten years, where the junior synonym (i.e. *Myrmothera guttata* Vieillot, 1824) has been used for a particular taxon, as its presumed valid name, as required by Art. 23.9.1.2 and in compliance with Art. 23.9.6 of the Code. The references are listed in chronological order.

- Oniki, Y. & Willis, E. O. 1972. Studies of ant-following birds north of the eastern Amazon. *Acta Amazonica* 2: 127–151.

- Haffer, J. 1978. Distribution of Amazon forest birds. *Bonn. Zool. Beitr.* 1–4: 38–78.
- Novaes, F. C. 1980. Observações sobre a avifauna do alto curso do rio parú de Leste, Estado do Pará. *Bol. Mus. Para. E. Goeldi, N. S. (Zool.)* 100: 1–58.
- Willis, E. O. 1984. *Myrmotherula antwrens* (Aves, Formicariidae) as army ant followers. *Rev. Bras. Zool.* 2: 153–158.
- Thiollay, J.-M. 1988. Comparative foraging success of insectivorous birds in tropical and temperate forests: ecological implications. *Oikos* 53: 17–30.
- Powell, G. V. N. 1989. On the possible contribution of mixed species flocks to species richness in neotropical avifaunas. *Behav. Ecol. Sociobiol.* 24: 387–393.
- Sibley, C. G. & Monroe, B. L. 1990. *Distribution and taxonomy of birds of the world*. Yale Univ. Press, New Haven, CT & London.
- Hackett, S. J. & Rosenberg, K. V. 1990. Comparison of phenotypic and genetic differentiation in South American antwrens (Formicariidae). *Auk* 107: 473–489.
- Willard, D. E., Foster, M. S., Barrowclough, G. F., Dickerman, R. W., Cannell, P. F., Coats, S. L., Cracraft, J. L. & O'Neill, J. P. 1991. The birds of Cerro de la Neblina, Territorio Federal Amazonas, Venezuela. *Fieldiana (Zool.)* 65: 1–80.
- Haffer, J. 1992. Parapatric species of birds. *Bull. Brit. Orn. Cl.* 112: 250–264.
- Thiollay, J.-M. 1994. Structure, density and rarity in an Amazonian rainforest bird community. *J. Trop. Ecol.* 10: 449–481.
- Stouffer, P. C. & Bierregaard, R. O. 1995. Use of Amazonian forest fragments by understory insectivorous birds. *Ecology* 76: 2429–2445.
- Mason, D. 1996. Responses of Venezuelan understory birds to selective logging, enrichment strips, and vine cutting. *Biotropica* 28: 296–309.
- Reynaud, P. A. 1998. Changes in understory avifauna along the Sinnamary River (French Guyana, South America). *Orn., Neotrop.* 9: 51–70.
- Hilty, S. L. 2003. *Birds of Venezuela*. Princeton Univ. Press.
- Lindell, C. A., Riffell, S. K., Kaiser, S. A., Battin, A. L., Smith, M. L. & Sisk, T. D. 2007. Edge responses of tropical and temperate birds. *Wilson J. Orn.* 119: 205–220.
- Aleixo, A., Poletto, F., Cunha Lima, M. F., Castro, M., Portes, E. & Sousa Miranda, L. 2011. Notes on the vertebrates of northern Pará, Brazil: a forgotten part of the Guianan Region, II. Avifauna. *Bol. Mus. Para. E. Goeldi* 6: 11–65.
- Bravo, G. A., Chesser, R. T. & Brumfield, R. T. 2012. *Isleria*, a new genus of antwren (Aves: Passeriformes: Thamnophilidae). *Zootaxa* 3195: 61–67.
- Belmonte-Lopes, R., Bravo, G. A., Bornschein, M. R., Maurício, G. N., Pie, M. R. & Brumfield, R. T. 2012. Genetic and morphological data support placement of *Myrmotherula gularis* (Spix) in the monotypic genus *Rhopias* Cabanis and Heine (Aves: Passeriformes: Thamnophilidae). *Zootaxa* 3451: 1–16.
- Dickinson, E. C. & Christidis, L. (eds.) 2014. *The Howard & Moore complete checklist of the birds of the world*, vol. 2. Fourth edn. Aves Press, Eastbourne.
- Bravo, G. A., Renssen, J. V. & Brumfield, R. T. 2014. Adaptive processes drive ecomorphological convergent evolution in antwrens (Thamnophilidae). *Evolution* 68: 2757–2774.
- Johnson, E. I. & Wolfe, J. D. 2014. Thamnophilidae (antbird) molt strategies in a central Amazonian rainforest. *Wilson J. Orn.* 126: 451–462.
- del Hoyo, J. & Collar, N. J. 2016. *HBW and BirdLife International checklist of the birds of the world*, vol. 2. Lynx Edicions, Barcelona.
- Spaans, A. L., Ottema, O. H., Ribot, J. H. J. M. & van Perlo, B. 2016. *Field guide to the birds of Suriname*. Brill, Leiden.
- Zimmer, K. & Isler, M. L. 2020. Rufous-bellied Antwren (*Isleria guttata*), version 1.0 in del Hoyo, J., Elliott, A., Sargatal, J., Christie, D. A. & de Juana, E. (eds.) *Birds of the world*. Cornell Lab of Ornithology, Ithaca, NY. <https://doi.org/10.2173/bow.rubant3.01> (accessed on 25 March 2021).

Catalogue of Cuban fossil and subfossil birds

by William Suárez

Received 4 July 2021; revised 17 December 2021; published 11 March 2022

<http://zoobank.org/urn:lsid:zoobank.org:pub:4C9216EC-E822-4CC7-A163-6E96CFB3078F>

SUMMARY.—All information relating to the Cuban palaeo-avifauna since the first published list in 1928 to the present, is summarised and presented as a catalogue with commentary. I update data on the composition, systematics and distribution of fossil and subfossil birds from Quaternary (Late Pleistocene-Holocene interval) deposits in Cuba, with a necessary critical review. Thirty-six taxa (30 extinct, two poorly represented and apparently also extinct, and four extirpated) are listed as valid records in Section I, under 14 families, with Teratornithidae the only extinct family grouping. Birds of prey and scavengers constitute 72.2% of these taxa, with Accipitridae (22.2%) and Falconidae (16.6%) the best represented, followed by nocturnal raptors. Sections II and III comment on and discuss material referred to 29 taxa, of which one is of dubious identity and the others misidentified and / or synonymised at class, family, genus or species level. Cuban neospecies currently known in paleontological localities throughout the archipelago are listed in Section IV; 49 are identified (14 considered today as endemic species, including six endemic genera) in 26 families.

In memoriam: Storrs L. Olson (1944–2021), mentor, friend and partner in the study of fossil birds

During 1911 and 1918, Carlos de la Torre, his assistant Víctor Rodríguez (both from Universidad de La Habana), Barnum Brown (American Museum of Natural History, New York), and allied personnel, conducted extensive field work at Quaternary fossil localities in central Cuba, especially in spring deposits at Baños de Ciego Montero, Cienfuegos province (Goldberg *et al.* 2017). The first mention of Cuban fossil birds—for the living avifauna of Cuba see Kirkconnell *et al.* (2020)—was published by Brown (1913: 228) with news of bones secured there along with remains of other vertebrates, including a remarkable mammalian assemblage (see Matthew 1931, Aguayo 1950, Williams 1950, Álvarez Conde 1951). Also in 1913, the Links collected fossil material, including of birds, from the western part of the archipelago (Peterson 1917; see Holland 1917: 356, Anthony 1919: 625) in a Quaternary cave deposit at Sierra de Caballos, Isla de Pinos (now Isla de La Juventud). Being more explicit than Brown on the avian specimens, Peterson (1917: 359) described the material as in ‘semi-petrified condition’ where ‘few limb-bones of snipes and small herons are represented’. At the end of excavations in Ciego Montero, a small collection (11 specimens) of bird elements emerged. Eight taxa were identified (Wetmore 1928), with two extinct, one extirpated and one intrusive.

The geologist Roy E. Dickerson discovered fossils (see Chawner 1932), including those of birds in a ‘tar pit near Hato Nuevo [now Martí]’, a locality currently known as ‘Las Breas de San Felipe’, Matanzas province, western Cuba, and the only fossil deposit of its kind in the Greater Antilles (Iturralde-Vinent 1998, Iturralde-Vinent *et al.* 1999, 2000). Some specimens were collected there in early 1933 (see Berry 1934: 237, Richards 1935: 255–256, Williams 1950: 7) by Dickerson, Pedro J. Bermúdez (both from the Atlantic Refining Company) and Horace G. Richards (New Jersey State Museum, Trenton), and

sent to Carlos de la Torre, but never studied (Iturralde-Vinent *et al.* 2000: 300). The next notable event was in 1947, when Abelardo Moreno (Museo Felipe Poey, La Habana) sent to Alexander Wetmore (Smithsonian Institution, Washington DC), two fossils of a large extinct raptor (genus *Ornimegalonyx* Arredondo, see Suárez 2020b), from the former Oriente (now Santiago de Cuba) province, eastern Cuba (Arredondo & Olson 1994) that was identified and considered to be a giant barn owl (genus *Tyto* Billberg) for some time (Wetmore 1959: 15, Brodkorb 1959: 357, Olson's footnote in Arredondo 1976: 172, Olson 1978: 105).

In the second half of the 20th century, studies of fossil vertebrates in Cuba were greatly enhanced by the dedication of Prof. Oscar Arredondo (1918–2001). Arredondo's explorations, discoveries and publications on fossil birds during his lifetime added significant advances to Cuban avian paleontology (Arredondo Antúnez 2007, see also Álvarez Conde 1957: 247–248, Olson 1978: 101). Wetmore (1956, 1959) and Brodkorb (1963, 1964, 1971, 1978) listed Cuban fossil birds, including those recorded by Wetmore (1928) and described by Arredondo (1958, 1970a) and Brodkorb (1969). These were treated in more detail by Arredondo (1984) in *Sinopsis de las aves halladas en depósitos fosilíferos pleistoholocénicos de Cuba* ['Synopsis of the birds found in Pleisto-Holocene fossil deposits of Cuba'], with the addition of most of the birds named and identified by Fischer (1968, 1970, 1977), Fischer & Stephan (1971a,b), Arredondo (1972a,b,c, 1982), Olson (1974) and Acevedo-González & Arredondo (1982), plus all others recovered, or then known, from Quaternary deposits throughout the archipelago. The 'synopsis' has been, for almost four decades, the main source of information for palaeontologists and archaeologists dealing with Cuban avian remains.

The catalogue of Cuban fossil and subfossil birds has been changing since 1984 (see Section I) by deletions, records of additional extinct and/or extirpated taxa, and descriptions of new genera and species for science (Olson 1985, Arredondo & Olson 1994, Suárez & Arredondo 1997, Suárez 2000a, 2001a,b, 2004a,b, 2020a,b, Suárez & Olson 2001a,b, 2003a,b,c, 2009a, 2015, 2020a,b, 2021, Arredondo & Arredondo 2002a,b, Olson & Suárez 2008a, Steadman & Takano 2016), with consequent modifications in composition, systematics and distribution of the palaeo-avifauna. Thirty-six taxa (including extinct and extirpated) are currently known in the palaeontological record of Cuba (see summary in Table 1). The present catalogue updates and critically summarises all data concerning Cuban palaeornithology since Wetmore's pioneering list published on 29 February 1928.

Material and Methods

The catalogue is divided into four sections: Section I: Extinct (+) & Extirpated (×) Taxa; Section II: Species of Dubious Identity; Section III: Misidentified & Synonymised Taxa; and Section IV: Cuban Neospecies in Fossil Deposits.

Only paleontological records are presented, with archaeological (pre- or post-Columbian) and recent (Late Holocene) material, usually derived from barn owl (= *Tyto*) pellets, excluded, or only mentioned for particular taxa or as incidental comments. In section I, under 'History', are summaries of relevant dates when known, in the history of some extinct birds, e.g., related to discovery, type material, taxonomy, etc. 'Other material' includes all specimens (mostly paratypes) mentioned in the original description of each taxon, other than the holotype. Distribution of taxa by their respective localities (= Late Pleistocene-Holocene deposits), are ordered from west to east, using an identification key (Appendix, Fig. 1). Each taxon is indicated following the publication in which it has been recorded and cited as appears in the original source, if the nomenclature is different from that used herein. For species with wider distribution (continental and/or insular), information provided under 'Referred material' and 'Distribution' is restricted

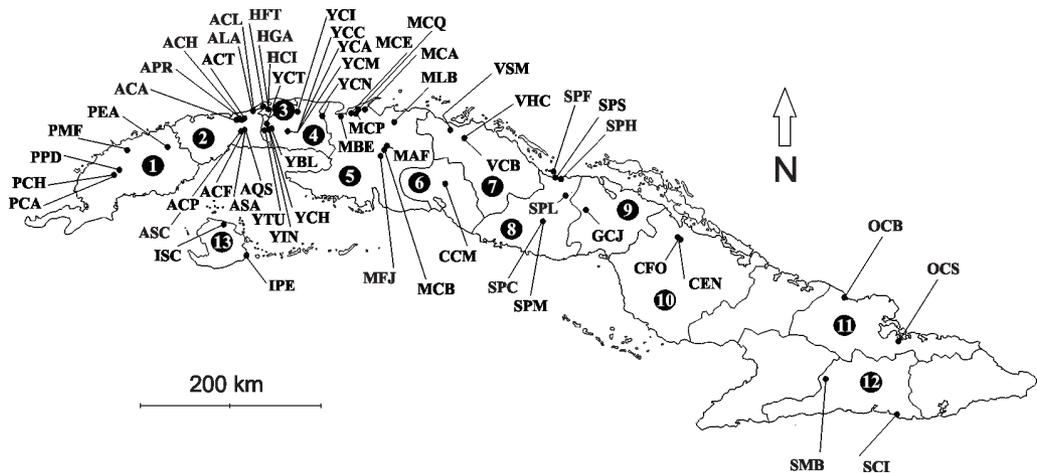


Figure 1. Distribution of Quaternary deposits in Cuban territory.

to Quaternary fossil localities in Cuba. Figures and/or drawings (*) from the literature are cited (when they exist) for each specimen, with their respective views indicated in brackets. Information concerning types and specimens that constitute first records to Cuba, with their localities and related bibliography, is summarised in Table 1. Acronyms, ordered alphabetically by collections and/or institutions from the USA, Cuba and France as follows: AMNH (American Museum of Natural History, New York), Av. (acronym as in Fischer & Stephan 1971a,b; Universidad de La Habana, La Habana; specimens currently in other Cuban collections are indicated in each case), CAZGA (Colección Arqueozoológica del Gabinete de Arqueología, Oficina del Historiador de La Habana, La Habana), CLV (Lazaro W. Viñola, Matanzas), CZACC (Colecciones del Instituto de Zoología, Academia de Ciencias de Cuba, now at Instituto de Ecología y Sistemática, La Habana), DPUH (Departamento de Paleontología de la Universidad de La Habana, La Habana), GEC (Grupo de Exploraciones Científicas, Cuba), GEPAB (Grupo Espeleológico Pedro A. Borrás, La Habana), IGP/ACC (Instituto de Geología y Paleontología, Academia de Ciencias de Cuba, La Habana), LACM (Natural History Museum of Los Angeles County, California), LMR (Luis M. Rodríguez, Holguín), MCZ (Museum of Comparative Zoology, Harvard University, Cambridge, MA), MNHN (Muséum national d'Histoire naturelle, Paris), MNHNCu (Museo Nacional de Historia Natural de Cuba, La Habana), OA (Oscar Arredondo, La Habana), OJ (Osvaldo Jiménez, La Habana), PB (Pierce Brodkorb, University of Florida, Gainesville), SEC (Sociedad Espeleológica de Cuba), UCMP (University of California Museum of Paleontology, Berkeley), UF (University of Florida, Gainesville), USNM (National Museum of Natural History, Smithsonian Institution, Washington DC; collections at the Department of Paleobiology with the acronym PAL, cited sporadically in recent literature) and WS (William Suárez, La Habana). Systematic arrangement follows the last edition of the American Ornithologists' Union (AOU 1998) and its supplements, except the extant White-winged Barn Owl *Tyto furcata* (Temminck, 1827), considered a full, insular species from Cuba, Jamaica and Cayman Islands (Suárez & Olson 2015, 2020a). Authors' names and titles of papers appear in 'References' without modifications from their original sources, with corrections indicated when necessary and in those cases, authors cited in the text as corrected. Osteological terminology is from Howard (1929).

TABLE 1

Extinct (+) and extirpated (×) fossil and subfossil birds with holotypes and specimens that constitute first records in Quaternary deposits in Cuba.

Taxon	Specimen(s)	Locality	Bibliography
1. † <i>Siphonorhis daiquiri</i> Olson, 1985	*Distal half of right tarsometatarsus (USNM 336506).	*Cueva de los Indios (SCI), Santiago de Cuba, Santiago de Cuba.	Olson 1985, <i>Proc. Biol. Soc. Wash.</i> 98: 528.
2. † <i>Nesotrochis picapicensis</i> (Fischer & Stephan, 1971)	*Left humerus (Av. 832/67 [as ' <i>Fulica picapicensis</i> ']).	*Caverna de Pío Domingo (PPD), Minas de Matahambre, Pinar del Río.	Fischer & Stephan 1971b, <i>Wiss. Zeitsch. Humboldt-Univ. Berlin, Math.-Nat. R.</i> 20: 595.
3. † <i>Antigone cubensis</i> (Fischer & Stephan, 1971)	*Skull with its respective mandible and left quadrate (Av. 1/67 [as ' <i>Grus cubensis</i> ']).	*Caverna de Pío Domingo (PPD), Minas de Matahambre, Pinar del Río.	Fischer & Stephan 1971a, <i>Wiss. Zeitsch. Humboldt-Univ. Berlin, Math.-Nat. R.</i> 20: 565.
4. × <i>Burhinus bistriatus</i> (Wagler, 1829)	Distal ends of left (OA 2958) and right (OA 2959) humeri (as ' <i>Burhinus</i> sp.').	Cueva de Paredones (ACP), Caimito, Artemisa.	Arredondo 1984, <i>Rep. Invest. Inst. Zool.</i> 17: 16 (see Suárez 2020a).
5. † <i>Gallinago kakuki</i> Steadman & Takano, 2016	Right humerus (MNHNCu 75.4709 [as ' <i>Capella</i> sp.']).	Cueva El Abrón (PEA), Los Palacios, Pinar del Río.	Suárez 2004b, <i>Carib. J. Sci.</i> 40: 155 (see Steadman & Takano 2016).
6. † <i>Ciconia maltha</i> L. Miller, 1910	Distal left tibiotarsus (AMNH unnumbered) and proximal right (AMNH unnumbered) tarsometatarsus (as ' <i>Jabiru mycteria</i> ').	Baños de Ciego Montero (CCM), Palmira, Cienfuegos.	Wetmore 1928, <i>Amer. Mus. Novit.</i> 301: 2 (see Howard 1942).
7. <i>Ciconia</i> sp.	Distal end of right tibiotarsus (MNHNCu 75.4599).	Las Breas de San Felipe (MLB), Martí, Matanzas.	Suárez & Olson 2003a, <i>Condor</i> 105: 151.
8. † <i>Mycteria wetmorei</i> Howard, 1935	Proximal end of right carpometacarpus (MNHNCu 75.4602), distal end of right tibiotarsus (MNHNCu 75.4603), proximal end of left tarsometatarsus (juvenile, MNHNCu 75.4604), distal end of right tarsometatarsus (MNHNCu 75.4605).	Las Breas de San Felipe (MLB), Martí, Matanzas.	Suárez & Olson 2003a, <i>Condor</i> 105: 151.
9. × <i>Tigrisoma mexicanum</i> Swainson, 1834	Left tarsometatarsus (AC-33).	Casimba en los Buentes (VCB), Mal Páez, Villa Clara.	Olson & Suárez 2008a, <i>Waterbirds</i> 31: 285.
10. † <i>Oscaravis olsoni</i> Arredondo & Arredondo, 2002	*Right femur (IGP/ACC 400–649 [as ' <i>Teratornis</i> sp.']).	*Cueva de Paredones (ACP), Caimito, Artemisa.	Suárez & Arredondo 1997, <i>El Pitirre</i> 10: 101 (see Arredondo & Arredondo 2002b, Suárez & Olson 2009a).
11. † <i>Gymnogyps varonai</i> (Arredondo, 1972)	*Proximal fragmentary left tarsometatarsus (DPUH 1254 [as ' <i>Antillovultur varonai</i> ']).	*Cueva de Paredones (ACP), Caimito, Artemisa.	Arredondo 1972c, <i>Mem. Soc. Cienc. Nat. La Salle</i> 31: 310 (see Suárez & Emslie 2003).
12. † <i>Coragyps seductus</i> Suárez, 2020	*Left tarsometatarsus (MNHNCu 75.4719).	*Las Breas de San Felipe (MLB), Martí, Matanzas.	Suárez 2020a, <i>Zootaxa</i> 4780: 12.
13. † <i>Cathartes emslieii</i> Suárez & Olson, 2020	*Proximal half of left tarsometatarsus (MNHNCu 75.4752).	*Las Breas de San Felipe (MLB), Martí, Matanzas.	Suárez & Olson 2020b, <i>Bull. Brit. Orn. Cl.</i> 140: 335.
14. † <i>Gigantohierax suarezi</i> Arredondo & Arredondo, 2002	*Left femur (MNHNCu 75.574).	*Cueva de Sandoval (ASA), Caimito, Artemisa.	Arredondo & Arredondo 2002a, <i>Poeyana</i> 470–475: 10.

Taxon	Specimen(s)	Locality	Bibliography
15. † <i>Gigantohierax itchei</i> Suárez, 2020	*Distal third of right tarsometatarsus lacking trochlea IV (MNHNCu 75.4869).	*Las Breas de San Felipe (MLB), Martí, Matanzas.	Suárez 2020a, <i>Zootaxa</i> 4780: 25.
16. <i>Buteogallus</i> cf. † <i>B. fragilis</i> (L. Miller, 1911)	Distal end of right tibiotarsus (MNHNCu 75.4735), distal shaft of left tarsometatarsus (MNHNCu 75.4736).	Las Breas de San Felipe (MLB), Martí, Matanzas.	Suárez 2020a, <i>Zootaxa</i> 4780: 17.
17. † <i>Buteogallus borraisi</i> (Arredondo, 1970) ¹	*Left tarsometatarsus lacking distal end (DPUH 1250 [as ' <i>Aquila borraisi</i> ']).	*Cueva del Túnel (YTU), Quivicán, Mayabeque.	Arredondo 1970a, <i>Cienc. Biol. Univ. Habana</i> 4(8): 3 (see Suárez & Olson 2008).
18. † <i>Buteogallus royi</i> Suárez, 2020	*Left tarsometatarsus (MNHNCu 75.4909).	*Las Breas de San Felipe (MLB), Martí, Matanzas.	Suárez 2020a, <i>Zootaxa</i> 4780: 20.
19. † <i>Buteogallus irpus</i> Suárez & Olson, 2021	***Partial skeleton (WS 365 [as ' <i>Amplibuteo</i> sp.]).	Cueva de Sandoval (ASA), Caimito, Artemisa.	Suárez & Arredondo 1997, <i>El Pitarre</i> 10: 101 (see Suárez & Olson 2021).
20. × <i>Buteo lineatus</i> (J. F. Gmelin, 1788)	Proximal end of right femur (MNHNCu 75.4614), distal halves of right (MNHNCu 75.4615) and left (MNHNCu 75.4616) tibiotarsi, distal end of left tibiotarsus (MNHNCu 75.4617), distal halves of right (MNHNCu 75.4618) and left (MNHNCu 75.4619) tarsometatarsi.	Las Breas de San Felipe (MLB), Martí, Matanzas.	Suárez & Olson 2003b, <i>J. Raptor Res.</i> 37: 71.
21. † <i>Buteo sanfelipensis</i> Suárez, 2020	*Left tarsometatarsus lacking trochlea IV (MNHNCu 75.4910).	*Las Breas de San Felipe (MLB), Martí, Matanzas.	Suárez 2020a, <i>Zootaxa</i> 4780: 28.
22. † <i>Tyto pollens</i> Wetmore, 1937	Distal left tarsometatarsus (DPUH 1252 [holotype of ' <i>Tyto riveroi</i> ']).	Cueva de Bellamar (MBE), Matanzas, Matanzas.	Arredondo 1972b, <i>Bol. Soc. Venez. Cienc. Nat.</i> 30 (124/125): 131 (see Suárez & Olson 2015).
23. † <i>Tyto noeli</i> Arredondo, 1972	*Right tarsometatarsus (DPUH 1251).	*Cueva del Túnel (YTU), Quivicán, Mayabeque.	Arredondo 1972a, <i>Bol. Soc. Venez. Cienc. Nat.</i> 29 (122/123): 416.
24. † <i>Tyto cravesae</i> Suárez & Olson, 2015	*Associated postcranial elements of one individual (MNHNCu 75.590 [= proximal half of left humerus, proximal end of right ulna, right carpometacarpus and right femur]).	*Cueva de Paredones (ACP), Caimito, Artemisa.	Suárez & Olson 2015, <i>Zootaxa</i> 4020: 545.
25. † <i>Tyto maniola</i> Suárez & Olson, 2020	*Proximal half of left tarsometatarsus (MNHNCu 75.4651).	*Las Breas de San Felipe (MLB), Martí, Matanzas.	Suárez & Olson 2020a, <i>Zootaxa</i> 4830: 552.
26. † <i>Pulsatrix arredondoii</i> Brodkorb, 1969	*Left tarsometatarsus (PB 8420).	*Cueva de Paredones (ACP), Caimito, Artemisa.	Brodkorb 1969, <i>Quart. J. Fla. Acad. Sci.</i> 31: 112.
27. † <i>Bubo osvaldoi</i> Arredondo & Olson, 1994	*Right tarsometatarsus lacking proximal end (MNHNCu 75.27).	*Cueva del Mono Fósil (PMF), Viñales, Pinar del Río.	Arredondo & Olson 1994, <i>Proc. Biol. Soc. Wash.</i> 107: 438.
28. † <i>Ornimegalonyx oteroi</i> Arredondo, 1958	**Left tarsometatarsus lacking distal end (SEC P-383.E [at MCZ]).	*Caverna de Pío Domingo (PPD), Minas de Matahambre, Pinar del Río.	Arredondo 1958, <i>El Cartero Cubano</i> 17(7): 11 (see Brodkorb 1961).

Taxon	Specimen(s)	Locality	Bibliography
29. † <i>Ornimegalonyx ewingi</i> Suárez, 2020	*Right femur (USNM 447022).	*'Mine' in vicinity of Baire (SMB), Contramaestre, Santiago de Cuba.	Suárez 2020b, <i>Bull. Brit. Orn. Cl.</i> 140: 391.
30. † <i>Caracara creightoni</i> Brodkorb, 1959	Incomplete skull (OA 3928).	Cueva Calero (MCA), Cantel, Matanzas.	Suárez & Arredondo 1997, <i>El Pitirre</i> 10: 101.
31. † <i>Milvago carbo</i> Suárez & Olson, 2003	*Near-complete right tarsometatarsus (MNHN Cu 75.4569).	*Las Breas de San Felipe (MLB), Martí, Matanzas.	Suárez & Olson 2003c, <i>Proc. Biol. Soc. Wash.</i> 116: 302.
32. † <i>Milvago diazfrancoi</i> Suárez, 2020	*Left tarsometatarsus lacking trochleae II and IV (MNHN Cu 75.4610).	*Las Breas de San Felipe (MLB), Martí, Matanzas.	Suárez 2020a, <i>Zootaxa</i> 4780: 36.
33. <i>Milvago</i> sp.	Proximal left tarsometatarsus (WS 977).	Cueva de Paredones (ACP), Caimito, Artemisa.	Suárez & Arredondo 1997, <i>El Pitirre</i> 10: 101.
34. × <i>Falco femoralis</i> Temminck, 1822	Incomplete right carpometacarpus (MNHN Cu 75.4606, MNHN Cu 75.4607), distal end of left tibiotarsus (MNHN Cu 75.4608), proximal end of left tarsometatarsus (MNHN Cu 75.4609).	Las Breas de San Felipe (MLB), Martí, Matanzas.	Suárez & Olson 2003b, <i>J. Raptor Res.</i> 37: 73.
35. † <i>Falco kurochkini</i> Suárez & Olson, 2001	*Left tarsometatarsus (MNHN Cu 75.3229).	*Cueva de Sandoval (ASA), Caimito, Artemisa.	Suárez & Olson 2001a, <i>Proc. Biol. Soc. Wash.</i> 114: 35.
36. † <i>Ara tricolor</i> Bechstein, 1811	Proximal half of right carpometacarpus (AMNH unnumbered)	Baños de Ciego Montero (CCM), Palmira, Cienfuegos.	Wetmore 1928, <i>Amer. Mus. Novit.</i> 301: 4.

¹ For *Geranoaetus melanoleucus* see section II.

* Holotype and type locality. ** Lectotype. *** Paratype.

I—EXTINCT & EXTIRPATED TAXA

Systematic palaeontology

Order CAPRIMULGIFORMES Ridgway

Family CAPRIMULGIDAE Vigors

Genus *Siphonorhis* P. L. Sclater, 1861

Siphonorhis P. L. Sclater, 1861, *Proc. Zool. Soc. London*, pl. 1, p. 77. Type, by original designation, *Caprimulgus americanus* Linnaeus (not '*Siphonorhis jamaicensis*' sensu Garrido 2003: 62).

Microsiphonorhis Chapman, 1917, *Bull. Amer. Mus. Nat. Hist.* 37: 329. Type, by original designation, *M. brewsteri* Chapman.

1. †*Siphonorhis daiquiri* Olson, 1985

Cuban Pauraque (Torico Cubano)

Siphonorhis daiquiri Olson, 1985, *Proc. Biol. Soc. Wash.* 98: 528.

Siphonorhis sp.: Acevedo-González & Arredondo 1982: table 1.

Siphonornis daiquiri: Zelenkov & González 2020: 416 (*lapsus calami*).

History.—*February 1917*: Harold E. Anthony collects first material at type locality (see Anthony 1917, 1919). *October 1980*: field work by S. L. Olson *et al.* provides the holotype and some paratypes (Olson 1985: 528–530). *1982*: two additional specimens identified (April) by Olson, previously collected by E. N. Kurochkin in Camagüey province (Olson 1985: 529, see Olson & Kurochkin 1987: 354). First mentioned as '*Siphonorhis* sp.' by Acevedo-González &

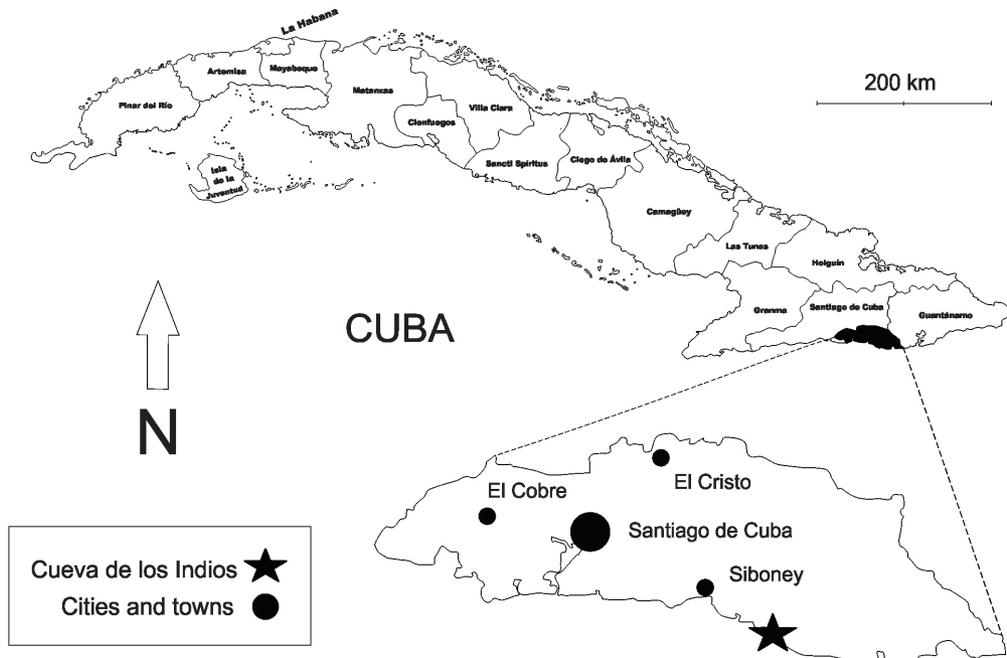


Figure 2. Cueva de los Indios (SCI), Santiago de Cuba, eastern Cuba. Type locality of †*Siphonorhis daiquiri* Olson.

Arredondo (1982: table 1). 16 May 1985: original description of *S. daiquiri* published (Olson 1985). Autumn 2000: first record from western Cuba, in El Sumidero, Cueva de Sandoval, Artemisa (formerly La Habana) province, an apparently older deposit than the type locality (Suárez 2000b: 67). April 2004: reported from Cueva El Abrón, its westernmost known fossil locality (Suárez 2004b: 156), in the mountains of Pinar del Río province (see Suárez & Díaz-Franco 2003).

Holotype.—Distal half of right tarsometatarsus, USNM 336506—not ‘Right proximal humerus (USNM 336506)’ as stated by Orihuela (2019: 64)—(Olson 1985: 528, fig. 1: A [anterior], B [posterior], fig. 2: B [posterior]). Collected 31 October 1980 by S. L. Olson *et al.* [= Jim Lynch, Nicasio Viña and Fernando González (S. L. Olson *in litt.* 2015)] (Olson 1985: 528).

Other material.—**Coracoid:** left, USNM 336507. **Humerus:** right, AMNH 21905 (Olson 1985: 529, fig. 3: B [anconal]), AMNH 21906; right lacking distal end, AMNH 21907; proximal ends of right, AMNH 21908, USNM 336508; proximal end of left, USNM 336509; left lacking proximal end, AMNH 21909. **Carpometacarpus:** right lacking minor metacarpal, AMNH 21904; proximal end of left, USNM 336510. AMNH material collected by H. E. Anthony in 1917 (Olson 1985: 529, see ‘History’).

Type locality.—Cueva de los Indios (SCI), near Daiquirí, c.22 km east-southeast of Santiago de Cuba, Santiago de Cuba province, Cuba (Olson 1985: 528; see Anthony 1917, 1919). Fig. 2.

Distribution.—Cave deposits across the main island of Cuba (see Appendix). *Pinar del Río*. Los Palacios: **PEA** (Suárez 2004b: 156). *Artemisa*. Caimito: **ASA** (Suárez 2000b: 66, fig. 3 = tarsometatarsus: A [anterior], B [posterior], fig. 4 = idem: A [anterior]). *Mayabeque*. Quivicán: **YBL** (Jiménez Vázquez *et al.* 2005: 97–98). *Camagüey*. Sierra de Cubitas: **CFO**

(Olson 1985: 529). *Santiago de Cuba*. Santiago de Cuba: **SCI** = type locality (Olson 1985: 528–529 [*Siphonorhis daiquiri*, new species'], Arredondo 1996: 1).

Direct ¹⁴C dating.—None. For dating of associated fauna from PEA (17,406 ± 161 ¹⁴C yr BP) and YBL (7,864 ± 96 ¹⁴C yr BP), see Suárez & Díaz-Franco (2003: 373) and Jiménez Vázquez *et al.* (2005: 90), respectively.

Notes.—Not rare in cave deposits containing relatively ancient barn owl pellets (*cf.* *Tyto furcata* and *T. noeli*). Genus *Siphonorhis* is endemic to the Greater Antilles and a primitive caprimulgid stock, being one of the most ancient members of the West Indies avifauna (Olson 1978, 1985). The extinct (but see Olson 1985: 531, Suárez 2000b: 68) Cuban Pauraque was first mentioned by Acevedo-González & Arredondo (1982: table 1) as '*Siphonorhis* sp.', without reference to specimens or locality, based on information supplied by S. L. Olson (O. Arredondo pers. comm.). Subsequently, it was deleted without comment in Arredondo (1984: 30). Three species are known in *Siphonorhis* (not '*S. noctitherus*† in Puerto Rico' as appears in Kirkconnell *et al.* 2020: 65), distributed on Hispaniola including Gonâve Island (Least Pauraque *S. brewsteri* [Chapman, 1917]; see Garrido 2003, Keith *et al.* 2003, Latta *et al.* 2006), Jamaica (Jamaican Pauraque †*S. americana* [Linnaeus, 1758], see Olson & Steadman 1977, Downer & Sutton 1990, AOU 1998) and Cuba (Cuban Pauraque †*S. daiquiri*). The latter is intermediate in size compared to the two other species (Olson 1985: 530, see Olson & Steadman 1977: 456).

Order GRUIFORMES Bonaparte
Family INCERTAE SEDIS
Genus †*Nesotrochis* Wetmore, 1918

Nesotrochis Wetmore, 1918, *Proc. US Natl. Mus.* 54: 516. Type, by original designation, *Nesotrochis debooyi* Wetmore.

2. †*Nesotrochis picapicensis* (Fischer & Stephan, 1971)
Pica-Pica's Rail (Gallinuela de Pica-Pica)

Fulica picapicensis Fischer & Stephan, 1971b (part), *Wiss. Zeitsch. Humboldt-Univ. Berlin, Math.-Nat. R.* 20: 595.

Fulica picapicensis: Fischer & Stephan 1971b: 595 (part).

Nesotrochis picapicensis: Olson 1974: 441.

Nesotrochis picapicensis: Jiménez Vázquez & Arrazcaeta Delgado 2015: 142 (*lapsus calami*).

Nesotrochis picapicensis: Oswald *et al.* 2021: 2 (*lapsus calami*).

Fulica picapicensis: Oswald *et al.* 2021: 2 (*lapsus calami*).

History.—*Summer 1967*: members of the Cuban-German Expedition (Universidad de La Habana & Institut für Paläontologie und Museum der Humboldt-Universität zu Berlin) collect the type material in western Cuba (Castellanos 1968: 4, Fischer 1968: 270, 1970). *1971*: original description of *Fulica picapicensis* published (Fischer & Stephan 1971b: 595–597). *31 December 1974*: Antillean extinct genus *Nesotrochis* identified from Cuba, leading to the new combination *N. picapicensis* (Olson 1974: 441, see 'Notes'). *September 1995*: first record outside the type locality, in Cueva del Indio, Mayabeque (formerly La Habana) province (Jiménez Vázquez & Valdés Ruiz 1995: 62). *27 August 2019*: morphology of the hypotarsus in *Nesotrochis* indicates it is not a Rallidae (Mayr 2019), but shares osteological characters with flufftails, Sarothruridae (Africa and New Guinea) and related taxa (Heliornithidae). *17 March 2021*: mitochondrial genome analysis of *N. steganinos* Olson, 1974 (Hispaniola) corroborates that the genus is not a rallid (Oswald *et al.* 2021), but a sister taxon to Sarothruridae and the extinct flightless Aptornithidae (New Zealand).

Holotype.—Left humerus, Av. 832/67, at CZACC (Fischer & Stephan 1971b: 595, fig. 9: a [anconal], b [palmar], Olson 1977: 352, fig. 1b: bottom [anconal]). Collected summer 1967 by members of the Cuban-German Expedition [= Wolfgang Reichel, Hans-Hartmat Krueger,

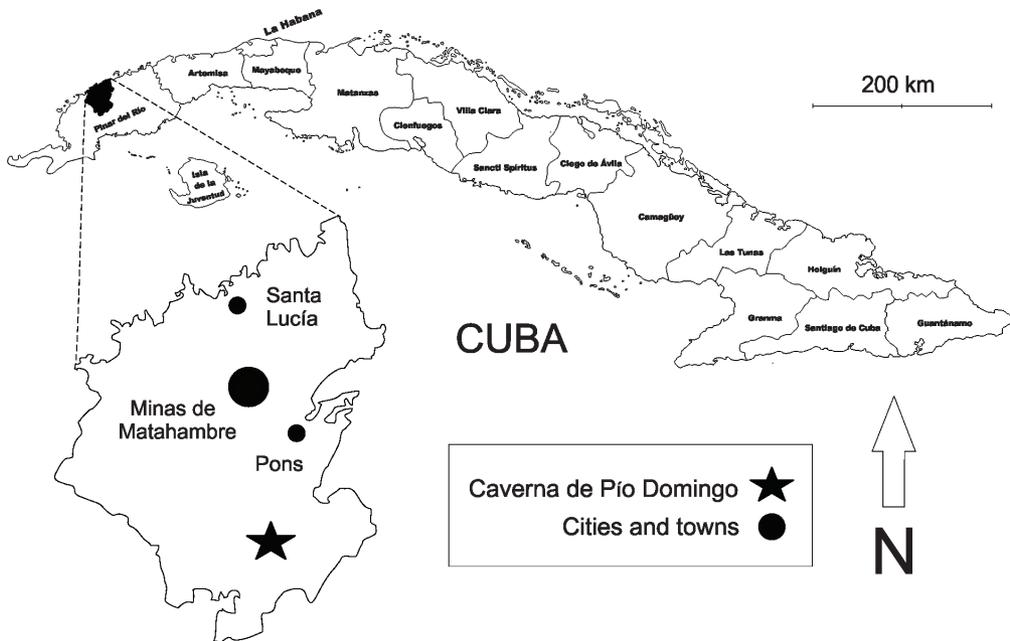


Figure 3. Caverna de Pío Domingo (PPD), Minas de Matahambre, western Cuba. Type locality of †*Nesotrochis picapicensis* (Fischer & Stephan), †*Antigone cubensis* (Fischer & Stephan) and †*Ornimegalonyx oteroi* Arredondo.

Karlheinz Fischer, Gustavo Furrázola Bermúdez, Manuel Acevedo González, Néstor Mayo and Manuel Iturralde Vinent (Castellanos 1968: 4) in El Abismo [= Furnia del Aguacero, or del Abismo] at the type locality (see Fischer & Stephan 1971a: 541, b: 593).

Other material.—**Skull:** incomplete, Av. 833/67 (fig. 8: a [dorsal]). **Vertebra:** cervical, Av. 834–838/67; thoracic, Av. 839/67. **Humerus:** right, Av. 840–841/67⁺; left, Av. 842/67⁺. **Ulna:** see ‘Notes’. **Pelvis:** incomplete, Av. 844 (Figs. 11a [dorsal], 12a [lateral]) to 849/67⁺. **Femur:** right, Av. 850 (fig. 13a [posterior]) to 851/67; proximal right, Av. 852/67⁺; left, Av. 853/67⁺. **Tibiotarsus:** right, Av. 854/67; proximal right, Av. 855–857/67; left, Av. 858 (fig. 14: a [anterior], b [posterior]) to 860/67⁺; proximal left, Av. 861–862/67⁺; distal left, Av. 863–864/67⁺. **Tarsometatarsus:** right, Av. 865 (fig. 15a [anterior]; Olson 1977: 352, fig. 1B: top [anterior]), 866/67⁺, and Av. 867/67 (the last is immature); proximal right, Av. 868/67; distal right, Av. 869–870/67; left, Av. 871/67⁺ (immature); proximal left, Av. 872/67⁺; distal left, Av. 873–874/67⁺. Cited figures from pl. 2–6 of Fischer & Stephan (1971b), other than when indicated. The annotation (‘⁺’) indicates specimens (= paratypes) at CZACC (see comments in Arredondo 1984: 14 and Livezey 2003: 55).

Type locality.—Caverna de Pío Domingo (PPD), Sierra de Sumidero, municipality of Minas de Matahambre, Pinar del Río province, Cuba (Fischer & Stephan 1971b: 595). Fig. 3.

Distribution.—Cave deposits in west Cuba (see Appendix). *Pinar del Río*. Viñales: **PMF** (Arredondo & Rivero 1997: 111 [‘*Nesotrochis* sp.’], Jiménez Vázquez 1997b: 97, Arredondo & Arredondo 2000: Anexo 1 [‘*Nesotrochis* sp.’]), Minas de Matahambre: **PPD** = type locality (Fischer & Stephan 1971b: 595 [‘*Fulica picapicensis*, n. sp.’]). *Artemisa*. Caimito: **ACP** (Jiménez Vázquez 1997b: 97), **ASA** (cf. Suárez & Arredondo 1997: 101, Suárez 2000b: table 1, Arredondo & Arredondo 2002a: table 1 [‘*Nesotrochis* sp.’]). *Mayabeque*. Quivicán: **YBL** (Jiménez Vázquez 1997b: 97), San José de las Lajas: **YCI** (Jiménez Vázquez & Valdés Ruiz 1995: 62, Jiménez Vázquez 1997b: 97, Rojas Consuegra *et al.* 2012: 6, 10), Madruga: **YCN** (Orihuela 2012: 306–308, tables 1 [‘*Nesotrochis* sp.’] and 3 [‘*Rallidae* cf. *Nesotrochis* sp.’], fig.

8A = femur [*Nesotrochis* sp. (cf.) *N. picapicensis*]: left [medial], right [anterior], Orihuela 2019: 61, fig. 3 = idem: A [medial], B [anterior]. *Matanzas*. Jagüey Grande: **MFJ** (cf. CLV).

Direct ¹⁴C dating.—None. For indirect dating from relevant Cuban archaeological sites, see Córdova Medina *et al.* (1997), Jiménez Vázquez (2005), Orihuela (2019), Orihuela *et al.* (2020b).

Notes.—Bones of this cave rail are common in palaeontological deposits of western Cuba and are abundant in cultural (*contra* Steadman *et al.* 2013: 1355) sites (see Jiménez Vázquez 1997b, 2001, Jiménez Vázquez & Arrazcaeta Delgado 2008, 2015). Formerly described as a coot, genus *Fulica* Linnaeus. One of the paratypes, the incomplete right ulna, Av. 843/67 (Fischer & Stephan 1971b: 595, fig. 10a [medial]), ‘is not from a rail and is possibly columbid’ (Olson 1974: 441, footnote). The extinct genus *Nesotrochis* is endemic to the Greater Antilles but has Old World origins (Oswald *et al.* 2021). Three large flightless species (Olson 1977: 352–353, Olson 1978: 107, Cuello 1988: 15; see Livezey 1998) have been described, from the Virgin Islands (*N. debooyi* Wetmore, 1918), but also present in Puerto Rico (Wetmore 1922, Olson 1974), Hispaniola (*N. steganinos* [= *M. steganinos* Arredondo 1984: 15, *lapsus calami*]) and Cuba (*N. picapicensis*), and seem to have survived on these islands until recently (Olson 1974, Jiménez Vázquez & Arrazcaeta Delgado 2008, 2015, Carlson & Steadman 2009). The Cuban species was for some time considered the same bird named ‘Biaya’ or ‘Bambiaya’ by native peoples (cf. Jiménez Vázquez 1997b, 2005), but this is incorrect (Jiménez Vázquez & Arrazcaeta Delgado 2015: 144). Figueredo (2011: 13) commented that the distribution of *Nesotrochis* could be extended to the Bahamas, citing Steadman *et al.* (2007). This appears to be a misinterpretation, as the only flightless rail mentioned in the latter paper (see also Steadman *et al.* 2013) is ‘*Rallus* undescribed sp.’. For a summary of extinct birds in Quaternary deposits of the Bahamas, see Steadman & Franklin (2020).

Family GRUIDAE Vigors Genus *Antigone* Reichenbach, 1852

Antigone Reichenbach, 1852, *Av. Syst. Nat.*, p. xxiii. Type, by original designation and tautonymy, *Grus torquata* Vieillot = *Ardea antigone* Linnaeus.

3. †*Antigone cubensis* (Fischer & Stephan, 1971) Cuban Flightless Crane (Grulla Cubana)

Grus cubensis Fischer & Stephan, 1971a, *Wiss. Zeitsch. Humboldt-Univ. Berlin, Math.-Nat. R.* 20: 565.

Ciconia: Castellanos 1968: 4.

Grus cubensis: Fischer & Stephan 1971a: 565.

G[rus]. *cubanensis*: Kilmer & Steadman 2016: table 3 (*lapsus calami*).

Antigone cubensis: Suárez 2020a: 6.

History.—*April 1968*: first notice of material collected by the Cuban-German Expedition, being tentatively identified as ‘*Ciconia*’ (Castellanos 1968). The name *Baeopteryx cubensis* (*nomen nudum*) appears (Fischer 1968: 271) with the comment ‘wie der pleistozäne Cuba-Kranich später heißen soll’ [‘as the Pleistocene Cuban crane will later be called’]), without indication of type material or catalogue numbers, along with comments on the proportions of some elements. Referred to as a flightless crane for the first time: ‘Flugunfähiger Kranich aus dem Pleistozän Cubas’ [‘Flightless crane from the Pleistocene of Cuba’] (Fischer 1968). *1971*: original description of *Grus cubensis* published (Fischer & Stephan 1971a). *September 1995*: first record outside the type locality, in Cueva del Indio, Mayabeque (formerly La Habana) province, west Cuba (Jiménez Vázquez & Valdés Ruiz 1995: 62, not Suárez 2000b: table 1). *December 2000*: reported from asphalt deposits at Las Breas de San Felipe, Matanzas province (Iturralde-Vinent *et al.* 2000: table 2). *22 May 2020*: direct ¹⁴C dating of material

from tar seeps and treated under new combination *Antigone cubensis* (Suárez 2020a: 6, table 2).

Holotype.—Skull with its respective mandible and left quadrate [but not ‘atlas’, see ‘Notes’], Av. 1/67, at CZACC (Fischer 1968: 271, fig. unnumbered* [lateral], Fischer 1970: 234, Plate 1*, skull: a [lateral], e [dorsal], f [ventral], g [posterior]; quadrate: c [lateral]; mandible: b [lateral], d [dorsal]; Arredondo 1971: 96, fig. centre left unnumbered*: top [lateral], Fischer & Stephan, 1971a: 565, Figs. 26*: skull and quadrate [lateral], 27*: mandible [lateral], 28*: skull [ventral], 29*: skull [posterior]; pl. 1, skull: 1 [lateral], 4 [dorsal], 5 [ventral], mandible: 2 [lateral], 3 [dorsal]). Collected summer 1967 by the Cuban-German Expedition [= Wolfgang Reichel, Hans-Hartmat Krueger, Karlheinz Fischer, Gustavo Furrázola Bermúdez, Manuel Acevedo González, Néstor Mayo and Manuel Iturralde Vinent (Castellanos 1968: 4)] in El Abismo [= Furnia del Aguacero, or del Abismo] at the type locality (Fischer & Stephan 1971a: 565, see also Fischer 1968: 270, 1970: 233–235).

Other material.—**Skull:** calvaria, Av. 2/67, Av. 5–11/67, Av. 15–16/67; crania, Av. 3–4/67. **Mandible:** ‘upper and lower’, Av. 12/67; ‘lowers’, Av. 13–14/67. **Vertebra:** atlases, Av. 17 (fig. 7*: a [anterior], b [posterior]) to 18/76; axes, Av. 19 (fig. 8* [lateral]) to 20/67; cervical 3, Av. 21–24/67; cervical 4, Av. 25–28/67; cervical 5, Av. 29–35/67; cervical 6, Av. 36–42/67; cervical 7, Av. 43/67; cervical 8–2, Av. 44–51/67, Av. 52 (fig. 9*: a [dorsal], b [ventral], c [lateral], d [anterior], e [posterior]) to 63/67; cervical 13 to 14, Av. 102–110/67; cervical 15, Av. 111–118/67; cervical 16, Av. 119–126/67; cervical 17, Av. 127–143/67; cervical indet., Av. 144–149/67; thoracic 1, Av. 150–159/67; thoracic 2, Av. 160–161/67; thoracic 3–5, Av. 162–163/67; thoracic 5–8, Av. 164 (fig. 10*: a [lateral], b [anterior]) to 192/67; thoracic indet., Av. 193–194/67. **Rib:** right, Av. 195–198/67; left, Av. 199–205/67. **Sternum:** incomplete, Av. 206/67 (fig. 31* [lateral]). **Coracoid:** right, Av. 207 (fig. 32*: a [ventral], b [dorsal]) to 210/67; left, Av. 211/67. **Scapula:** right, Av. 212 (fig. 33*: a [dorsal], b [ventral]) to 218/67, Av. 227/67; left, Av. 219–226/67, Av. 228/67. **Furcula:** right, Av. 229–231/67; left, Av. 232 (fig. 14*: a [internal], b [external]) to 235/67. **Humerus:** right, Av. 236/67, 237 (fig. 34*: a [anconal], b [palmar]) to 239/67; right without distal end, Av. 240/67; proximal half of right, Av. 241/67; proximal half of left, Av. 242/67; distal ends of left, Av. 243/67, Av. 247/67; left without distal end, Av. 244/67; proximal end of left, Av. 245/67; shaft piece of left, Av. 246/67. **Radius:** right, Av. 248/67 (fig. 35*: a [dorsal], b [ventral]); proximal ends of right, Av. 249–257/67, Av. 274/67; distal ends of right, Av. 258–265/67, Av. 275/67; proximal ends of left, Av. 266–269/67; distal ends of left, Av. 270–273/67. **Ulna:** distal ends of right, Av. 276–277/67; distal ends of left, Av. 278 (fig. 36*: a [dorsal], b [ventral]) to 280/67. **Carpometacarpus:** right, Av. 281/67; fragmentary right, Av. 282–284/67; left, Av. 285/67 (fig. 37*: a [medial], b [lateral]), Av. 287/67; left without proximal end, Av. 286/67; left without distal end, Av. 288/67. **Pelvis:** incomplete, Av. 289 (fig. 30*: a [dorsal], b [ventral]) to 292/67; synsacral vertebrae 1–2, Av. 293/67. **Femur:** right, Av. 294/67 (fig. 38*: a [anterior], b [posterior]); shaft of right, Av. 295/67; left without proximal end, Av. 296/67; fragmentary proximal half of left, Av. 297/67; distal end of left, Av. 298/67; shaft of left, Av. 299/67; distal articular region, Av. 300/67. **Tibiotarsus:** right, Av. 301 (fig. 39*: a [anterior], b [posterior]) to 304/67; right without proximal ends, Av. 313–317/67; distal ends of right, Av. 322–327/67; shafts of right, Av. 334–335/67; left, Av. 305–312/67; left without proximal ends, Av. 318–321/67; distal ends of left, Av. 328–333/67; shaft of left, Av. 336/67. **Fibula:** right, Av. 337 (fig. 40*: a [medial], b [lateral]) to 340/67; left, Av. 341–342/67. **Tarsometatarsus:** right, Av. 343 (fig. 41*: a [anterior], b [posterior]) to 352/67; proximal ends of right, Av. 361–364/67; right without proximal end, Av. 372/67; distal ends of right, Av. 373–375/67; left, Av. 353–360/67; proximal ends of left, Av. 365–371/67; distal ends of left, Av. 376–381/67. **Phalanges:** right digit II, phalanx 1, Av. 382–390/67; right digit II, phalanx 2, Av. 391–393/67; right digit III, phalanx 1, Av. 407–412/67; right digit IV, phalanx 1, Av.

433–438/67; left digit II, phalanx 1, Av. 394–403/67; left digit II, phalanx 2, Av. 404–406/67; left digit III, phalanx 1, Av. 413–422/67; left digit IV, phalanx 1, Av. 439–443/67; digit III, phalanx 2, Av. 423–429/67; digit III, phalanx 3, Av. 430–432/67; digit IV, phalanx 2, Av. 444–447/67; digit IV, phalanx 3, Av. 448–450/67; digit I?, phalanx 1, Av. 451/67; ungual phalanges, Av. 452–456/67. Cited material and figures are from Fischer & Stephan (1971a), in which catalogue numbers on figure legends are preceded by '67', contrary to the holotype, or the same paratypes listed in their table 1.

Type locality.—Caverna de Pío Domingo (PPD), Sierra de Sumidero, municipality of Minas de Matahambre, Pinar del Río province, Cuba (Fischer & Stephan 1971a: 565). Fig. 3.

Distribution.—Cave and asphalt deposits in west Cuba (see Appendix). *Pinar del Río*. Minas de Matahambre: PPD = type locality (Castellanos 1968: 4 [*Ciconia*], Fischer 1968: 271 [*Baeopteryx cubensis*], Fischer 1970: 234 [*Baeopteryx*], Arredondo 1971: 95 [*Baeopteryx cubensis*], Acevedo González 1971: 36 [*Baeopteryx cubensis*], Fischer & Stephan 1971a: 565 [*Grus cubensis*, nov. spec.], Arredondo 1984: 13 [*Grus cubensis* see 'Notes']). *Artemisa*. Caimito: ACP (cf. Suárez & Arredondo 1997: 101 [*Grus cubensis*], Arredondo & Arredondo 2002a: table 1 [*Grus cubensis*], 2002b: table 1 [*Grus cubensis*]), ASA (Suárez 2000b: table 1 [*Grus cubensis*]). *Mayabeque*. San José de las Lajas: YCI (Jiménez Vázquez & Valdés Ruiz 1995: 62 [*Grus cubensis*], Rojas Consuegra *et al.* 2012: 6, 10 [*Grus cubensis*]). *Matanzas*. Martí: MLB (Iturralde-Vinent *et al.* 2000: table 2 [*Grus cubensis*], fig. 6 = tarsometatarsus: A [anterior], Suárez 2020a: 6–7, fig. 3A–D = tibiotarsus: A [anterior], B [distal], C [medial], D [posterior], 3E–F = tarsometatarsus: E [anterior], F [proximal], 3G–J = tarsometatarsus: G [posterior], H [medial], I [anterior], J [distal]).

Direct ¹⁴C dating.—Late Pleistocene (MLB): 22,900 ± 2,700 ¹⁴C yr BP (Suárez 2020a: table 2, tibiotarsus).

Notes.—Remains of this large crane are known to be common in just three Cuban Quaternary deposits (see Fischer & Stephan 1971a, Rojas Consuegra *et al.* 2012, Suárez 2020a). In the original description, Fischer & Stephan (1971a: 565) mentioned: 'Cranium mit Atlas (Abb. 7–12), Universität Habana, Av. 1/67' [*Cranium with atlas* (fig. 7–12), University of Havana, Av. 1/67]. The indication of 'atlas' seems to be a mistake for mandible, as no atlas with the catalogue number of the holotype is mentioned in the text or figures of this work. The only two atlases mentioned are paratypes (Fischer & Stephan 1971a, fig. 7, table 1, see 'Other material' above). Otherwise, in figures the mandible and a left quadrate accompanying the skull has the same number, Av. 1/67, as the holotype. Fischer (1968) tentatively identified this species as a member of *Baeopteryx* Wetmore, a genus described as a fossil from Bermuda (Wetmore 1960), but considered subsequently to be a junior synonym of *Grus* Brisson (Fischer & Stephan 1971a: 574; see Olson & Wingate 2000: 356). Use of '*Grus cubensis* (Fischer, 1968)' by Arredondo (1975: 146, 1984: 13) and Arredondo Antúnez (1997: 5) is incorrect, being based on '*Baeopteryx cubensis*', which name is not available (see 'History' and ICZN 1999, Art. 15.1). Apart from its large size and other osteological characters related to flightlessness, the Cuban species is most similar to *Antigone antigone* (Linnaeus, 1758) and *A. canadensis* (Linnaeus, 1758) in features of the skull, rather than to *Grus americana* (Linnaeus, 1758). Recently, Mayr *et al.* (2020) considered species of the genus *Antigone* under *Grus* Brisson.

Order CHARADRIIFORMES Huxley Family BURHINIDAE Mathews Genus *Burhinus* Illiger, 1811

Burhinus Illiger, 1811, *Prodromus Syst. Mamm. Av.*, p. 250. Type, by monotypy, *Charadrius magnirostris* Latham (not '*Charadrius magnirostris* Latham' *sensu* Arredondo 1984: 16).

4. ×*Burhinus bistriatus* (Wagler, 1829)

Double-striped Thick-knee (Búcaro)

Charadrius bistriatus Wagler, 1829, *Isis von Oken* 22, col. 648.

Burhinus: Olson & Hilgartner 1982: 33 [Cuba].

Burhinus sp.: Acevedo-González & Arredondo 1982: table 1 [Cuba].

Burhinus bistriatus: Suárez 2020a: 7 [Cuba].

History.—*November 1980*: S. L. Olson identifies fossils of *Burhinus* at CZACC and OA (Olson & Hilgartner 1982: 33). *1982*: first published notice (5 August) as to presence in Cuban collections of fossil material referable to *Burhinus* (Olson & Hilgartner 1982: 33). Reported as '*Burhinus* sp.' by Acevedo-González & Arredondo (1982: table 1) without indicating specimens or locality. *May 1984*: fossils in OA (see 'Referred material') recorded as '*Burhinus* sp.' (Arredondo 1984: 16–17). *December 2000*: first record from asphalt deposits at Las Breas de San Felipe (Iturralde-Vinent *et al.* 2000: table 2). *22 May 2020*: some Cuban specimens identified as '*Burhinus bistriatus*' (Suárez 2020a: 7).

Referred material.—**Humerus**: right lacking distal end, MNHNCu 75.4783; distal end of right, MNHNCu 75.4792; distal ends of left, OA 2958, and right, OA 2959. **Tibiotarsus**: distal end of right, MNHNCu 75.4798. See Arredondo (1984: 16), Suárez (2020a: 7).

Distribution.—Cave and asphalt deposits in west Cuba (see Appendix). *Artemisa*. Caimito: **ACP** (Arredondo 1984: 16 ['*Burhinus* sp.'], Arredondo & Arredondo 2002a: table 1 ['*Burhinus* sp.'], 2002b: table 1 ['*Burhinus* sp.']), **ASA** (Suárez 2000b: table 1 ['*Burhinus* sp.'], Arredondo & Arredondo 2002a: table 1 ['*Burhinus* sp.']). *Mayabeque*. San José de las Lajas: **YCC** (Jiménez & Orihuela 2021: 169). *Matanzas*. Martí: **MLB** (Iturralde-Vinent *et al.* 2000: table 2 ['*Burhinus* sp.'], Suárez 2020a: 7).

Direct ¹⁴C dating.—None in Cuba. For dating of other bird species at MLB, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct mammals (*Parocnus browni* = 11,880 ± 420 to 4,960 ± 280 years ¹⁴C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005). For dating of *Burhinus* material from the Bahamas, see Jones O'Day (2002).

Notes.—Common in Pleistocene deposits, considered a palaeo-ecological indicator of arid open habitat (Feduccia 1980, Pregill & Olson 1981, Iturralde-Vinent *et al.* 2000). Some material referred to *Burhinus* from Cuba is of a different size (Suárez 2020a; WS & S. L. Olson unpubl.), and perhaps involves the smaller *B. nanus* Brodkorb, 1959, described from the Bahamas and considered a species, or a subspecies of *B. bistriatus* by some authors (see Olson & Hilgartner 1982: 33, Oswald & Steadman 2018: 363). *B. bistriatus* still inhabits the Greater Antilles, with the endemic *B. b. dominicensis* (Cory, 1883) resident on Hispaniola (AOU 1998, Raffaele *et al.* 1998, 2003, Keith *et al.* 2003, Latta *et al.* 2006).

Family SCOLOPACIDAE Bonaparte

Genus *Gallinago* Brisson, 1760

Gallinago Brisson, 1760, *Ornithologia*, vol. 5, pp. 298, 304. Type, by tautonymy, *Scolopax gallinago* Linnaeus.

5. +*Gallinago kakuki* Steadman & Takano, 2016

West Indian Snipe (Becasina Isleña)

Gallinago kakuki Steadman & Takano, 2016, *Zootaxa* 4109: 348.

Capella delicata: Wetmore 1937: 435 [Bahamas].

Capella sp.: Olson & Hilgartner 1982: 31 [Bahamas].

Capella sp.: Morgan 1994: 480 [Cayman Islands; see also Morgan 1977a,b].

Capella sp.: Suárez 2004b: 155 [Cuba].

History.—*October 1937*: three specimens from 'Great Exuma' (= Little Exuma *fide* Hecht 1955) identified as '*Capella delicata* (Ord.)', but said to probably 'represent an extinct species'

of large size (Wetmore 1937: 435). *25 March 1977*: fossils from Cayman Brac, Cayman Islands, identified as a new, extinct large species of *Capella* (Morgan 1977a: 68–73, b: 21; see Morgan 1994: 480–481). *5 August 1982*: summary of the fossil record of this large snipe (as '*Capella* sp.') in the West Indies, with comparisons of known material, including new specimens identified from Banana Hole, New Providence, Bahamas (Olson & Hilgartner 1982: 31–33). *April 2004*: recorded from Cuba as '*Capella* sp.' on basis of four specimens, including one immature humerus which suggests the bird was a year-round resident in the Antillean subregion (Suárez 2004b: 157). *9 May 2016*: original description of *G. kakuki* published (Steadman & Takano 2016), which species seems to be more similar to Old World *Gallinago*.

Holotype.—Complete right humerus, UF 297382 (Steadman & Takano 2016: 348, figs. 3A [anconal], 4A [palmar]). Collected in 1958–60 by J. C. Dickinson *et al.* at the type locality (Steadman & Takano 2016: 348).

Type locality.—Banana Hole, New Providence, Bahamas (Steadman & Takano 2016: 348).

Referred material.—**Humerus**: right, MNHNCu 75.4709 (fig. 1: left [palmar]), OA 3138; left, MNHNCu 75.4711 (immature). **Ulna**: right, MNHNCu 75.4712 (fig. 1: right [palmar]). Cited material and figures are from Suárez (2004b).

Distribution.—Cave deposits in west and central Cuba (see Appendix). *Pinar del Río*. Los Palacios: **PEA** (Suárez 2004b: 155 ['*Capella* sp.']). *Sancti Spiritus*. Yaguajay: **SPH** and **SPS** (Suárez 2004b: 155–156 ['*Capella* sp.']).

Direct ¹⁴C dating.—None in Cuba. For dating of associated fauna from PEA (17,406 ± 161 ¹⁴C yr BP), see Suárez & Díaz-Franco (2003: 373).

Notes.—Remains of this snipe are sporadically found in Cuban cave deposits containing ancient barn owl pellets (*cf. Tyto furcata* and *T. noeli*). *G. kakuki* had a wider distribution in the West Indies that also included the Bahamas and Cayman Islands (Olson & Hilgartner 1982, Steadman & Takano 2016) where apparently it was a resident, endemic species (Suárez 2004b, Steadman & Takano 2016). Probably the first material to be collected was from Isla de la Juventud (= Isla de Pinos), west Cuba, as Peterson (1917: 359) noted 'few limb-bones of snipes' in the remains he studied, but this requires corroboration.

Order CICONIIFORMES Bonaparte Family CICONIIDAE Sundevall Genus *Ciconia* Brisson, 1760

Ciconia Brisson, 1760, *Ornithologia*, vol. 1, p. 48; vol. 5, p. 361. Type, by tautonymy, *Ardea ciconia* Linnaeus.

6. †*Ciconia maltha* L. Miller, 1910 La Brea Stork (Cigüeña de La Brea)

Ciconia maltha L. Miller, 1910, *Univ. California Publ. Bull. Dept. Geol.* 5: 440.

Jabiru mycteria: Wetmore 1928: 2.

Ciconia maltha: Howard 1942: 202.

Ciconia maltha: Newton 2003: 266 (*lapsus calami*).

Ciconia lydekkeri: Agnolin 2009: 57.

Holotype.—Left tarsometatarsus, UCMP 11202 (Miller 1910: 440, Figs. 1* [proximal], 2* [distal]). Collected by members of the 'University of California' (Miller 1910: 439).

Type locality.—Rancho La Brea, Los Angeles, California, USA (see Miller 1910, Howard 1942, Wetmore 1956: 22, Brodkorb 1963: 289).

Referred material.—**Tibiotarsus**: distal left, AMNH unnumbered. **Tarsometatarsus**: proximal right, AMNH unnumbered (see Howard 1942).

Distribution.—Spring deposit (not ‘from a cave’ as indicated by Howard 1942: 189) in central Cuba (see Appendix). *Cienfuegos*. Palmira: **CCM** (Wetmore 1928: 2 [*Jabiru mycteria*], Howard 1942: 201). For summary of continental distribution, see Wetmore (1956: 22, 1959: 8–9), Brodkorb (1963: 289–290), Emslie (1998: 26–27) and Kilmer & Steadman (2016: table 4).

Direct ¹⁴C dating.—None in Cuba. Two indirect conventional dates from its fossil locality in Cienfuegos. Late Pleistocene (CCM): >30,000 to 25,000 ± 2000 ¹⁴C yr BP (Kulp *et al.* 1952: 419, table 2 [two samples: pine cones and wood]).

Notes.—The two referred specimens (Howard 1942: 201–202) are the only known material of this taxon in Cuba. Formerly recorded as *Jabiru mycteria* (M. H. C. Lichtenstein, 1819) by Wetmore (1928: 2–3), reidentified as *Ciconia maltha* by Howard (1942: 202; see also Wetmore 1956: 22, 1959: 9). Navarro (2021: 58, table 4) confused *C. maltha* with another fossil congeneric taxon in Cuba, the smaller and undescribed *Ciconia* sp. (see below), which is restricted to tar seeps in Matanzas province (Suárez & Olson 2003a, Suárez 2020a).

7. *Ciconia* sp.

Referred material.—**Tibiotarsus:** distal end of right, MNHNCu 75.4599, formerly P4599 (Suárez & Olson 2003a: 151, fig. 1E [distal], Suárez 2020a: 9, fig. 4A [distal]). Collected 25 February 2001 by WS & Stephen Díaz Franco in San Felipe I, C area (Suárez & Olson 2003a: 151).

Distribution.—Asphalt deposits in west Cuba (see Appendix). *Matanzas*. Martí: **MLB** (Suárez & Olson 2003a, Suárez 2020a).

Direct ¹⁴C dating.—None. For dating of other bird species at MLB, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct mammals (*Parocnus browni* = 11,880 ± 420 to 4,960 ± 280 years ¹⁴C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005).

Notes.—Extremely rare. Known from Cuba by a single specimen of a species smaller than *C. maltha* (Suárez & Olson 2003a: 151). Orihuela (2019: 58–59) incorrectly indicated ‘type material’ and ‘type locality’ for *Ciconia* sp., which is an undescribed species. Navarro (2021: 58, table 4) erroneously listed *Ciconia* sp. as the only representative of the genus in Cuba (see ‘Notes’ under *C. maltha*), indicating it was ‘originally identified as *Jabiru mycteria* (Lichtenstein, 1819), by Wetmore (1928)’ which was not the case.

Genus *Mycteria* Linnaeus, 1758

Mycteria Linnaeus, 1758, *Syst. Nat.*, edn. 10, vol. 1, p. 140. Type, by monotypy, *Mycteria americana* Linnaeus.

8. †*Mycteria wetmorei* Howard, 1935 Wetmore’s Stork (Cayama de Wetmore)

Mycteria wetmorei Howard, 1935, *Condor* 37: 253.

Mycteria americana: L. Miller 1910: 446.

Mycteria americana: Campbell 1980: 121.

Mycteria americana: Emslie 1998: table 14.

Holotype.—Fragment of lower mandible, LACM K3527 (Howard 1935: 253, fig. 47: 1 [lateral], 2 [dorsal]). Collected by members of the Southern California Academy of Sciences (Howard 1935: 251).

Type locality.—‘North bank of “pool” near Wilshire Boulevard, Rancho La Brea, Los Angeles, California’, USA (Howard 1935: 253).

Referred material.—**Carpometacarpus:** proximal end of right, MNHNCu 75.4602 (fig. 1E [internal]). **Tibiotarsus:** distal end of right, MNHNCu 75.4603 (fig. 1D [distal]). **Tarsometatarsus:** left, MNHNCu 75.4757 (Suárez 2020a: 10, fig. 4: E [proximal], F [distal],

G [anterior], H [medial], I [posterior]); proximal end of left (immature), MNHNCu 75.4604 (fig. 1H [anterior]); distal end of right, MNHNCu 75.4605 (fig. 1F [anterior]). Cited material and figures are from Suárez & Olson (2003a), other than where indicated.

Distribution.—Asphalt deposits in west Cuba (see Appendix). *Matanzas*. Martí: **MLB** (Suárez & Olson 2003a, Suárez 2020a).

Direct ¹⁴C dating.—None in Cuba. For dating of other bird species at MLB, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct mammals (*Parocnus browni* = 11,880 ± 420 to 4,960 ± 280 years ¹⁴C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005).

Notes.—Very rare. *M. wetmorei* occurred sympatrically with *M. americana* Linnaeus, 1758, only in Cuba (*contra* Kirkconnell *et al.* 2020: 69) in the tar seep deposits (Suárez & Olson 2003a). Previous records of Wood Stork in fossil localities of North America, including Florida (see Emslie 1998), represent misidentifications, including of *M. wetmorei* (Olson 1991, Suárez & Olson 2003a).

Order PELECANIFORMES Sharpe Family ARDEIDAE Leach Genus *Tigrisoma* Swainson, 1827

Tigrisoma Swainson, 1827, *Zool. J.* 3: 362. Type, by original designation, *Ardea tigrina* 'Latham' (= J. F. Gmelin, 1789) = *Ardea lineata* Boddaert.

9. ×*Tigrisoma mexicanum* Swainson, 1834 Bare-throated Tiger Heron (Garza Tigre Mejicana)

Tigrisoma mexicana Swainson, 1834, in Murray, *Encycl. Geogr.*, p. 1383.

Referred material.—**Tarsometatarsus:** left, AC-33 (Olson & Suárez 2008a: 285, figs. 1B [anterior], 2A [anterior]). Collected during February–April 2004 by members of Arqueocentro [= Néstor A. Gómez, Lorenzo Morales and Raul Villavicencio Finalet], Sagua La Grande (Olson & Suárez 2008a: 285).

Distribution.—Sinkhole deposit in central Cuba (see Appendix). *Villa Clara*. Sagua La Grande: **VCB** (Olson & Suárez 2008a: 286).

Direct ¹⁴C dating.—None.

Notes.—Extremely rare. The single tarsometatarsus from Cuba referred to *T. mexicanum* is the first evidence of this genus in a fossil locality anywhere, and the first record of the subfamily Tigrisomatinae in the West Indies (Olson & Suárez 2008a).

Order INCERTAE SEDIS Family †TERATORNITHIDAE L. Miller Genus †*Oscaravis* Suárez & Olson, 2009

Oscaravis Suárez & Olson, 2009a, *Proc. Biol. Soc. Wash.* 122: 106. Type, by monotypy, *Teratornis olsoni* Arredondo & Arredondo.

10. †*Oscaravis olsoni* (Arredondo & Arredondo, 2002) Cuban Teratorn (Teratorno Cubano)

Teratornis olsoni Arredondo & Arredondo, 2002b, *Poeyana* 470–475: 16 [for 1999].

Teratornis sp.: Suárez & Arredondo 1997: 100.

Teratornis olsoni: Arredondo & Arredondo 2002b: 16.

'*Teratornis*' *olsoni*: Suárez 2004a: 124.

Oscaravis olsoni: Suárez & Olson 2009a: 111.

History.—1969: holotype collected in a cave deposit from western Cuba by members of IGP (Arredondo & Arredondo 2002b). *Winter 1997*: first record of Teratornithidae in Cuba, the West Indies, and outside continental America, is announced (Suárez & Arredondo 1997). *13 December 2002*: original description (not ‘26 May 1999’, see ‘Notes’) of *Teratornis olsoni* published (Arredondo & Arredondo 2002b), based on some of the material then known. *1 January 2009*: first revision of *T. olsoni* with description of new material from Cuban cave and asphalt deposits, and erection of the genus *Oscaravis* (Suárez & Olson 2009a).

Holotype.—Near-complete right femur, IGP/ACC 400-649, at CZACC (Arredondo & Arredondo 2002b: 16, figs. 1* [anterior], 2* left [anterior], 3*A: reversed [anterior], Suárez & Olson 2009a: 111, fig. 7, left in each pair: A [anterior], B [posterior], C [proximal], D [distal], Orihuela 2019: 59, fig. 2: A [anterior], B [posterior]). Collected in 1969 by members of IGP at the type locality (Arredondo & Arredondo 2002b: 15).

Other material.—**Quadrates**: incomplete right, OA 3205 (Arredondo & Arredondo 2002b: 16, fig. 4*: A [lateral], B [ventral], Suárez & Olson 2009a: 111, fig. 3, left in each pair: A [lateral], B [posterior], C [medial], D [ventral]). **Femur**: fragmentary distal half of right, OJ P-8 (as ‘P-8’, in the original description), at CZACC; internal condyle of left, OA 3151. See Arredondo & Arredondo (2002b: 16).

Type locality.—Cueva de Paredones (ACP), c.3 km south-west of Ceiba del Agua, municipality of Caimito, Artemisa [not ‘Mayabeque’ as stated by Orihuela 2019: fig. 2] province, Cuba (Arredondo & Arredondo 2002b: 16). Fig. 4.

Distribution.—Cave and asphalt deposits in west Cuba (see Appendix). *Artemisa*. Caimito: ACP = type locality (Suárez & Arredondo 1997: 100 [‘*Teratornis* sp.’], Arredondo & Arredondo 2002a: table 1 [‘*Teratornis* sp.’], 2002b: 16 [‘*Teratornis olsoni* sp. nov.’]), ASA (Suárez & Arredondo 1997: 100 [‘*Teratornis* sp.’], Suárez 2000b: 68 [‘*Teratornis*’], Suárez & Olson 2009a: 111–112, figs. 4 = coracoid: B–D [dorsal], F [sternal], 5 = humerus: C [palmar], D [ventral], 6 = humerus: C [palmar], D [anconal], E [distal], 8 = tibiotarsi: B–C [anterior]).

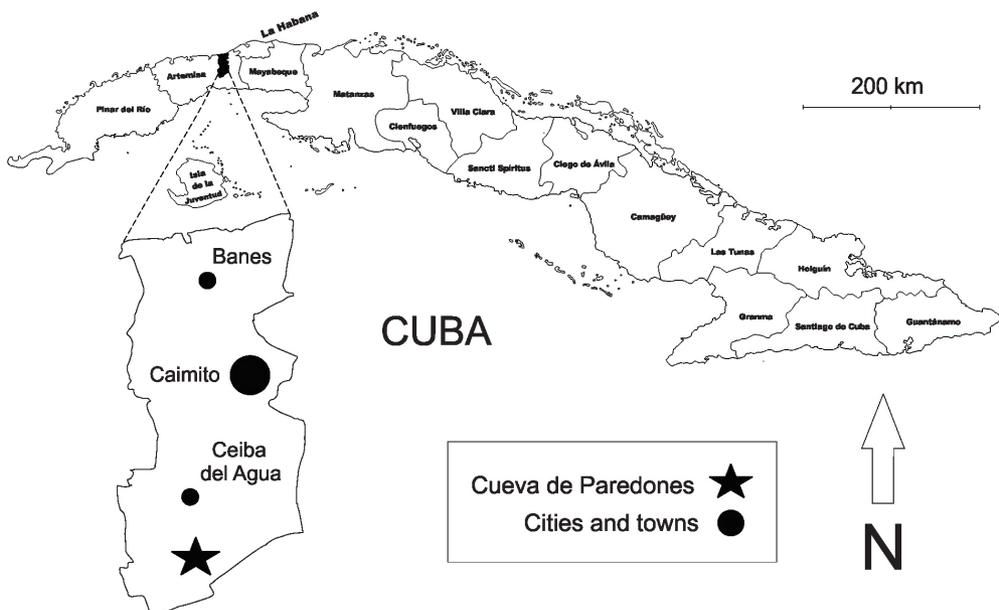


Figure 4. Cueva de Paredones (ACP), Caimito, western Cuba. Type locality of †*Oscaravis olsoni* (Arredondo & Arredondo), †*Gymnogyps varonai* (Arredondo) and †*Tyto cravesae* Suárez & Olson.

Mayabeque. Quivicán: **YBL** (Jiménez Vázquez *et al.* 1995: 25 [‘Buitre gigante ind.’], Suárez & Arredondo 1997: 100 [‘*Teratornis* sp.’], Arredondo & Arredondo 2002b: 16 [‘*Teratornis olsoni* sp. nov.’]), **YIN** (Arredondo & Arredondo 2002b: 16 [after correction of the locality of OA 3205, by Suárez & Olson 2009a: 111]). *Matanzas*. Martí: **MLB** (Suárez & Olson 2009a: 112, fig. 8 = tarsometatarsus: E [anterior], Suárez 2020a: 10–12, fig. 5 = tibiotarsus: A [anterior], B [distal], C [medial]; fig. 5 = tarsometatarsi: D [anterior], E [posterior], F [distal]). See ‘Notes’.

Direct ¹⁴C dating.—None. For dating of other bird species at MLB, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct mammals (*Parocnus browni* = 11,880 ± 420 to 4,960 ± 280 years ¹⁴C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005).

Notes.—Not rare in Cuban Quaternary fossil localities, wherein it is the only known extinct avian family (Suárez & Olson 2009a). Formerly described (Arredondo & Arredondo 2002b) as a smaller species of the North American genus *Teratornis* L. Miller. Orihuela (2019: 57) erroneously mentioned the limited flight capabilities of the Cuban Teratorn, which is incorrect (see Olson & Alvarenga 2002: 704, Suárez & Olson 2009a: 114). While revising fossil mammals, for a study published elsewhere (Silva Taboada *et al.* 2008), I identified an additional fragmentary specimen referable to Teratornithidae. This was apparently collected in central Cuba by Carlos de la Torre *et al.* during their field work (see Brown 1913, Goldberg *et al.* 2017), but was obviously not seen by Wetmore (1928) for his study of fossil birds from Cuba. This fact probably indicates that the bone is not from Baños de Ciego Montero. The specimen is stored at the Facultad de Biología, Universidad de La Habana, mixed with fragmentary material of mammals of the same colour and degree of mineralisation (recalling fossils from Las Llanadas and sinkhole deposits in northern Villa Clara), and without a catalogue number. Although no precise date, locality or collectors are certainly known, probably the specimen constitutes the first material of the Teratornithidae collected in Cuba, but this requires further study.

The original description of the Cuban Teratorn was published in *Poeyana*, special number 470–475, for 26 May 1999. However, the issue was not printed until more than three years later, on 13 December 2002, as recorded in the Poeyana archives at the Instituto de Ecología y Sistemática (La Habana) library. Following the ICZN (1999, Art. 21.4), the original description of *T. olsoni* must be dated 13 December 2002. The same holds for original descriptions of other taxa published in the same issue, including *Gigantohierax suarezi* Arredondo & Arredondo (see below). Both these species were incorrectly cited as being published in 2003 by Arredondo Antúnez & Arredondo de la Mata (2012) and Arredondo de la Mata & Arredondo Antúnez (2012).

Order CATHARTIFORMES Coues
Family CATHARTIDAE Lafresnaye
Genus *Gymnogyps* Lesson, 1842

Gymnogyps Lesson, 1842, *Écho du Monde Sav.* (2)9, no. 44, col. 1037. Type, by monotypy, *Vultur californianus* Shaw.

Antillovultur Arredondo, 1972c, *Mem. Soc. Cienc. Nat. La Salle* 31: 310 [for 1971]. Type, by monotypy, *A. varonai* Arredondo.

11. †*Gymnogyps varonai* (Arredondo, 1972)
Cuban Condor (Cónдор Cubano)

Antillovultur varonai Arredondo, 1972c, *Mem. Soc. Cienc. Nat. La Salle* 31: 310 [for 1971].

Antillovultur varonai: Arredondo 1972c: 310.

Gymnogyps varonai: Emslie 1988: 213.

Antillovultur varoni: Arredondo 1996: 1 (*lapsus calami*).

Gymnogyps sp.: Suárez & Arredondo 1997: 100.

Antillovultur varonai: Pradas 1998: 7 (*lapsus calami*).
Gymnogyps varonae: Vergara 2003: 454, 456 (*lapsus calami*).
Gymnogyps varonai: Suárez 2004c: 15 (*lapsus calami*).

History.—7 September 1959: Arredondo and members of GEC collect the type series in a cave deposit in west Cuba (Arredondo 1972c: 209). 5 February 1971: first news published of ‘un Buitre cubano extinguido...aparentemente de la talla del actual Cóndor de los Andes’ [‘an extinct Cuban vulture...apparently about the size of the living Andean Condor’] (Arredondo 1971: 96). 1972: original description (after March 1972, not ‘1971’, see ‘Notes’) of ‘*Antillovultur*’ *varonai* published (Arredondo 1972c). May 1978: S. L. Olson comments on similarities between the extinct genus *Antillovultur* and living *Gymnogyps* (Olson 1978: 103–104). June 1988: Cuban Condor treated as *Gymnogyps varonai* (Emslie 1988: 222). 1 February 2000: cranial and postcranial elements from cave, asphalt and sinkhole deposits described, further evidencing it is a *Gymnogyps* (Suárez 2000a). 23 April 2003: redescription of *G. varonai* published after first direct comparison with living and extinct North American congeners (Suárez & Emslie 2003). 22 May 2020: direct ¹⁴C dating published, on material from asphalt deposits (Suárez 2020a: table 2).

Holotype.—Proximal fragmentary left tarsometatarsus, DPUH 1254 (Arredondo 1972c, figs. 1—not ‘MPUH’ (*lapsus calami*) as in the figure legend—[anterior], 2*A [anterior], 3*D [anterior], 1976, figs. 1: A [anterior], B [posterior], 2*C [anterior], Suárez 2000a, fig. 1: ‘A’ = left [anterior], ‘B’ = right [posterior]). Collected 7 September 1959 by Oscar Arredondo [with Manuel Acevedo-González, Juan N. Otero and Walter M. Acevedo-González (see Morejón 1974: 85)], in ‘Salón del Pozo’, at the type locality (Arredondo 1972c: 309, 311).

Other material.—**Vertebra:** incomplete ‘7th’ cervical, OA 848. **Humerus:** left lacking proximal end, GEC P-80, formerly GEC unnumbered, at CZACC (Arredondo 1972c: figs. 4 [palmar], 5*C: left [anconal], right [dorsal], 1976, fig. 1C [palmar]). **Tarsometatarsus:** trochlea IV of left, OA 847 (Arredondo 1972c: fig. 3*D [anterior], 1976: fig. 2*C [anterior]). See Arredondo (1972c: 311).

Type locality.—Cueva de Paredones (ACP), c.3 km south-west of Ceiba del Agua, municipality of Caimito [formerly San Antonio de los Baños], Artemisa [formerly La Habana] province, Cuba (Arredondo 1972c: 311). Fig. 4.

Distribution.—Cave, asphalt and sinkhole deposits over Cuba’s main island (see Appendix). *Pinar del Río*. Minas de Matahambre: **PPD** (Suárez 2000a: 113). *Artemisa*. Caimito: **ACP** = type locality (Arredondo 1971: 96 [see ‘History’], 1972a: table 1 [‘Especie de Buitre ligeramente mayor que un Cóndor’], 1972c: 310 [‘*Antillovultur varonai* n. gen., n. sp.’], 1975: 151 [‘*Antillovultur varonai*’], Suárez & Arredondo 1997: 100 [‘*Gymnogyps* sp.’], Suárez 2000a: 113, fig. 2* = tarsometatarsus: A [anterior], B [posterior], Suárez & Emslie 2003: 30, fig. 4 = tarsometatarsi: middle [anterior], right [anterior], Arredondo & Arredondo 2002a: table 1 [‘*Antillovultur varonai*’], 2002b: table 1 [‘*Antillovultur varonai*’]), **ASA** (Suárez 2000a: 112–113, 2000b: 68 [‘*Gymnogyps*’], 2004a: 124, Arredondo & Arredondo 2002a: table 1 [‘*Antillovultur varonai*’]). *Mayabeque*. Quivicán: **YIN** (Suárez 2000a: 113). *Matanzas*. Martí: **MLB** (Suárez 2000a: 112, fig. 4* = rostrum: A [dorsal], B [lateral], Iturralde-Vinent *et al.* 2000: table 2, Suárez & Emslie 2003: 30, fig. 2 = rostrum: middle [lateral], Suárez 2020a, fig. 7: A = humerus [anconal], B = coracoid [ventral], C = carpometacarpus [ventral], D = tibiotarsus [anterior], E = tibiotarsus [distal], F–J = tarsometatarsus: F [anterior], G [proximal], H [posterior], I [anterior], J [distal]). *Villa Clara*. Corralillo: **VSM** (Pradas 1998: 7 [‘*Antillovultur* [sic] *varonai*’], Suárez 2000a: 112, fig. 3* = skull: A [dorsal], B [lateral], C [posterior], Suárez & Emslie 2003: 30, figs. 1 = skull: top row, middle [dorsal], bottom row, middle [posterior], 3 = tibiotarsus: left [anterior], Arredondo Antúnez & Villavicencio Finalet 2006: 163, tables I–II). *Holguín*.

Mayarí: OCS (Arredondo 1984: 8 [*Antillovultur varonai*], 1996: 1 [*Antillovultur varoni* [sic]). This record has been cited with reservations, see Suárez 2000a, fig. 5]).

Direct ¹⁴C dating.—Late Pleistocene (MLB): >41,000 ¹⁴C yr BP (Suárez 2020a: table 2, tibiotarsus).

Notes.—The commonest cathartid in Cuban Late Pleistocene / Early Holocene deposits, from where it is known by most of its skeletal elements (Suárez 2000a, 2020a, Suárez & Emslie 2003). Approximately the same size (not ‘bigger’, as incorrectly indicated by Gutiérrez Domech 2010: 12, Gutiérrez Domech *et al.* 2018: 42) as Andean Condor *Vultur gryphus* Linnaeus, 1758, and larger than California Condor *Gymnogyps californianus* (see Arredondo 1971: 96, 1972c: 311, 1976: 172, 1984: 8). Comments on the taxonomic status of Cuban Condor by Navarro (2020: 51) are outdated, overlooking the taxon’s redescription (Suárez & Emslie 2003). The original description of *Antillovultur* (= *Gymnogyps*) *varonai* was not published in September–December 1971, as appears on *Mem. Soc. Cienc. Nat. La Salle* 31(90). Some evidence indicates it was printed after the description (March 1972) of the extinct barn owl *Tyto noeli* Arredondo, and probably before that of ‘*T. riveroi*’ Arredondo (December 1972 [but see Arredondo 1975: 159, 189]). On 5 February 1971, Arredondo (1971: 95–96) commented about his discoveries and progress with investigations concerning the two large *Tyto* species and the condor. Of the barn owls, he wrote that ‘aunque están descritas, no han sido aún dadas a conocer como especies nuevas’ [‘although they are described, they have not yet been released as new species’], and concerning the condor, ‘aún no está descrita, pero en un futuro se dará a conocer’ [‘it is not yet described, but in the future it will be released’], indicating that both *Tyto* manuscripts were finished (one being in press, see Arredondo 1970b: 151) and he expected them to be published before that of the condor, which was still not finished. This accords with the original description of *T. noeli* (supposedly published 3–4 months after the condor paper), wherein the condor is listed in a table without a scientific name (Arredondo 1972a: table 1). This seems logical, as Arredondo had no means of easily modifying manuscripts in press outside Cuba (in this case Venezuela) (O. Arredondo pers. comm.). But, the barn owl paper, supposedly published a year after ‘*A. varonai*’, is cited in the condor’s original description as a source that had previously mentioned the presence of this scavenger in Cuba, with a precise indication of page numbers (Arredondo 1972c: 309, 322), year (= 1972), month (= March), and even the scientific name of the tytonid (Arredondo 1972c: 319, table 1). Or, in other words, a publication from 1972, is cited in all its details in a paper supposedly published the previous year, 1971. More precise information exists in an article on the history of the discovery of Cuban Condor and other fossil raptors by Arredondo, published by Morejón (1974: 85): ‘En septiembre de 1959 un grupo de investigadores, entre los cuales se encontraban...Manuel Acevedo-González, Juan N. Otero y Walter M. Acevedo-González, todos espeleólogos; y el paleontólogo Arredondo, encontraron en...la Cueva de Paredones...huesos de un ave que muy posteriormente, en 1972, pudieron ser clasificados como pertenecientes a una especie de buitre mayor que el actual cóndor de California. Se trata de un nuevo género y una nueva especie, y recibió la denominación de “Antillovultur varonai” ...’ [‘In September 1959, a group of researchers, among them...Manuel Acevedo-González, Juan N. Otero and Walter M. Acevedo-González, all speleologists, and the palaeontologist Arredondo, found in...Cueva de Paredones...bones of a bird that much later, in 1972, was finally classified as belonging to a species of vulture larger than the living California Condor. It is a new genus and a new species, and received the name of “Antillovultur varonai” ...’]. Considering the evidence from these papers, the publication date of the condor cannot be in the last quarter of 1971, but sometime after March 1972. Delays, even of a year, in the printing of some issues of *Mem. Soc. Cienc. Nat. La Salle* were common at the time (F. Rojas *in litt.*

2021). As the precise date is unknown, according to the ICZN (1999, Art. 21.3 and 21.4), the date of publication for *Antillovultur* (= *Gymnogyps*) *varonai* Arredondo to be adopted is 31 December 1972, rather than September–December 1971, as has been generally accepted by the palaeontological community.

Genus *Coragyps* Le Maout, 1853

Coragyps Le Maout, 1853, *Hist. Nat. Oiseaux*, p. 57, 66. Type, by monotypy, *Vultur urubu* Vieillot = *Vultur atratus* Bechstein.

12. †*Coragyps seductus* Suárez, 2020 Cuban Black Vulture (Zopilote Cubano)

Coragyps seductus Suárez, 2020a, *Zootaxa* 4780: 12.

History.—*May 2001*: first notification of an extinct small vulture ‘larger than *C. aura*’ from Cuba (Suárez 2001b: 110). *25–27 December 2002*: WS & Stephen Díaz Franco collect paratypes in San Felipe II, at the type locality. *22 May 2020*: original description published (Suárez 2020a).

Holotype.—Near-complete left tarsometatarsus, MNHNCu 75.4719 (Suárez 2020a: 12, fig. 6: A [anterior], B [posterior], C [distal]). Collected in San Felipe II on 24 February 2001 by WS and Stephen Díaz Franco (Suárez 2020a: 3).

Other material.—**Femur**: proximal half of left lacking trochanter, MNHNCu 75.4718 (fig. 6: E [anterior], F [posterior]). **Tarsometatarsus**: proximal left, MNHNCu 75.4720 (fig. 6: D [proximal]). Cited material and figures are from Suárez (2020a).

Type locality.—Las Breas de San Felipe (MLB), c.5.5 km west of town of Martí, San Felipe Valley, municipality of Martí, Matanzas province, Cuba (Suárez 2020a: 12; for description of the deposit, see Iturralde-Vinent *et al.* 2000). Fig. 5.

Distribution.—Asphalt deposits in west Cuba (see Appendix). *Matanzas*. Martí: **MLB** (Suárez 2020a: 12).

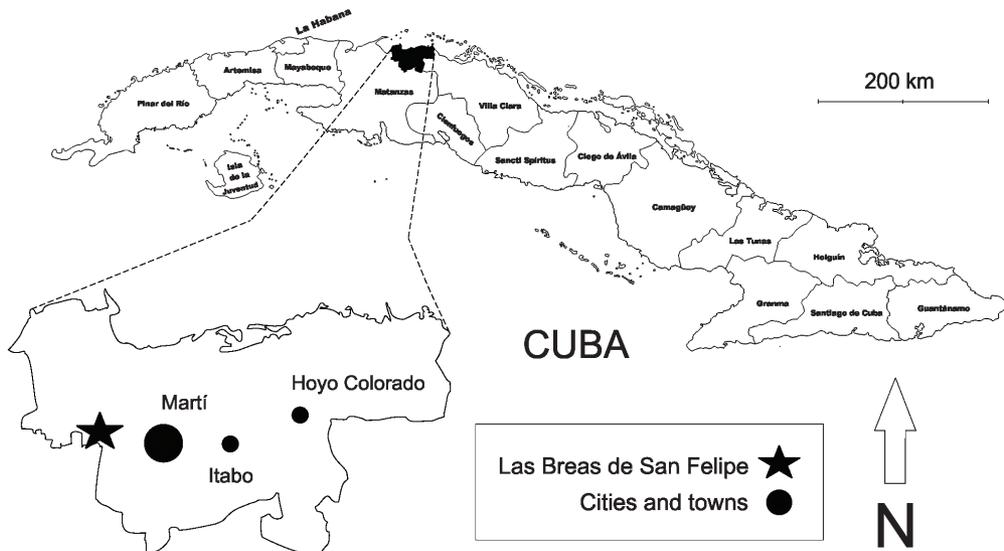


Figure 5. Las Breas de San Felipe (MLB), Martí, western Cuba. Type locality of †*Coragyps seductus* Suárez, †*Cathartes emsleyi* Suárez & Olson, †*Gigantohierax itchei* Suárez, †*Buteogallus royi* Suárez, †*Buteo sanfelipensis* Suárez, †*Milvago carbo* Suárez & Olson and †*M. diazfrancoi* Suárez.

Direct ^{14}C dating.—None. For dating of other bird species at the type locality, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct mammals (*Parocnus browni* = 11,880 ± 420 to 4,960 ± 280 years ^{14}C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005).

Notes.—The rarest extinct Cuban cathartid, restricted to its type locality. Larger and more robust than living Black Vulture *Coragyps atratus* (Bechstein, 1793) and similar in size to extinct *C. occidentalis* (L. Miller, 1909), but with tarsometatarsus slender, among other characters (Suárez 2020a: 12). Also, proximal foramina of the tarsometatarsus are more distally placed in the two Cuban specimens available (S. L. Olson & WS unpubl.) than in congeneric species, but this can be variable and requires further evaluation of additional, insular fossil material. A distal fragment of carpometacarpus from a cave deposit in ASA, western Cuba, probably involves this taxon, but it is insufficient in diagnostic characters for a positive identification (Suárez 2020a: 13). As with Cuban Condor, the Cuban Black Vulture seems to have diverged during the Quaternary, after colonisation probably from Florida, evolving rapidly in isolation and depending on an endemic, insular ‘megafauna’, where competitive carnivorous mammals were absent (see Arredondo 1976: 170, Morgan *et al.* 1980: 606, Suárez 2000a: 120, Suárez & Emslie 2003: 36, Silva Taboada *et al.* 2008: 328–329, Suárez & Olson 2020b: 341).

March (1863: 150–151) reported vultures observed and prepared for collection by him in Jamaica, including the ‘John Crow Vulture [= *Cathartes aura*]’, ‘The Black, or Carrion Crow Vulture [= *Coragyps atratus*]’ and another, unknown vulture species, of which he stated: ‘In the autumn of 1828, I obtained from Great Salt Pond a specimen of a black Vulture, mottled with white spots, about the size of *Pandion carolinensis*. It was so obese, with deep fulvous fat, that I had much difficulty in preserving it in part. I sent the specimen to the Royal Dublin Society, but have received no information of its having been identified with any described species.’ The specimen, or material that matches March’s description, are unknown in the Dublin collection (P. Viscardi *in litt.* 2021). William T. March (1804–72) was a Jamaican native naturalist and collector (see Levy 2008, 2013). Although the bird he collected in 1828 could have been a leucistic *Cathartes aura* (see Zeiger *et al.* 2017), it is also possible that it was an individual of the Cuban (Antillean?) extinct species *Coragyps seductus*, which was larger than *C. atratus* (Suárez 2020a). If the skin still exists, and its identity, are the subject of pending investigations.

Genus *Cathartes* Illiger, 1811

Cathartes Illiger, 1811, *Prodrum Syst. Mamm. Av.*, p. 236. Type, by subsequent designation, *Vultur aura* Linnaeus.

13. †*Cathartes emsliei* Suárez & Olson, 2020 Emslie’s Vulture (Aura de Emslie)

Cathartes emsliei Suárez & Olson, 2020b, *Bull. Brit. Orn. Cl.* 140: 335.

Cathartes aura: Jiménez Vázquez & Valdés Ruiz 1995: 62.

Cathartes? sp.: Suárez 2000a: 120.

Cathartes sp.: Arredondo & Arredondo 2002a: table 1.

History.—1997: first identified specimen (tarsometatarsus) of the type series collected by WS in a cave deposit in west Cuba (Suárez & Olson 2020b: 335). *February 2000*: comment published, clarifying that Turkey Vulture *C. aura* (Linnaeus, 1758) is unknown in Cuba from Pleistocene / Early Holocene deposits, where fossils represent another taxon (Suárez 2000a: 120). *May 2001*: the presence of two additional ‘undescribed, smaller species’ of vultures from Cuba is reported (Suárez 2001b: 110). *2020*: first record from asphalt deposits (22 May)

at Las Breas de San Felipe, west Cuba (Suárez 2020a: 14), and the original description (21 September) of *C. emsliei* is published (Suárez & Olson 2020b).

Holotype.—Proximal half of left tarsometatarsus, MNHNCu 75.4752 (Suárez & Olson 2020b: 336, fig. 3: B [anterior], E [posterior]). Collected in San Felipe I on 27 December 2002 by WS and Stephen Díaz Franco (see Suárez 2020a: 3).

Other material.—**Scapula:** right, MNHNCu 75.692, formerly P-692 (fig. 1B [ventral]). **Coracoid:** fragmentary left, MNHNCu 75.4755, formerly P-691 (fig. 1D [dorsal]). **Tibiotarsus:** right without proximal end, MNHNCu 75.4750 (fig. 2A [anterior]); distal right, MNHNCu 75.4754, MNHNCu 75.4749 (fig. 2C [anterior]); distal left, MNHNCu 75.4748. **Tarsometatarsus:** proximal right, MNHNCu 75.4745, MNHNCu 75.4753, WS 778—immature (fig. 3: A [anterior], D [posterior]); distal half of right, MNHNCu 75.4746 (fig. 3: H [anterior], J [posterior]); proximal half of left, MNHNCu 75.4747; distal half of left, MNHNCu 75.4751 (fig. 3: G [anterior], I [posterior]). Cited material and figures are from Suárez & Olson (2020b).

Type locality.—Las Breas de San Felipe (**MLB**), c.5.5 km west of the town of Martí, San Felipe Valley, municipality of Martí, Matanzas province, Cuba (Suárez & Olson 2020b: 338; for description of the deposit, see Iturralde-Vinent *et al.* 2000). Fig. 5.

Distribution.—Cave, asphalt and sinkhole deposits in west and central Cuba (see Appendix). *Artemisa*. Caimito: **ACP** (WS unpubl.), **ASA** (Suárez 2004a: 124 [‘a small species of vulture’], Suárez & Olson 2020b: 338). *Mayabeque*. San José de las Lajas: **YCI** (Jiménez Vázquez & Valdés Ruiz 1995: 62 [‘*Cathartes aura*’], Rojas Consuegra *et al.* 2012: 10 [‘*Cathartes* sp.’, after being re-identified by WS (= ‘*C. aura*’ of Jiménez Vázquez & Valdés Ruiz 1995)], Suárez & Olson 2020b: 335). *Matanzas*. Martí: **MLB** = type locality (Suárez 2020a: 14 [‘*Cathartes* sp.’], Suárez & Olson 2020b: 336 [‘*Cathartes emsliei* sp. nov.’]). *Villa Clara*. Corralillo: **VSM** (WS unpubl.).

Direct ¹⁴C dating.—None. For dating of other bird species at the type locality, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct mammals (*Parocnus browni* = 11,880 ± 420 to 4,960 ± 280 years ¹⁴C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005).

Notes.—Uncommon in Quaternary deposits on the main island. Postcranial elements smaller compared to specimens of living *C. aura* (Suárez 2001b, 2004a, Suárez & Olson 2020b). Scarce material of *C. emsliei* from cave deposits in west Cuba, and from sinkhole deposits in Villa Clara province, central Cuba, are present at CZACC and AC, respectively (WS unpubl.). Emslie’s Vulture is comparable in size to the extinct, tiny *Wingegyps cartellei* Alvarenga & Olson, 2004, from the Pleistocene of Brazil (see Nascimento & Silveira 2020: 502–503), but the latter is similar to *Gymnogyps* condors rather than to *Cathartes* (Alvarenga & Olson 2004: 3).

Order ACCIPITRIFORMES Vieillot Family ACCIPITRIDAE Vieillot Genus †*Gigantohierax* Arredondo & Arredondo, 2002

Gigantohierax Arredondo & Arredondo, 2002a, *Poeyana* 470–475: 10 [for 1999]. Type, by original designation, *G. suarezi* Arredondo & Arredondo.

Gigantohierax Arredondo Antúnez & Arredondo de la Mata 2012: 298 (*lapsus calami*).

14. †*Gigantohierax suarezi* Arredondo & Arredondo, 2002 Suárez’s Giant Eagle (Águila Gigante de Suárez)

Gigantohierax suarezi Arredondo & Arredondo, 2002a, *Poeyana* 470–475: 10 [for 1999].

Aquila borraasi: Arredondo 1970a: 3 (part).

Titanohierax borraasi: Olson & Hilgartner 1982: 28 (part).

History.—*July 1954*: first material collected by members of SEC in a cave deposit in western Cuba (Arredondo 1955: 29, 1958: 11, 1961: 20, 1964: 19, 1970a: 1–2, 1971: 94). *December 1955*: a drawing of an ungual phalanx, digit I, is labelled ‘ave prehistórica, tal vez andadora’ [‘prehistoric bird, maybe a walker’] (Arredondo 1955: 26). *July 1958*: an incomplete right femur and the same ungual phalanx are figured and tentatively identified as a supposed larger species of terror bird than *Ornimegalonyx oteroi* (see Arredondo 1958). The length of the phalanx is compared to one of ‘*Phororhacos longissimus*’ (Arredondo 1958: 11). *27 March 1959*: B. Patterson (MCZ, *in litt.* to O. Arredondo) mentions a large eagle identified (see ‘Notes’) among Cuban material sent to him for study (Arredondo 1964: 21, 1970a: 2). *1961*: first published notice in Cuba of an extinct eagle from the island (Arredondo 1961: 20; see also Arredondo 1964: 19, 21, 90). *January 1970*: original description of ‘*Aquila borrasii*’ published (Arredondo 1970a) based on a composite type series including some specimens at MCZ (Arredondo 1970a: 3–4, see *Buteogallus borrasii*). *5 August 1982*: species transferred to extinct genus *Titanohierax* Wetmore (Olson & Hilgartern 1982: 28). *16 February 1995*: Jesús Martínez González and WS collect the holotype (Arredondo & Arredondo 2002a: 9). *13 December 2002*: original description (not ‘26 May 1999’, see ‘Notes’ under *Oscaravis olsoni*) of *Gigantohierax suarezi* is published (Arredondo & Arredondo 2002a: 10). The type series includes some large specimens at MCZ, formerly described as ‘*Aquila borrasii*’. *22 May 2020*: first record in asphalt deposits, with description of previously unknown skeletal elements (Suárez 2020a: 22–25).

Holotype.—Left femur, MNHNCu 75.574, original number ‘MNH.NH. P-574’ (Arredondo & Arredondo 2002a: 10, figs. 1* [anterior], 3*A [posterior]; see Díaz-Franco 2004: 156, Herrera-Uria *et al.* 2015: 114). Collected 16 February 1995 by Jesús Martínez González and WS in the deposit known as El Sumidero (see Suárez 2000b) at the type locality (Arredondo & Arredondo 2002a: 9). The holotype was not ‘discovered since the late 1950s’ (*contra* Orihuela 2019: 60).

Other material.—**Femur**: right lacking trochanter and condyles, SEC P-26, at MCZ (Arredondo 1958: 12, fig. left unnumbered: top [anterior], 1964: 19, fig. left unnumbered: right [anterior], 1970a: 4, fig. 7 [anterior], 1971: 96, fig. top left unnumbered: A, left [anterior], Arredondo & Arredondo 2002a: 9–10, fig. 2* [anterior]). **Tarsometatarsus**: three shaft fragments of right, WS 80120.E. **Phalanges**: ungual phalanx, digit I, SEC P-31, at MCZ (Arredondo 1955: 27, fig. unnumbered*: centre [lateral], 1958: 10, fig. left unnumbered*: 2 [lateral], 12, fig. left unnumbered: middle right [lateral], 1970a: 4, fig. 3A [lateral], 1971: 96, fig. top left unnumbered: A, top [lateral], bottom* [lateral], Arredondo & Arredondo 2002a: 9–10, fig. 4A*:[lateral]).

Type locality.—Cueva de Sandoval (**ASA**), c.4 km south of Vereda Nueva, municipality of Caimito, Artemisa [formerly La Habana] province, Cuba (Arredondo & Arredondo 2002a: 10). Fig. 6.

Distribution.—Cave, asphalt and sinkhole deposits in west and central Cuba (see Appendix). **Artemisa**. Caimito: **ACP** (Arredondo 1955: 26 [‘ave prehistórica, tal vez andadora’], 1958: 11 [‘especie mucho mayor’], 1964: 19 [‘Aguila cubana de la prehistoria’], 1970a: 4 [‘*Aquila borrasii* sp. nov.’(part)], figs. 5*A= ungual phalanx [lateral], 9* = ungual phalanx [lateral], see ‘Notes’ under *Buteogallus borrasii*; 1971: 96 [‘*Aquila borrasii* (part)’], Arredondo & Arredondo 2002a: 9–10; WS unpubl.), **ASA** = type locality (Suárez 2000b: table 1 [‘Accipitridae indeterminate’], Arredondo & Arredondo 2002a: 10 [‘*Gigantohierax suarezi* n. gen., n. sp.’]), **ACF** (Arredondo & Arredondo 2002a: 10). **Mayabeque**. Quivicán: **YIN** (WS unpubl.). **Matanzas**. Jagüey Grande: **MFJ** (WS unpubl.), **Martí**: **MLB** (Suárez 2020a, fig. 11 = humerus: A [palmar], B [anconal], C = carpometacarpus [external], D = tarsometatarsus [distal], E [idem: anterior], F [idem: medial], G [idem: posterior], H = digit

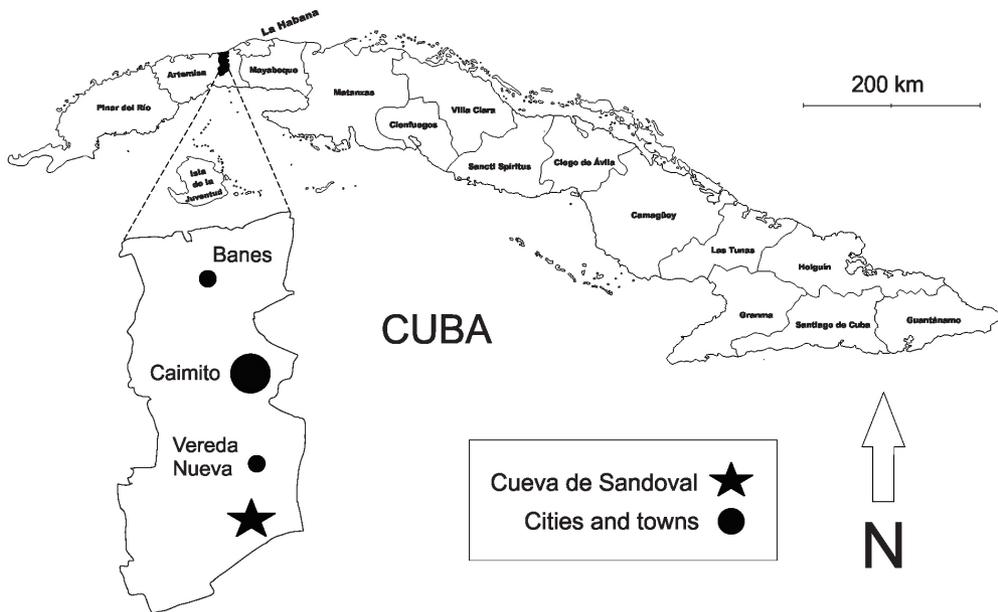


Figure 6. Cueva de Sandoval (ASA), Caimito, western Cuba. Type locality of †*Gigantohierax suarezi* Arredondo & Arredondo and †*Falco kurochkini* Suárez & Olson.

I, phalanx 1 [dorsal], I = ungual phalanx, digit I [lateral]). *Villa Clara*. Sagua La Grande: **VCB** (WS unpubl.).

Direct ^{14}C dating.—None. For dating of other bird species at MLB, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct mammals (*Parocnus browni* = $11,880 \pm 420$ to $4,960 \pm 280$ years ^{14}C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005).

Notes.—Common in Cuban Quaternary deposits. This taxon is the largest Accipitridae ever known from the Americas, larger than the living Harpy Eagle *Harpia harpyja* (Linnaeus, 1758) or any of the extinct described species there (Arredondo & Arredondo 2002a: 10, Suárez 2020a: 22); the genus seems to have been also present on Hispaniola (Suárez 2020a: 25). Another paratype of *Aquila* (= *Buteogallus*) *borrasi*, the ungual phalanx GEC unnumbered, at CZACC, from ACP (Arredondo 1970a: 4), is referred herein to *G. suarezi* (see ‘Notes’ under *B. borrasi*). According to B. Patterson’s notes comparing fossil material from Cuba with museum specimens, femur SEC P-26 (see ‘Other material’) was considered by him as a ‘Giant Cuban Cathartid’, instead of ‘Accipitridae’, as he identified other bones in the sample. Arredondo correctly assumed (*contra* Patterson’s notes) that the largest femur was an Accipitridae (now *G. suarezi*), and included it in the type series of ‘*Aquila*’ *borrasi* (see Arredondo 1970a: 4, Arredondo 1984: 11). On the other hand, the skeleton of *G. suarezi* is similar to some Old World vultures in characters (Suárez & Olson 2021: 264, Suárez *et al.* unpubl.), which confused B. Patterson to the point that he considered the large Cuban femur as belonging to a cathartid. A more complete study of the anatomy and relationships of this taxon will be presented elsewhere (Suárez *et al.* unpubl.).

15. †*Gigantohierax itchei* Suárez, 2020 Itche’s Eagle (Águila de Itche)

Gigantohierax itchei Suárez, 2020a, *Zootaxa* 4780: 25.

Holotype.—Distal third of right tarsometatarsus lacking trochlea IV, MNHNCu 75.4869 (Suárez 2020a: 25, fig. 11: M [anterior], N [medial], O [posterior], P [distal]). Collected in San Felipe II, during 25–28 November 1998 by members of the Depto. de Geología y Paleontología, MNHNCu (see ‘Type locality’).

Other material.—**Femur:** proximal end of fragmentary right, MNHNCu 75.4725 (Suárez 2020a: 25, fig. 11: J [anterior], K [posterior], L [lateral]).

Type locality.—Las Breas de San Felipe (**MLB**), c.5.5 km west of the town of Martí, San Felipe Valley, municipality of Martí, Matanzas province, Cuba (Suárez 2020a: 25; for description of this deposit see Iturralde-Vinent *et al.* 2000). Fig. 5.

Distribution.—Asphalt deposits in west Cuba (see Appendix). *Matanzas*. Martí: **MLB** (Suárez 2020a: 25).

Direct ¹⁴C dating.—None. For dating of other bird species at the type locality, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct mammals (*Parocnus browni* = 11,880 ± 420 to 4,960 ± 280 years ¹⁴C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005).

Notes.—Very rare. Unknown from other Quaternary deposits in Cuba. This taxon is c.29% smaller than *Gigantohierax suarezi*. The holotype, MNHNCu 75.4869, was for some time held in the same collection under the incorrect catalogue number P4569, preoccupied by material of *Milvago carbo* (see below).

Genus *Buteogallus* Lesson, 1830

Buteogallus Lesson, 1830, *Traité d’Orn.*, livr. 2, p. 83. Type, by monotypy, *B. cathartoides* Lesson = *Falco aequinoctialis* J. F. Gmelin.

16. *Buteogallus* cf. †*B. fragilis* (L. Miller, 1911)

Fragile Eagle (Águila Frágil)

Geranoaëtus fragilis L. Miller, 1911, *Univ. California Publ. Bull. Dept. Geol.* 6: 315.

Urubitinga fragilis: Howard 1932: 16.

Buteogallus fragilis: Howard 1946: 117.

Holotype.—Left tarsometatarsus, UCMP 12757 (Miller 1911: 315, fig. 5*: A [proximal], B [anterior]).

Type locality.—Rancho La Brea, Los Angeles, California, USA (Miller 1911; see Howard 1932, Wetmore 1956: 45, Brodkorb 1964: 269).

Referred material.—**Tibiotarsus:** distal end of right, MNHNCu 75.4735 (fig. 8I [anterior]). **Tarsometatarsus:** distal shaft segment of left, MNHNCu 75.4736 (fig. 8J [posterior]). Cited material and figures are from Suárez (2020a).

Distribution.—Asphalt deposits in west Cuba (see Appendix). *Matanzas*. Martí: **MLB** (San Felipe II, Suárez 2020a: 17).

Direct ¹⁴C dating.—None in Cuba. For dating of other bird species at MLB, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct mammals (*Parocnus browni* = 11,880 ± 420 to 4,960 ± 280 years ¹⁴C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005).

Notes.—Extremely rare in the archipelago, where unknown outside tar seeps. The Cuban material referred to *B. fragilis* constitutes the first record of this taxon in the West Indies and outside continental America (Suárez 2020a: 17).

17. †*Buteogallus borraasi* (Arredondo, 1970)

Borrás’s Hawk (Gavilán de Borrás)

Aquila borraasi Arredondo, 1970a (part), *Cienc. Biol. Univ. Habana* (4)8: 3.

Aquila borraasi: Arredondo 1970a: 3 (part).

Aquila borraisi: Acevedo González *et al.* 1975: VIII (typographical error).
Aquila sp.: Fischer 1977: 214.
Sarcoramphus sp.: Acevedo-González & Arredondo 1982: table 1.
Titanohierax borraisi: Olson & Hilgartner 1982: 28 (part).
Sarcoramphus sp.?: Arredondo 1984: 9.
Aquila sp.: Arredondo 1984: 12.
Titanohierax borraisi: Milberg & Tylberg 1993: 243 (*lapsus calami*).
Sarcoramphus? sp.: Suárez 2000a: 120.
Tytanohierax borraisi: Vergara 2003: 454 (*lapsus calami*).
Aquila borraige: Newton 2003: 267 (*lapsus calami*).
‘*Aquila*’ *borraisi*: Suárez 2004a: 121.
Buteogallus borraisi: Suárez & Olson 2008: 289.
Buteogallus borras: Hunt & Lucas 2018: 285 (*lapsus calami*).
Aguila borraisi: Orihuela 2019: 60 (*lapsus calami*).

History.—27 March 1959: B. Patterson (MCZ, *in litt.* to O. Arredondo) reports a large eagle identified in the Cuban material sent to him for study (Arredondo 1964: 21). 1961: first published notification in Cuba about the presence of an extinct eagle on the island (Arredondo 1961: 20; see Arredondo 1964: 19, 21, 90). February 1968: Noel González Gotera and Arredondo collect the holotype in a cave deposit in western Cuba (Arredondo 1970a: 2). January 1970: original description of *Aquila borraisi* published (Arredondo 1970a), based on a composite type series including material at MCZ (Arredondo 1970a: 3–4, see *Gigantohierax suarezi*). 5 August 1982: species transferred to the extinct genus *Titanohierax* Wetmore (Olson & Hilgartner 1982: 28). December 2000: first record in Cuban asphalt deposits (Iturralde-Vinent *et al.* 2000: table 2). 13 December 2002: two large specimens of the type series included in the original description of *Gigantohierax suarezi* (Arredondo & Arredondo 2002a). April 2004: generic position of *Titanohierax borraisi* questioned by Suárez (2004a: 124). 2008: Borrás’s Hawk redescribed on basis of additional fossil material and reassigned to *Buteogallus* (Suárez & Olson 2008: 289).

Holotype.—Left tarsometatarsus lacking distal end, DPUH 1250 (Arredondo 1970a: 4, fig. 1 [anterior], 1971: 96, fig. top left unnumbered: A, centre [anterior], 1976: fig. 3 [anterior]). Collected 11 February 1968 by Noel González Gotera and Oscar Arredondo at the type locality (Arredondo 1970a: 4), in a place known as ‘Bolsón de los Huesos del Salón del Depósito’ (see Acevedo González *et al.* 1975: 16, 18, figs. 4–5).

Other material.—**Phalanges:** pedal phalanx, OA 674 (1000B), at CZACC (Arredondo 1970a: 15, fig. 5*: C [lateral], D [dorsal]); unguis phalanx, digit IV, SEC P-32, at MCZ (Arredondo 1970a: 4, fig. 5*: B [lateral]); unguis phalanx, digit IV, OA 675 (1000A), at CZACC (Arredondo 1970a: 14, fig. 4 [lateral]). Three specimens, a femur and two unguis phalanges, formerly paratypes of ‘*Aquila*’ *borraisi*, represent *Gigantohierax suarezi* (see ‘History’ and ‘Notes’). Other material mentioned in the original description at MCZ (Arredondo 1970a: 2, fig. 3: B [lateral], C [lateral], see Olson & Hilgartner 1982: 28), need re-evaluation.

Type locality.—Cueva del Túnel (YTU), c.3 km south-east of La Salud, municipality of Quivicán, Mayabeque [formerly La Habana] province, Cuba (Arredondo 1970a: 4, see Acevedo González *et al.* 1975: 18). Fig. 7.

Distribution.—Cave, asphalt and sinkhole deposits in west and central Cuba (see Appendix). *Artemisa*. Caimito: ACP (Arredondo 1970a: 4 [‘*Aquila borraisi* sp. nov.’ (part), see ‘Notes’]; 1972a: table 1 [‘*Aquila borraisi*’ (part)], 1972c: table 1 [‘*Aquila borraisi*’ (part)], 1975: 151 [‘*Aquila borraisi*’ (part)], 1984: 11 [‘*Aquila borraisi*’ (part)], 12 [‘*Aquila* sp.’], Suárez & Olson 2008: 290–291, fig. 1: A = tarsometatarsus [anterior], fig. 2: A = humerus [anconal], B = ulna [palmar], fig. 3: C = tarsometatarsus [anterior], Arredondo & Arredondo 2002a: table 1 [‘*Titanohierax borraisi*’]), ASA (Suárez 2000b: table 1 [‘*Titanohierax borraisi*’], Suárez & Olson 2008: 291, fig. 3: E = tibiotarsus [anterior], Arredondo & Arredondo 2002a: table

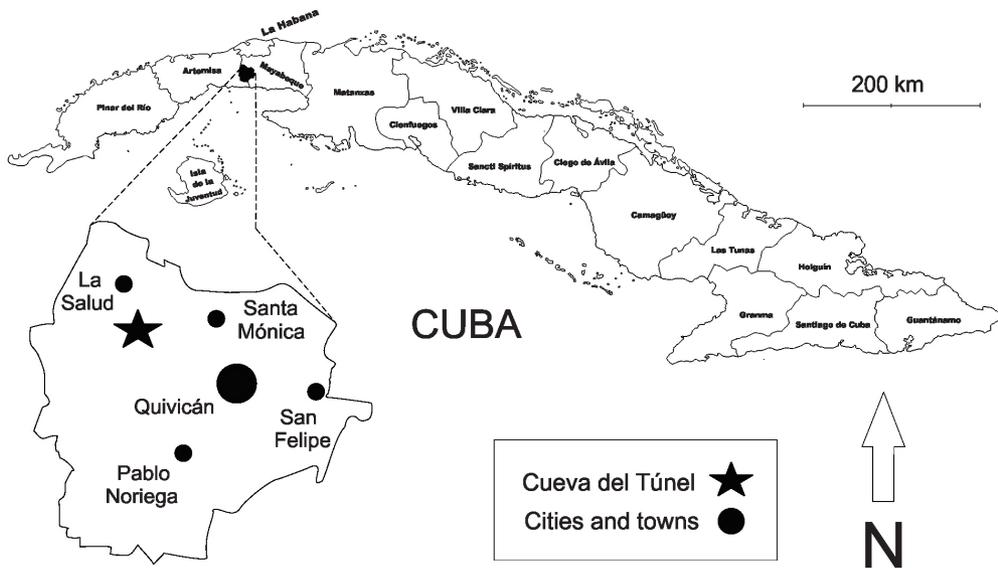


Figure 7. Cueva del Túnel (YTU), Quivicán, western Cuba. Type locality of †*Buteogallus borrasii* (Arredondo) and †*Tyto noeli* Arredondo.

1 [*Titanohierax borrasii*]). Bauta: **ALA** (Fischer 1977: 214 [*Aquila* sp.], Arredondo 1984: 12 [*Aquila* sp.], Suárez & Olson 2008: 291). *La Habana*. Boyeros: **HCI** (Arredondo 1984: 9–10 [*Sarcoramphus* sp.?, reidentified by Suárez 2001b: 110, as '*Titanohierax borrasii*', fig. 1* = ulna: A [internal], B [external], C [distal], see section III, Suárez & Olson 2008: 291). *Mayabeque*. Quivicán: **YTU** = type locality (Arredondo 1970a: 3–4 [*Aquila borrasii* sp. nov.], 1971: 96 [*Aquila borrasii*], 1972a: table 1 [*Aquila borrasii*], 1975: 154 [*Aquila borrasii*], Acevedo González *et al.* 1975: 18 [*Aquila borrasii*], Arredondo 1976: 175 [*Aquila borrasii*], Suárez & Olson 2008: 291), **YIN** (Suárez & Olson 2008: 291), **YBL** (Suárez & Olson 2008: 291, fig. 2 = tibiotarsus [anterior]). San José de las Lajas: **YCI** (Jiménez Vázquez & Valdés Ruiz 1995: 62 [*Titanohierax borrasii*], Rojas Consuegra *et al.* 2012: 6, 10 [*Titanohierax borrasii*], Suárez & Olson 2008: 291), **YCC** (Jiménez & Orihuela 2021: 169). *Matanzas*. Martí: **MLB** (Iturralde-Vinent *et al.* 2000: table 2 [*Titanohierax borrasii*], Suárez & Olson 2008: 291–293, Suárez & Olson 2009b, fig. 1: C = tarsometatarsus [anterior], Suárez 2020a: 16–17, fig. 8 = tarsometatarsus: A [anterior], B [posterior], C [proximal], D = tarsometatarsus [posterior], E = tibiotarsus [anterior], F = idem [distal], G = digit I, phalanx 1 [plantar], H = ungual phalanx, digit II [lateral]). *Villa Clara*. Corralillo: **VSM** (Suárez & Olson 2008: 293). *Sagua La Grande*: **VHC** (Suárez & Olson 2008: 293). *Sancti Spiritus*. Yaguajay: **SPF** (Arredondo 1984: 12 [*Aquila* sp.], Suárez & Olson 2008: 293). *Jatibonico*: **SPL** (Aranda *et al.* 2017: 115 [on p. 118 as '*Buteogallus* sp.'], fig. 1E = digit I, phalanx 1 [ventral], Martínez-López 2019: fig. 5f–g = digit I, phalanx 1: f [ventral], g [dorsal]).

Direct ^{14}C dating.—None. For dating of other bird species at MLB, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct mammals (*Parocnus browni* = 11,880 ± 420 to 4,960 ± 280 years ^{14}C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005).

Notes.—The commonest extinct Accipitridae in Cuban fossil deposits (Suárez 2004a, Suárez & Olson 2008, Suárez 2020a). Originally described in *Aquila* Brisson (Arredondo

1970a), transferred to *Titanohierax* Wetmore (Olson & Hilgartner 1982), and finally redescribed under *Buteogallus* (Suárez & Olson 2008), this is an extinct eagle-size hawk with general morphology resembling the living *B. urubitinga* J. F. Gmelin, 1788, but c.33% larger. Material from CCM identified by Wetmore (1928: 3–4) as *Geranoaetus melanoleucus* (Vieillot, 1819) probably is this species (Suárez 2020a: 17, see section II). Arredondo (1984: 11) commented about some femora from PPD (see also Arredondo 1976: 175) that ‘parecen corresponder a esta especie’ [‘seem to correspond to this species’]. I have found no evidence, until now, of large Accipitridae at this locality. The paratype ungual phalanx, digit I, GEC unnumbered, at CZACC, from ACP (see Arredondo 1970a: 4, figs. 5*A, 9* [not figures of SEC P-31, *contra* Arredondo & Arredondo 2002a: 9], table 2), is re-identified herein as *Gigantohierax suarezi*, based on its size and characters. Material recorded as ‘*Titanohierax* cf. *T. gloveralleni*’, from Crab Cave, Grand Cayman, Cayman Islands (Morgan 1994: 479–480, fig. 22.5A = mandible [dorsal]), seems to represent one of the large, extinct species of *Buteogallus* now known from Cuba, including Borrás’s Hawk (Suárez 2004a, Suárez & Olson 2008, 2021).

18. †*Buteogallus royi* Suárez, 2020

Roy’s Hawk (Gavilán de Roy)

Buteogallus royi Suárez, 2020a, *Zootaxa* 4780: 20.

Holotype.—Left tarsometatarsus, MNHNCu 75.4909 (Suárez 2020a: 20, figs. 9C [anterior], 10: A [anterior], B [medial], C [posterior]). Collected in San Felipe I, C area, on 12 May 2009 by WS and Stephen Díaz Franco.

Type locality.—Las Breas de San Felipe (**MLB**), c.5.5 km west of Martí, San Felipe Valley, municipality of Martí, Matanzas province, Cuba (Suárez 2020a: 21; for description of this deposit see Iturralde-Vinent *et al.* 2000). Fig. 5.

Other material.—**Ulna:** distal third of right, MNHNCu 75.4737, San Felipe II (Suárez 2020a: 21, fig. 10: D [dorsal], E [ventral]).

Distribution.—Asphalt deposits in west Cuba (see Appendix). *Matanzas*. Martí: **MLB** (San Felipe I and II, Suárez 2020a: 21).

Direct ¹⁴C dating.—None. For dating of other bird species at the type locality, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct mammals (*Parocnus browni* = 11,880 ± 420 to 4,960 ± 280 years ¹⁴C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005).

Notes.—Extremely rare and unknown outside tar seeps in the west of the archipelago. Roy’s Hawk is currently the smallest of the known extinct species of *Buteogallus* from Cuba (Suárez 2020a).

19. †*Buteogallus irpus* Suárez & Olson, 2021

Wolf Hawk (Gavilán Lobo)

Buteogallus irpus Suárez & Olson, 2021, *Bull. Brit. Orn. Cl.* 141: 259.

Titanohierax gloveralleni: Woods 1980: 8 (part) [Hispaniola].

Titanohierax sp.: Olson & Hilgartner 1982: 28 [Hispaniola].

Amplibuteo sp.: Suárez & Arredondo 1997: 100 [Cuba].

Amplibuteo woodwardi: Suárez 2004a: 121 [Cuba].

History.—24 April 1978: Charles Woods (UF) collects the holotype in a cave deposit in the Dominican Republic (Suárez & Olson 2021: 260; see Olson & Hilgartner 1982: 28). July 1980: material of large Accipitridae from Hispaniola referred to *Titanohierax gloveralleni* Wetmore by Woods (1980: 8). 5 August 1982: holotype identified as ‘*Titanohierax* sp.’ by Olson & Hilgartner (1982: 28). 2 March 1995: paratype collected in a cave deposit in western Cuba (Suárez & Olson 2021: 259; see Suárez 2004a: 121). Winter 1997: mentioned for Cuba

as '*Amplibuteo* sp.' by Suárez & Arredondo (1997: 100–101). *April 2004*: Cuban material compared with continental fossil taxa and identified as *A. woodwardi* L. Miller, but shows some differences interpreted as individual variation (Suárez 2004a: 122). *10 September 2021*: original description of *Buteogallus irpus* published (Suárez & Olson 2021) based on fossils from Hispaniola and Cuba, with the extinct genus *Amplibuteo* Campbell, 1979, treated as synonym of *Buteogallus*.

Holotype.—Left tarsometatarsus lacking proximal end, USNM PAL 299573 (Suárez & Olson 2021: figs. 1: A [anterior], B [medial], C [distal], D [posterior], E [lateral], 2: A [anterior]). Collected on 24 April 1978 by Charles Woods, under 60 cm of red earth, at the type locality (Suárez & Olson 2021; see also Olson & Hilgartner 1982: 28).

Other material.—**Partial skeleton:** WS 365 (see Suárez 2004a: Figs. 1–2), including: one cervical (axis) and three thoracic vertebrae, seven fragments of ribs, fragmentary pelvis (fig. 2E [lateral]), proximal fragmentary right humerus (fig. 2A [palmar], B [anconal]), distal fragments of left humerus (fig. 2C [palmar]), segment of shaft of left ulna (fig. 2D [palmar]), left fragmentary femur without distal end (fig. 2G [anterior]), proximal and distal fragmentary ends of right femur (fig. 2F–F' [anterior]), shaft of left tibiotarsus (fig. 2I [posterior]), proximal right fibula (fig. 2H [internal]), left tarsometatarsus lacking inner calcaneal ridge, part of the metatarsal facet, wing of trochlea II, and posterior surface of trochlea III (fig. 1A [anterior], fig. 2J [anterior], K [proximal], L [posterior], Suárez & Olson 2008: fig. 1C [anterior], 2021: fig. 2B [anterior]), left digit I, phalanx 1 (fig. 2M [dorsal]) and phalanx 2 (fig. 2N [lateral]), left digit III, phalanx 2 and phalanx 3, right digit III, phalanx 4 (fig. 2O [lateral]), right digit IV, phalanx 4. Collected on 2 March 1995 by WS. Cited figures are from Suárez (2004a), other than where indicated.

Type locality.—Cueva de las Abejas (18°01'N, 71°67'W; elevation *c.*20 m), near Cabo Rojo, 8 km south-east of Pedernales, Pedernales province, Dominican Republic. Quaternary, probably late Pleistocene, but not directly dated (Suárez & Olson 2021: 260; see Olson & Hilgartner 1982: 28, Steadman *et al.* 2019: 321).

Distribution.—Cave deposit in west Cuba (see Appendix). *Artemisa*. Caimito: **ASA** ([Sandoval III low deposit, see Suárez 2000b: 67–68] Suárez & Arredondo 1997: 100–101 [*Amplibuteo* sp.], Suárez 2004a: 121 [*Amplibuteo woodwardi*], Suárez & Olson 2021: 259 [*Buteogallus irpus*, sp. nov.]).

Direct ¹⁴C dating.—None.

Notes.—Very rare, known from a single cave deposit in west Cuba and the type locality in south-central Hispaniola (Suárez & Olson 2021). *B. irpus* possesses a tarsometatarsus within the size range of the extinct continental species *B. woodwardi* (L. Miller, 1911) and *B. hibbardi* (Campbell, 1979), but relatively shorter and more robust, with reduced trochleae (Suárez & Olson 2021). Although currently synonyms of the genus *Buteogallus*, both *Harpyhaliaetus* Lafresnaye and *Heterospizias* Sharpe were incorrectly cited in place of the former by Suárez & Olson (2021: 259) when listing characters 9 and 10 of '*Amplibuteo*' described by Campbell (1979: 77). These characters of the distal tarsometatarsus (trochleae) are of specific value and their presence is variable in living and extinct species currently in *Buteogallus*, as partially described by Campbell (1979: 74). The extinct genus *Titanohierax*, described from the Bahamas (Wetmore 1937) and currently unknown outside those islands (Suárez & Olson 2008, Suárez 2020a), was erroneously considered to be more widely distributed in the West Indies (*cf.* Woods 1980, Olson & Hilgartner 1982, Morgan 1977a,b, 1994, Morgan *et al.* 2019). See *Buteogallus borrsi*. A re-evaluation of some fossils representing large members of Accipitridae from continental deposits in North America probably will shed more light on the taxonomy and distribution of *T. gloveralleni*.

Genus *Buteo* Lacépède, 1799

Buteo Lacépède, 1799, *Tabl. Mamm. Oiseaux*, p. 4. Type, by tautonymy, *Falco buteo* Linnaeus.

20. ×*Buteo lineatus* (J. F. Gmelin, 1788)

Red-shouldered Hawk (Gavilán de Hombros Rojos)

Falco lineatus J. F. Gmelin, 1788, *Syst. Nat.*, edn. 13, vol. 1, pt. 1, p. 268.

Calohierax quadratus: Wetmore 1937: 429.

Buteo sp.: Olson & Hilgartner 1982: 26.

Buteo lineatus: Olson 2000: 60.

Buteo quadratus: Oswald & Steadman 2018: 363.

Falco [*lineatus*]: Orihuela 2019: 60.

Referred material.—**Femur**: proximal end of right, MNHNCu 75.4614 (fig. 1A, right [anterior]). **Tibiotarsus**: distal halves of right, MNHNCu 75.4615 (fig. 1B, right [anterior]), and left, MNHNCu 75.4616; distal end of left, MNHNCu 75.4617. **Tarsometatarsus**: distal halves of right, MNHNCu 75.4618 (fig. 1C, right [anterior]), and left, MNHNCu 75.4619. Cited material and figures are from Suárez & Olson (2003b). Specimens collected in San Felipe II during 25–28 November 1998 (not ‘1988’ as stated [*lapsus calami*] in Suárez & Olson 2003b: 71) by members of Depto. de Geología y Paleontología, MNHNCu. Catalogue numbers for this material in Suárez (2020a: 27) are incorrect.

Distribution.—Asphalt deposits in west Cuba (see Appendix). *Matanzas*. Martí: **MLB** (San Felipe II, Suárez & Olson 2003b: 71, Suárez 2020a: 27). For fossil localities in the Bahamas (as ‘*Buteo quadratus*’), see Steadman & Franklin (2020). For current continental distribution, see Dykstra *et al.* (2020).

Direct ¹⁴C dating.—None in Cuba. For dating of other bird species at MLB, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct mammals (*Parocnus browni* = 11,880 ± 420 to 4,960 ± 280 years ¹⁴C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005).

Notes.—Very rare in Cuba (Suárez & Olson 2003b, Suárez 2020a). Orihuela (2019: 60) indicated that ‘Cuban remains [of *Buteo lineatus*] were described as “more consistently robust” than the comparative material of the Grey Hawk (*Buteo nitidus*)’, but the reverse is true (Suárez & Olson 2003b: 71). Also recorded from Quaternary deposits in the Bahamas (Olson 2000; see Olson & Hilgartner 1982, Steadman & Franklin 2020), where it was originally described (Wetmore 1937) as *Calohierax quadratus* Wetmore. The latter species is considered valid under *Buteo* by some authors (see Oswald & Steadman 2018, Steadman & Franklin 2020).

21. †*Buteo sanfelipensis* Suárez, 2020

San Felipe’s Hawk (Gavilán de San Felipe)

Buteo sanfelipensis Suárez, 2020a, *Zootaxa* 4780: 28.

Holotype.—Left tarsometatarsus without trochlea IV, MNHNCu 75.4910 (Suárez 2020a: 28, fig. 10 F [anterior], G [medial], H [posterior]). Collected in San Felipe I on 14 May 2009 by WS and Stephen Díaz Franco.

Type locality.—Las Breas de San Felipe (**MLB**), c.5.5 km west of the town of Martí, San Felipe Valley, municipality of Martí, Matanzas province, Cuba (Suárez 2020a: 28; for description of this deposit see Iturralde-Vinent *et al.* 2000). Fig. 5.

Distribution.—Asphalt deposits in west Cuba (see Appendix). *Matanzas*. Martí: **MLB** (Suárez 2020a: 28).

Direct ¹⁴C dating.—None. For dating of other bird species at the type locality, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct

mammals (*Parocnus browni* = 11,880 ± 420 to 4,960 ± 280 years ¹⁴C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005).

Notes.—Unknown from other Quaternary deposits in Cuba, being the rarest extinct species of Accipitridae in the country's fossil record. Known only by the tarsometatarsus, which resembles the equivalent element in Swainson's Hawk *B. swainsoni* Bonaparte, 1838, and Rough-legged Buzzard *B. lagopus* (Pontoppidan, 1763) in size and general morphology, but shorter, among other characters (Suárez 2020a: 28). Much larger and distant in morphology to living species in Cuba (see Kirkconnell *et al.* 2020) of the genera *Chondrohierax* Lesson, *Elanooides* Vieillot, *Circus* Lacépède, *Ictinia* Vieillot, or *Rostrhamus* Lesson (S. L. Olson & WS unpubl.), which are currently unknown in the archipelago's fossil record.

Order STRIGIFORMES Wagler
Family TYTONIDAE Ridgway
Genus *Tyto* Billberg, 1828

Tyto Billberg, 1828, *Syn. Faun. Scand.*, vol. 1, pt. 2, tab. A, p. 2. Type, by monotypy, *Strix flammea* Linnaeus = *Strix alba* Scopoli

22. †*Tyto pollens* Wetmore, 1937

Bahamian Giant Barn Owl (Lechuza Gigante de las Bahamas)

Tyto pollens Wetmore, 1937, *Bull. Mus. Comp. Zool.* 80: 436.

Tyto riveroi: Arredondo 1972b: 131.

[*Tyto*]. *Triveroi*: Arredondo 1982: 36 (typographical error).

Tyto pollens: Suárez & Olson 2015: 539.

History.—1937: Vivienne Knowles collects the type series in the Bahamas and the original description (October) of *T. pollens* is published (Wetmore 1937). 3 June 1959: additional specimens from Banana Hole, New Providence, Bahamas, are described and illustrated by Brodkorb (1959: 357–358, pl. 1, figs. 5 = tibiotarsus [anterior], 6 = tarsometatarsus [anterior]). April 1970: Manuel Rivero de la Calle presents to O. Arredondo the first known material from Cuba, collected in 'Galería de los Megalocnus', Cueva de Bellamar, western Cuba (Arredondo 1972b: 131). 1972: original description of '*Tyto riveroi*' published (Arredondo 1972b). 23 September 2015: first direct comparisons between Bahamian and Cuban giant barn owls (including previously unrecorded material) reveal '*Tyto riveroi*' to be a junior subjective synonym of *T. pollens*, and expand the ancient range of the latter to Cuba (Suárez & Olson 2015).

Holotype.—Left femur, MCZ 2262 (Wetmore 1937: 436–437, figs. 10* [anterior], 11* [posterior], 12* [lateral], 13* [distal], 14* [medial]). Collected during early 1937 by Vivienne Knowles (Wetmore 1937: 427, 437).

Type locality.—Cave deposit on 'Great Exuma [= Little Exuma *fide* Hecht 1955]', Bahama Islands (Wetmore 1937: 437; see Suárez & Olson 2015: 540).

Referred material.—**Tarsometatarsus:** proximal half of right, CZACC unnumbered; proximal end of right, OA 3215 (Suárez & Olson 2015: 539, fig. 6: D [anterior]); distal half of left, DPUH 1252 (holotype of '*T. riveroi*', Arredondo 1972b: 132, figs. 1 [anterior], 2 [posterior], 3 [lateral], 4* = reversed: D, top row [distal], bottom row [anterior], Arredondo 1976: 185, fig. 11: C [anterior], D [posterior], E [lateral], 1982: 39, fig. 2*: left [anterior], right [posterior]). Collected by Manuel Rivero de la Calle in 'Galería de los Megalocnus', Cueva de Bellamar (see Arredondo 1972b: 131, Suárez & Olson 2015: 540).

Distribution.—Cave deposit in west Cuba (see Appendix). *Matanzas.* Matanzas: **MBE** (Arredondo 1972b: 132 [*Tyto riveroi* sp. nov.], Suárez & Olson 2015: 539). For fossil localities in the Bahamas see Wetmore (1937: 437), Brodkorb (1959: 357–358), Olson & Hilgartner

(1982: 36–37), Suárez & Olson (2015: 540) and Steadman & Franklin (2020: SI appendix, table S1).

Direct ¹⁴C dating.—None.

Notes.—The largest *Tyto* in the Americas (Olson & Hilgartner 1982: 36, Steadman & Hilgartner 1999: 79, Suárez & Olson 2015: 540) and the rarest of the giant barn owls in Cuban fossil deposits (see ‘Notes’ under *T. cravesae*). *T. pollens* probably evolved in Cuba and subsequently colonised the Bahamas (Suárez & Olson 2015: 549), where it is recorded from Quaternary deposits on some islands of the Great Bahama Bank (Suárez & Olson 2015, Steadman & Franklin 2020).

23. †*Tyto noeli* Arredondo, 1972

Noel’s Giant Barn Owl (Lechuza Gigante de Noel)

Tyto noeli Arredondo, 1972a (part), *Bol. Soc. Venez. Cienc. Nat.* 29: 416.

Tyto noelli: Arredondo 1972a: table 5 (*lapsus calami*).

Tyto neddi: Steadman & Hilgartner 1999: 76.

Tyto noelii: Bolufé Torres 2016: 41 (*lapsus calami*).

History.—7 September 1959: first material collected by O. Arredondo and members of GEC at a cave deposit in western Cuba (Arredondo 1972a: 416). 3 March 1968: the holotype is secured by O. Arredondo and N. González Gotera in a cave in western Cuba (Arredondo 1972a: 417). 5 February 1971: first published news of this extinct large barn owl (Arredondo 1971: 95–96). March 1972: original description published (Arredondo 1972a) based on a composite type series (see ‘Notes’). December 2003: material of *T. noeli* from Cueva El Abrón, western Cuba, is dated (¹⁴C), the first extinct bird from Cuba to be so analysed (Suárez & Díaz-Franco 2003: 373). 23 September 2015: first direct comparisons between all large extinct barn owls in the West Indies (Suárez & Olson 2015), with result that ‘*Tyto neddi*’ described on fragmentary material from Barbuda, Lesser Antilles (Steadman & Hilgartner 1999: 76), is considered a junior synonym of *T. noeli*. Fossils from Jamaica are also identified as the latter taxon.

Holotype.—Right tarsometatarsus, DPUH 1251 (Arredondo 1972a: 416–417, fig. 1 [anterior], 1972b, fig. 4*B: top [distal], bottom [anterior], 1975: fig. 23B [anterior], 1976: 183, fig. 11B [anterior], 1982: 38, fig. 1 [image with wrong number ‘3’]: right [anterior]). Collected on 3 March 1968 by Noel González Gotera and Oscar Arredondo at the type locality (Arredondo 1972a: 417).

Other material.—**Coracoid:** right, OA 839 (Arredondo 1972a: 417, fig. 2 [images in figs. 2 and 4 of the original description are therein reversed]: 6 [ventral], 1976: 183, fig. 10e: right [ventral]). **Ulna:** proximal, OA 806 (Arredondo 1972a: 417, fig. 2: 5, top [palmar], 1976: 183, fig. 10b: bottom right [palmar]), and distal, OA 815 (Arredondo 1972a: 417, fig. 2: 5, bottom [palmar], 1976: 183, fig. 10b: top right [palmar]), ends of right. **Femur:** right, OA 818 (Arredondo 1972a: 417, fig. 2: 1 [anterior], 1976: 183, fig. 10d: right [anterior], 1982: 38, fig. 1 [image wrongly numbered ‘3’]: left [anterior]); left, OA 834. **Tibiotarsus:** proximal half of right, OA 827; shaft of right, OA 822; distal end of left, OA 812. These three specimens formed a reconstructed element (Arredondo 1972a: 417, fig. 2: 3 [posterior], 1976: 183, fig. 10c: right [posterior]). Collected by O. Arredondo and members of GEC in September 1959 (see ‘History’) at ‘Salón del Pozo’, ACP, and during November–December 1963 and January–March 1968 by N. González Gotera and Arredondo at the type locality (Arredondo 1972a: 415–416). See *T. cravesae* Suárez & Olson for specimens formerly included in the type series of *T. noeli*.

Type locality.—Cueva del Túnel (YTU), c.3 km south-east of La Salud, municipality of Quivicán, Mayabeque [formerly La Habana] province, Cuba (Arredondo 1972a: 417). Type

material from this locality was collected at a place known as ‘Bolsón de los Huesos del Salón del Depósito’ (see Acevedo González *et al.* 1975: 16, 19–20, figs. 4–5). Fig. 7.

Distribution.—Cave deposits across the Cuban archipelago (see Appendix). *Pinar del Río*. Los Palacios: **PEA** (Suárez & Díaz-Franco 2003: 373, Suárez 2004b: 156–157). *Artemisa*. Caimito: **ACP** (Arredondo 1972a: 417 [part], 1972c: table 1 [part], 1982: 39 [part], 1984: 21 [part], Suárez & Olson 2001a: 37, Arredondo & Arredondo 2002a: table 1 [part], 2002b: table 1 [part], Suárez & Olson 2015: 541), **ASA** (Suárez 2000b: table 1, Suárez & Olson 2001a: 37, Arredondo & Arredondo 2002a: table 1, Suárez 2004a: 124, Suárez & Olson 2015: 541–542). *La Habana*. Boyeros: **HCI** (Arredondo 1976: 183, 1982: 39, 1984: 21, Suárez & Olson 2015: 542). *Mayabeque*. Quivicán: **YBL** (Jiménez Vázquez *et al.* 1995: 25, Arredondo & Arredondo 2002b: table 1, Suárez & Olson 2015: 542), **YTU** = type locality (Arredondo 1972a: 416 [*Tyto noeli* sp. nov.’ (part)], 1976: 183 [part], Acevedo González *et al.* 1975: 19 [part], Arredondo 1982: 38 [part], 1984: 21 [part], Arredondo & Arredondo 2002b: table 1 [part], Suárez & Olson 2015: 542), **YIN** and **YCH** (Suárez & Olson 2015: 542), **YCC** (Jiménez & Orihuela 2021: 169). *Matanzas*. Cárdenas: **MCE** (Orihuela 2013: 13, 2019: 62, fig. 4 = ulna: A [palmar], B [anconal], D [dorsal]). *Sancti Spiritus*. Yaguajay: **SPS** (Suárez 2004b: 157). *Sancti Spiritus*: **SPM** (Arredondo 1976: 183, 1982: 39, 1984: 21, Suárez & Olson 2015: 542). *Ciego de Ávila*. Florencia: **GCJ** (Suárez & Olson 2015: 542). *Holguín*. Gibara: **OCB** (*cf.* LMR).

Direct ¹⁴C dating.—Late Pleistocene (PEA): 17,406 ± 161 ¹⁴C yr BP. Calibration (95% confidence interval) of same sample gave ages from 21,474 to 20,050 ¹⁴C yr BP (Suárez & Díaz-Franco 2003: 373, long bones). For discussion of age of material from other islands, see Suárez & Olson (2015: 543).

Notes.—The commonest and smallest of the three (not ‘four large barn-owls’ as stated by Orihuela 2019: 57) Cuban giant barn owls in cave deposits (Arredondo 1984: 22, Suárez & Olson 2015: 542) is currently unknown from tar seep or sinkhole deposits (Suárez 2020a: 29–30). The composite type series of this taxon included specimens of the larger *T. cravesae*. Also recorded from cave deposits in Jamaica, Greater Antilles, and Barbuda, Lesser Antilles (Suárez & Olson 2015: 543).

24. †*Tyto cravesae* Suárez & Olson, 2015 Craves’s Giant Barn Owl (Lechuza Gigante de Craves)

Tyto cravesae Suárez & Olson, 2015, *Zootaxa* 4020: 545.

Tyto noeli: Arredondo 1972a: 416 (part).

Tyto sp.: Iturralde-Vinent *et al.* 2000: 309, table 2.

History.—*March* 1972: first known material described as *Tyto noeli* (see Arredondo 1972a, Suárez & Olson 2015: 547). *5 June* 1998: holotype collected by WS in a cave wall cavity at the type locality, western Cuba (Suárez & Olson 2015: 545). *23 September* 2015: original description published (Suárez & Olson 2015), including some specimens formerly in the type series of *T. noeli* (see ‘Other material’). *22 May* 2020: single specimen known from asphalt deposits (a paratype) illustrated (Suárez 2020a).

Holotype.—Associated postcranial elements of one individual, MNHNCu 75.590 (cited figures from Suárez & Olson 2015), consisting of proximal half of a left humerus (fig. 3A [anconal]), proximal end of a right ulna, a near-complete right carpometacarpus (fig. 3C [external]) and a near-complete right femur (fig. 4: C [anterior], G [internal]). Collected 5 June 1998 by WS in an amoeboid-shaped patch of red clay matrix, in a wall cavity near (c.30 m) ‘Salón del Pozo’ (not ‘Type locality: Salón del Pozo’, as stated by Orihuela 2019: 62) at the type locality (Suárez & Olson 2015: 546).

Other material.—**Coracoid**: sternal end of left, OA 832 (Suárez & Olson 2015: fig. 2D [dorsal]). **Humerus**: proximal end of right, OA 826 = paratype of *T. noeli* (Arredondo 1972a:

417, fig. 2 [images in figs. 2 and 4 of the original description are therein reversed]: 4, top [anconal], 1976: 183, fig. 10a: top right [anconal]; distal half of right, OA 804 = paratype of *T. noeli* (Arredondo 1972a: 417, fig. 4: 4, bottom [anconal], 1976: 183, fig. 10a: bottom right [anconal]); shaft of left, WS 077. **Femur**: left lacking a proximal segment of shaft, MNHNCu 75.594 (Suárez & Olson 2015, fig. 4: D [anterior], E [internal]); proximal end of left, CZACC unnumbered. **Tibiotarsus**: distal half, MNHNCu 75.593 (Suárez & Olson 2015: fig. 5F [anterior]), and distal end, OA 831 = paratype of *T. noeli* (Suárez & Olson 2015: fig. 5E [anterior]), of left. **Tarsometatarsus**: right, MNHNCu 75.596 (Suárez & Olson 2015: 547, Figs. 6C: proximal portion [anterior], 7D [anterior], 8A: proximal portion [internal]); right lacking distal end, OA 828 = paratype of *T. noeli* (Arredondo 1972a: 417, fig. 2: 2 [anterior], Suárez & Olson 2015: fig. 7E [anterior]); proximal, MNHNCu 75.595, immature (Suárez & Olson 2015: fig. 6B [anterior]) and distal, MNHNCu 75.592 (Suárez & Olson 2015: fig. 6H [anterior]), WS 09L, immature (Suárez & Olson 2015: fig. 6G [anterior]) ends of right; shaft of right, CZACC unnumbered; distal ends of left, MNHNCu 75.591, MNHNCu 75.4801 (Suárez 2020a: 30–31, fig. 12: A [anterior], B [distal]). See Suárez & Olson (2015: 547).

Type locality.—Cueva de Paredones (ACP), c.3 km south-west of Ceiba del Agua, municipality of Caimito (not ‘San Antonio de los Baños’ as stated by Orihuela 2019: 62), Artemisa province, Cuba (Suárez & Olson 2015: 246). Fig. 4.

Distribution.—Cave and asphalt deposits in west Cuba (see Appendix). *Artemisa*. Caimito: ACP = type locality (Suárez & Olson 2015: 545–546 [*Tyto cravesae*, new species]), ACT (Suárez & Olson 2015: 547). *Mayabeque*. Quivicán: YBL and YTU (Suárez & Olson 2015: 547). *Matanzas*. Cárdenas: MCE (Orihuela 2019: 62), Martí: MLB (Suárez & Olson 2015: 547, Suárez 2020a: 30 [see ‘Other material’]). *Sancti Spiritus*. Sancti Spiritus: SPC (cf. CLV).

Direct ¹⁴C dating.—None. For dating of other bird species at MLB, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct mammals (*Parocnus browni* = 11,880 ± 420 to 4,960 ± 280 years ¹⁴C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005).

Notes.—Not ‘the rarest of Cuban tytonid owls’ as claimed by Orihuela (2019: 62; see *T. pollens* above). *T. cravesae* is about the size of *T. ostologa* from Hispaniola, being less robust, but having a femur with the deepest shaft of all known West Indian giant barn owls (Suárez & Olson 2015: 548). None of the Cuban large barn owls exhibits (*contra* Orihuela 2019: 57) ‘anatomical adaptations that suggest pronounced ground-dwelling’.

25. †*Tyto maniola* Suárez & Olson, 2020 Cuban Dwarf Barn Owl (Lechuza Enana de Cuba)

Tyto maniola Suárez & Olson, 2020a, *Zootaxa* 4830: 552.

Tyto sp.: Suárez 2020a: 29.

History.—*February–March 1997*: two specimens collected in cave deposits in west Cuba (Suárez & Olson 2020a: 558). *November 1998*: holotype collected by members of MNHNCu in asphalt deposits (Suárez & Olson 2020a: 558). *December 2003*: first notice of this extinct, small barn owl, appears in the original description of a fossil phyllostomid bat from Cuba (Suárez & Díaz-Franco 2003: 375). *14 August 2020*: original description published (Suárez & Olson 2020a).

Holotype.—Proximal half of left tarsometatarsus, MNHNCu 75.4651 (Suárez & Olson 2020a: 552, fig. 6: A [anterior], B [posterior], C [proximal], D [external], E [internal]; fig. 7B [anterior]). Collected in San Felipe II during 25–28 November 1998 by members of Depto. de Geología y Paleontología of MNHNCu.

Other material.—**Humerus**: right, WS 0.435, immature (fig. 3B [dorsal]). **Ulna**: near-complete right, WS 0.436, fig. 3F [palmar]). **Carpometacarpus**: right fragmentary, MNHNCu

75.4654. **Tarsometatarsus**: proximal right, MNHNCu 75.4656; distal right, MNHNCu 75.4652 (fig. 7F [anterior]); proximal left without inner calcaneal ridge, MNHNCu 75.4655 (fig. 7: C [anterior]), H [proximal]); distal left, MNHNCu 75.4657 (fig. 7: G [anterior], I [distal]). Cited material and figures from Suárez & Olson (2020a).

Type locality.—Las Breas de San Felipe (**MLB**), c.5.5 km west of the town of Martí, San Felipe Valley, municipality of Martí, Matanzas province, Cuba (Suárez & Olson 2020a: 552; for description of this deposit see Iturralde-Vinent *et al.* 2000). Fig. 5.

Distribution.—Cave and asphalt deposits in west Cuba (see Appendix). *Pinar del Río*. Los Palacios: **PEA** (Suárez & Díaz-Franco 2003: 375 [‘small, undescribed species of *Tyto*’], Suárez 2004b: 156 [‘a new species of *Tyto*’], Suárez & Olson 2020a: 556 [but not ‘municipality of La Palma’]). *Artemisa*. Caimito: **ACP** (Suárez & Olson 2020a: 556). *Matanzas*. Martí: **MLB** = type locality (Suárez & Olson 2020a: 552 [‘*Tyto maniola*, new species’]).

Direct ¹⁴C dating.—None. For dating of other bird species at the type locality, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct mammals (*Parocnus browni* = 11,880 ± 420 to 4,960 ± 280 years ¹⁴C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005). For dating of associated fauna at **PEA** (*Tyto noeli*), see Suárez & Díaz-Franco (2003: 373).

Notes.—Uncommon, currently unknown from sinkhole deposits. The smallest Cuban tytonid, living or extinct, being also smaller when compared to skeletal elements of Ashy-faced Owl *T. glaucops* (Kaup, 1852) —and its synonym *T. cavatica* Wetmore, 1920—of Hispaniola (Suárez & Olson 2020a: 556).

Family STRIGIDAE Leach Genus *Pulsatrix* Kaup, 1848

Pulsatrix Kaup, 1848, *Isis von Oken* 41, col. 771. Type, by monotypy, *Strix torquata* Daudin = *Strix perspicillata* Latham.

Pulsatrix Suárez 2020a: 31 (*lapsus calami*).

26. †*Pulsatrix arredondo* Brodkorb, 1969 Arredondo’s Owl (Búho de Arredondo)

Pulsatrix arredondo Brodkorb, 1969, *Quart. Jour. Fla. Acad. Sci.* 31: 112 [for 1968].

Pulsatrix arredondo: Louchart 2005: table 2 (*lapsus calami*).

Pulsatrix arredondo: Orihuela 2019: 62 (*lapsus calami*).

Pulsatrix arredondo: Orihuela *et al.* 2020a: table 1 (*lapsus calami*).

Holotype.—Left tarsometatarsus, PB 8420 (Brodkorb 1969: 112, fig. 1: left [anterior], top [proximal], bottom [distal], right [internal], Arredondo 1975, fig. 19*: B [anterior], 1982: 41, fig. 4: left [anterior], right [lateral, not ‘posterior’]). Collected in 1960 by O. Arredondo (Brodkorb 1969: 112).

Type locality.—Cueva de Paredones (**ACP**), c.3 km south-west of Ceiba del Agua, municipality of Caimito [formerly San Antonio de los Baños], Artemisa [formerly La Habana] province, Cuba (Brodkorb 1969: 112 [= ‘Caverna Paredones’]). Fig. 4.

Referred material.—**Tarsometatarsus**: right lacking calcaneal ridge, CZACC 6.4126 (Arredondo & González Gotera 1982: 2); incomplete left, OA 3216 (*cf.* Arredondo & Olson 1994: 436); left without part of the calcaneal ridge and portions of trochleae III and IV, CAZGA-267 (Jiménez & Orihuela 2021: 166–167, fig. 2B [anterior]); proximal half of left, MNHNCu 75.4808 (Suárez 2020a: 31, fig. 12: C [anterior], D [proximal]); fragmentary distal left lacking trochlea IV and lateral border, CAZGA-268 (= ‘CAZG04’ and ‘CAZGA04’ of Orihuela 2019: 63, fig. 6 [not ‘right’]: A [anterior], B [posterior], Jiménez & Orihuela 2021: 167, fig. 2A [anterior]).

Distribution.—Cave and asphalt deposits in west Cuba (see Appendix). *Artemisa*. Caimito: **ACP** = type locality (Brodkorb 1969: 112 [*Pulsatrix arredondoii*, new species], Arredondo 1972a: table 1, 1972c: table 1, 1975: 150, 1976: table 1, 1982: 41, 1984: 25, Arredondo & González Gotera 1982: 1, Arredondo & Arredondo 2002a: table 1, 2002b: table 1; WS unpubl.). *Mayabeque*. San José de las Lajas: **YCC** (Jiménez & Orihuela 2021: 166–167, fig. 2 = tarsometatarsus: B [anterior]), **YCM** (Orihuela 2019: 63, fig. 6 = tarsometatarsus [left not ‘right’]: A [anterior], B [posterior], Jiménez & Orihuela 2021: 166–167, fig. 2A [anterior]). *Matanzas*. Cárdenas: **MCA** (Arredondo & Olson 1994: 436), Martí: **MLB** (Suárez 2020a: 31, fig. 12 = tarsometatarsus: C [anterior], D [proximal]). *Sancti Spiritus*. Sancti Spiritus: **SPC** (cf. Orihuela 2019: 63, Suárez 2020a: 31, Jiménez & Orihuela 2021: 169).

Direct ¹⁴C dating.—Late Holocene (YCM): 1,390 ± 30 ¹⁴C yr BP (680–600 BC) (Orihuela 2019: 63, tarsometatarsus; see also Jiménez & Orihuela 2021: 170).

Notes.—Arredondo’s Owl is the only *Pulsatrix* in the Antillean subregion (Brodkorb 1969: 112, Olson 1978: 106, Arredondo 1982: 41, 1984: 25), and was not of large size (*contra* Gutiérrez Domech *et al.* 2018: 42). Its remains are uncommon in Cuban cave or asphalt deposits, being currently unknown from sinkholes. Jiménez & Orihuela (2021: 169) indicated the presence of this taxon at two localities in the province of Artemisa and one in Matanzas, but the reverse is true (see ‘Distribution’). Material from SPC, central Cuba, consists of a tarsometatarsus identified during early 1990 (O. Jiménez Vázquez *in litt.* 2021). Although the locality has been cited in the subsequent literature, the specimen was never mentioned. The tarsometatarsus is the only described skeletal element of *P. arredondoii* (Brodkorb 1969, Arredondo & González Gotera 1982, Arredondo 1984, Suárez 2020a, Jiménez & Orihuela 2021).

Genus *Bubo* Duméril, 1805

Bubo Duméril, 1805, *Zool. Anal.*, p. 34. Type, by subsequent monotypy, *Strix bubo* Linnaeus.

27. †*Bubo osvaldoi* Arredondo & Olson, 1994 Oswaldo’s Owl (Búho de Oswaldo)

Bubo osvaldoi Arredondo & Olson, 1994 (part), *Proc. Biol. Soc. Wash.* 107: 438.

Tyto riveroi: Salgado *et al.* 1992: 28, table 1.

History.—*July 1991*: holotype collected by O. Jiménez Vázquez and C. Morales in a cave deposit at Sierra de Galeras, western Cuba (see ‘Holotype’). *4 October 1994*: original description published (Arredondo & Olson 1994). *9 December 2020*: type series of *B. osvaldoi* revealed to be composite, and only specimens from the type locality represent this species (Suárez 2020b).

Holotype.—Right tarsometatarsus lacking proximal end above tubercle for tibialis anticus, MNHNCu 75.27, formerly MNHNCu-27.1 (Arredondo & Olson 1994: 438, fig. 1: B [posterior], C [anterior], D [distal], Orihuela 2019: 63, fig. 5: A [anterior], B [posterior]). Collected on 2 July 1991 (no collecting date appears in the original description, but was not ‘1992’ as reported in Díaz-Franco 2004: 156 and Herrera-Uria *et al.* 2015: 113) by Oswaldo Jiménez Vázquez and Carlos Morales at ‘Pozo del Búho’, in the type locality (O. Jiménez Vázquez *in litt.* 2021).

Other material.—**Femur**: right lacking internal condyle and abraded about the trochanter, MNHNCu 75.4908, formerly MNHNCu 27.3 (Arredondo & Olson 1994: 38, fig. 2: B [anterior], Suárez 2020b, fig. 1: D [anterior]). **Tarsometatarsus**: shaft of left, MNHNCu 75.4907, formerly MNHNCu 27.2. For discussion of incorrect data concerning the type series, see ‘Notes’.

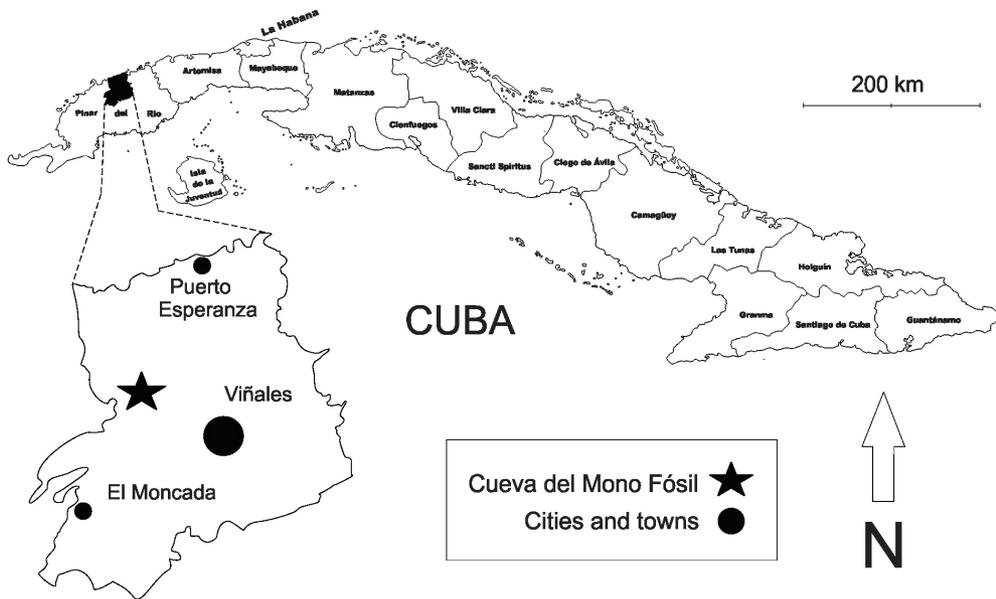


Figure 8. Cueva del Mono Fósil (PMF), Viñales, western Cuba. Type locality of †*Bubo osvaldoi* Arredondo & Olson.

Type locality.—Cueva del Mono Fósil (PMF), Sierra de Galeras, municipality of Viñales, Pinar del Río province, Cuba (Arredondo & Olson 1994: 438; see Rivero & Arredondo 1991, Salgado *et al.* 1992, Arredondo & Rivero 1997). Fig. 8.

Distribution.—Cave deposit in west Cuba (see Appendix). *Pinar del Río*. Viñales: PMF (Arredondo & Olson 1994: 438).

Direct ^{14}C dating.—None.

Notes.—Extremely rare, unknown away from the type locality. The type series of *B. osvaldoi* was a composite, including two fossil bones from eastern Cuba that belong to another large strigid, *Ornimegalonyx ewingi* Suárez, of about the same size (Suárez 2020b: 391). The catalogue numbers ‘MNHNCu P4607’ and ‘MNHNCu P4608’, assigned by Díaz-Franco (2004: 156), replicated by Herrera-Uria *et al.* (2015: 114), represent a *lapsus calami* (= the digit 9 was substituted by digit 6 on both specimens; S. Díaz-Franco & WS pers. obs.), maintained until today. Both numbers are in use for another taxon in the same collection (Suárez & Olson 2003b: 73). In addition, incorrect data concerning the collection date and collector of the paratype femur (MNHNCu 75. 4908) was also republished (Herrera-Uria *et al.* 2015: 114). The femur was secured at Cueva Alta, in the type locality, by other members (names unknown) of GEPAB, on a different (unknown) date to both tarsometatarsi (O. Jiménez Vázquez *in litt.* 2021).

Genus †*Ornimegalonyx* Arredondo, 1958

Ornimegalonyx Arredondo, 1958, *El Cartero Cubano* 17(7): 11. Type, by monotypy (*contra* Brodkorb 1961: 634), *O. oteroi* Arredondo.

28. †*Ornimegalonyx oteroi* Arredondo, 1958 Cuban Giant Owl (Búho Gigante Cubano)

Ornimegalonyx oteroi Arredondo, 1958, *El Cartero Cubano* 17(7): 11.

Ornimegalonyx sp.: Arredondo 1964: 21.

Ornimegalonyx acevedoi: Arredondo, 1982: 45.

Ornimegalonyx minor: Arredondo 1982: 46.
Ornimegalonyx gigas: Arredondo 1982: 47.
Cathartes aura: Arredondo 1984: 9 (see Suárez 2001b: 110).
Ornimegalonix oteroi: Weesie 1988: 62 (*lapsus calami*).
Ornimegalonix oteroi: Arredondo Antúnez 2007: 153 (*lapsus calami*).
Ornimegalonix gigas: Arredondo Antúnez 2007: 153 (*lapsus calami*).
Ornimegalonix minor: Arredondo Antúnez 2007: 153 (*lapsus calami*).
Ornimegalonix acevedoi: Arredondo Antúnez 2007: 153 (*lapsus calami*).
Ornimegalonix minor: Gutiérrez Domech 2010: 12 (*lapsus calami*).
Ornimegalonix oteroi: González Alonso 2011: 270 (*lapsus calami*).
Ornimegalonix oteroi: González Alonso 2012: 207, 208 (*lapsus calami*).
Ornimegalonix oteroi: Aranda *et al.* 2020: 2 (*lapsus calami*).

History.—2 January 1954: members of SEC collect the type material of what is initially considered a terror bird, family Phorusrhacidae Ameghino, at a cave deposit in western Cuba (Arredondo 1954, 1955, 1956, 1957a,b, 1958). July 1958: original description of *Ornimegalonyx oteroi* published (Arredondo 1958; see Brodkorb 1961). 27 March 1959: B. Patterson (MCZ, *in litt.* to O. Arredondo) reports an enormous owl identified in Cuban material sent to him for study (Arredondo 1964: 21). May 1961: lectotype designated and *O. oteroi* removed from Phorusrhacidae to Strigidae (Brodkorb 1961). July 1982: three additional species of *Ornimegalonyx* described from Cuba, *O. acevedoi*, *O. minor* and *O. gigas* (Arredondo 1982: 45–47). December 2000: first record in asphalt deposits at Las Breas de San Felipe, western Cuba (Iturralde-Vinent *et al.* 2000: 309, table 2). 2002: morphofunctional analysis of *O. oteroi* conducted (Alegre Lago 2002). 2020: direct ¹⁴C dating of material (22 May) from Las Breas de San Felipe (Suárez 2020a: table 1). Species described by Arredondo (1982) considered (9 December) junior subjective synonyms of *O. oteroi* (Suárez 2020b).

Lectotype.—Left tarsometatarsus lacking distal end, SEC P-383.E, at MCZ, designated by Brodkorb (1961: 634) (Arredondo 1954: 48, fig. top right unnumbered: top centre [anterior], 1955: 26, fig. unnumbered*: left [anterior], 1958: 12, fig. top unnumbered: bottom centre [anterior], 1964: 19, fig. right unnumbered: top centre [anterior], 1975: 135, figs. 1: top centre [anterior], 2*: right [anterior], 1976, figs. 5: top centre [anterior], 7*: b [anterior], 1982, figs. 5: top centre [anterior], 6* [anterior]). Collected on 2 January 1954 by Manuel Rivero de la Calle, Juan N. Otero and O. Arredondo, on the floor of the main gallery at the type locality (see Arredondo 1954: 46, 1975: 134).

Other material.—Skeletal elements from the same individual, SEC P-383.E (see Arredondo 1958: 10). **Skull:** small fragments (Arredondo 1955: 25, 1975: 136). **Mandible:** articular portions (Arredondo 1975: 136, figs. 13* [lateral], 14* [ventral], 1976: 177, fig. 9*A [ventral], 1982: 42, fig. 10*A [lateral]). **Vertebra:** few of unknown position (Arredondo 1975: 136). **Sternum:** fragments (Arredondo 1975, fig. 11*: A [lateral], B [ventral], 1976: 177, figs. 8*: left [ventral], right [lateral]). **Rib:** fragments of unknown laterality (Arredondo 1955: 25, 1975: 136). **Scapula:** one of unknown laterality (Arredondo 1976: 177). **Humerus:** fragments of right and left (Arredondo 1975: 136, 1976: 177, 1982: 43). **Ulna:** fragments of right and left (Arredondo 1955: 25, 1975: 136). **Radius:** fragments of right and left (Arredondo 1955: 25, 1975: 136). **Carpometacarpus:** proximal left (Arredondo 1975: 148, fig. 12*: A [lateral], Arredondo 1982: 42, fig. 10*A [lateral]). **Femur:** left without internal condyle (Arredondo 1954: 48, fig. top right unnumbered: top right [posterior], 1955: 25, 1958: 12, fig. top unnumbered: left bottom [posterior], 1964: 19, fig. right unnumbered: top right [posterior], 1975: 135, figs. 1: top right [posterior], 2*: left [posterior], 1976: figs. 5 [posterior], 7*C [posterior]; 1982, figs. 5: right [posterior]), fragments of right (Arredondo 1976: 177). **Tibiotarsus:** right fragmentary (Arredondo 1954: 48, fig. top right unnumbered: left [posterior], 1955: 25, 1958: 12, fig. top unnumbered: right [posterior], 1964: 19, fig. right unnumbered: left [posterior], 1975: 135, fig. 1: left [posterior], 1976: fig. 5 [posterior],

1982, fig. 5: left [posterior]), fragments of left (Arredondo 1976: 177). **Tarsometatarsus:** fragments of right (Arredondo 1976: 177). **Phalanges:** pedals (Arredondo 1954: 48, fig. top right unnumbered: bottom right [ventral], 1955: 25, 1958: 12, fig. top unnumbered: top left [ventral], 1964: 19, fig. right unnumbered: bottom right [ventral], 1975: 135, fig. 1 bottom: right [ventral], 1976: figs. 5: bottom right [ventral], 1982, figs. 5: bottom right [ventral]), unguals (Arredondo 1954: 48, fig. top right unnumbered: bottom centre [lateral], 1955: 26, fig. unnumbered*: top centre [lateral], 1958: 10, fig. left*: 3 [lateral], 12, fig. top unnumbered: top centre [lateral], 1964: 19, fig. right unnumbered: bottom centre [lateral], 1975: 135, fig. 1 bottom: centre [lateral], 1976: fig. 5: bottom centre [lateral], 1982: fig. 5: bottom centre [lateral]). Date, locality and collectors as in 'Lectotype'.

Type locality.—Caverna de Pío Domingo (**PPD**), Sierra de Sumidero, municipality of Minas de Matahambre, Pinar del Río province, Cuba (Arredondo 1958: 10). Fig. 3.

Distribution.—Cave and asphalt deposits in west and central Cuba (see Appendix). *Pinar del Río*. Minas de Matahambre: **PCH** (Alegre Lago 2002: 12–13; see Arredondo & Olson 1994: fig. 1A = tarsometatarsus [anterior]), **PPD** = type locality (Arredondo 1954: 48 ['especie grande de ave prehistórica'], 96 ['ave prehistórica de grandes y fuertes uñas'], 1955: 26 ['ave prehistórica, tal vez andadora'], 1958: 11 ['*Ornimegalonyx oteroi*...nueva especie'; see Brodkorb 1961], 1975: 144, figs. 10*A = digit II, phalanx 2: top [lateral], bottom [ventral], 10*C = ungual phalanx [lateral], 11* = sternum: A [lateral], B [ventral], 151, fig. 13* = hypothetical skull and mandible reconstruction [lateral], 152, fig. 14* = mandible [ventral], 182, fig. 28* = skeleton [lateral], 1982: 42, figs. 16* = skull [ventral], 17* = mandible [ventral], 1984: 26, Alegre Lago 2002: 15). *Artemisa*. Caimito: **ACP** (Arredondo 1964: 19, fig. left unnumbered, centre = tibiotarsus: top [lateral], bottom [posterior]; left = tarsometatarsus [posterior], 21, fig. bottom unnumbered: skull [posterior], 1971: 96, fig. bottom left unnumbered* = skull: 1 [ventral], 2 [lateral], 1972a: table 1, 1972c: table 1, 1975: 137, fig. 3 = tarsometatarsus [posterior], fig. 4* = idem: left [anterior], centre [posterior], right [proximal], 138, fig. 7 = tibiotarsus [lateral], 141 ['*Ornimegalonyx* sp.'], fig. 9 'A' = left: femur [posterior], 9'B' = right: femur [posterior], 144, fig. 10*D = digit IV, phalanx 2: top [lateral], bottom [dorsal], 147, fig. 11* = sternum: A [lateral], B [ventral], 155 ['*Ornimegalonyx* sp.'], figs. 15 = skull: A [anterior], B [ventral], 16* = skull [ventral], 1976: 177, figs. 4: a = tibiotarsus [lateral], b = tarsometatarsus [posterior], 8* = sternum: left [ventral], right [lateral], 9 = skull: b [anterior], c [ventral], 1982: 42, figs. 7: tarsometatarsus [posterior], fig. 8* idem: left [anterior], centre [posterior], right [proximal], fig. 14 = femur [posterior], 46 ['*Ornimegalonyx minor* sp. nov.']; see Suárez 2020b], 28 ['*Ornimegalonyx minor*'], Arredondo & Arredondo 2002a: table 1, 2002b: table 1, Alegre Lago 2002: 13–15, pl. 1: A = sternum [ventral]), C = scapula: 1 [ventral], 2 [dorsal], pl. 7 = tibiotarsus: A [posterior], B [anterior], pl. 8 = tarsometatarsus: A [anterior], B [posterior]), **ACA** (Arredondo 1955: 4 ['ave fósil andadora'], 1958: 11, 1975: 148, 1982: 42, 1984: 26), **ASA** (Suárez 2000b: table 1, Alegre Lago 2002: 13–15, pl. 3B = ulna: 1 [ventral], 2 [dorsal], Arredondo & Arredondo 2002a: table 1, 2002b: table 1), **AQS** (WS unpubl.). Bauta: **ACL** (Arredondo 1984: 8–9 ['*Cathartes aura*', reidentified by Suárez 2001b: 110]). *La Habana*. Mariano: **HFT** (Alegre Lago 2002: 14). *Mayabeque*. Bejucal: **YCT** (Alegre Lago 2002: 14). Quivicán: **YBL** (Jiménez Vázquez *et al.* 1995, Alegre Lago 2002: 14–15, pl. 3A = radius: 2 [palmar], Arredondo & Arredondo 2002b: table 1), **YIN** and **YCH** (Alegre Lago 2002: 14–15), **YTU** (Arredondo 1964: 21 ['*Ornimegalonyx*'], Acevedo González *et al.* 1975: 19, Arredondo 1975: 138, fig. 6* = tarsometatarsus: left [anterior], right [medial], 144, fig. 10*B = digit II, phalanx 2: top [lateral], bottom [ventral], 183, fig. 29* = hypothetical external aspect [lateral], 1982: 42, 1984: 26, Alegre Lago 2002: 14–15). San José de las Lajas: **YCI** (Jiménez Vázquez & Valdés Ruiz 1995: 62 ['*Ornimegalonyx* sp.'], Rojas Consuegra *et al.* 2012: 10 ['*Ornimegalonyx* sp.'], Alegre Lago 2002: 13–15). *Matanzas*. Cardenas: **MCQ** (Arredondo 1964: 21 ['un

ejemplar mayor que el de “Pío Domingo”], 1975: 137 [*Ornimegalonyx* cf. *oteroi*], fig. 5* = tarsometatarsus: left [anterior], right [posterior], 183, fig. 29* = hypothetical external aspect [lateral], 1982: 45 [*Ornimegalonyx acevedoi* sp. nov.], fig. 12* = tarsometatarsus: left [anterior], right [posterior], 1984: 27–28 [*Ornimegalonyx acevedoi*]), **MCB** (Orihuela 2019, fig. 7 = tarsometatarsus: A [anterior], B [posterior], C [lateral]). Martí: **MLB** (Iturralde-Vinent *et al.* 2000: table 2, Alegre Lago 2002: 14–15, Suárez 2020a: 31–32, fig. 12E–H = tarsometatarsus: E [anterior], F [proximal], G [distal], H [posterior]). Jagüey Grande: **MFJ** (cf. CLV). *Sancti Spiritus*. Yaguajay: **SPH** (Arredondo 1964: 21 [*Ornimegalonyx*'], Alegre Lago 2002: 13, pl. 1B = coracoid [internal], 2 = humerus: A [anconal], B [palmar], 6 = femur: A [posterior], B [anterior]). *Sancti Spiritus*: **SPC** (Arredondo 1964: 21, 1975: 141, fig. 8* = femur [anterior], Arredondo 1982: 47 [*Ornimegalonyx gigas* sp. nov.], fig. 15* = femur [anterior]), Arredondo 1984: 29 [*Ornimegalonyx gigas*']). *Camagüey*. Sierra de Cubitas: **CEN** (Kurochkin & Mayo 1973 [*Ornimegalonyx*']). Isla de la Juventud: **IPE** (Arredondo 1982: 42).

Direct ¹⁴C dating.—Late Pleistocene (MLB): 22,000 ± 2,600 ¹⁴C yr BP (Suárez 2020a: table 2, tarsometatarsus).

Notes.—The commonest of the Cuban extinct species of Strigidae, its remains are frequently present in fossil deposits at low elevations (see Suárez & Olson 2015: 550). *O. oteroi* is the largest owl ever known, living or extinct (Arredondo 1975, 1976, 1982, 1984, Olson 1978, 1985; see also Alcover *et al.* 1999, Louchart 2005), a weak flier (but not ‘flightless’, see Alegre Lago 2002) with considerable sexual and individual variation (Arredondo 1975, Alegre Lago 2002, Suárez 2020b). *Ornimegalonyx* is a member of the Striginae, closely related to the modern genera *Strix* Linnaeus and *Ciccaba* Wagler, as noted by E. Kurochkin (Olson 1978, 1984). Erection of a separate subfamily for the Cuban taxon, announced by Arredondo Antúnez (2007: 153), is not supported by osteological characters. Some authors, in early studies of *Ornimegalonyx* (cf. Arredondo 1964, Kurochkin & Mayo 1973), but also more recently (Morgan & Albury 2013), called it a ‘flightless barn owl’ (= Tytonidae) which is incorrect (see comment in Arredondo 1975: 134, footnote).

29. †*Ornimegalonyx ewingi* Suárez, 2020 Ewing’s Owl (Búho de Ewing)

Ornimegalonyx ewingi Suárez, 2020b, *Bull. Brit. Orn. Cl.* 140: 391.

Bubo osvaldoi: Arredondo & Olson 1994: 438 (part).

History.—*January 1947*: Abelardo Moreno (Museo Felipe Poey, La Habana) sends to A. Wetmore (USNM) two fossil bones (type material) of a large bird collected in a ‘mine’ in eastern Cuba (Arredondo & Olson 1994: 436, 438, Suárez 2020b: 391). *15 January 1959*: Wetmore (1959: 15) announces the presence of an undescribed, extinct ‘large barn owl’ (*Tyto*) from ‘a cave in eastern Cuba’ (see Brodtkorb 1959: 357, Olson’s footnote in Arredondo 1976: 172, Olson 1978: 105). *4 October 1994*: material identified by Wetmore (1959), and three other fossils from western Cuba, are described as *Bubo osvaldoi* (Arredondo & Olson 1994). *9 December 2020*: the type series of *B. osvaldoi* is revealed to be composite—including specimens from eastern Cuba representative of another large extinct owl—when the original description of *O. ewingi* is published (Suárez 2020b).

Holotype.—Right femur without anterior surface of head, piece of posterior face of shaft, and internal condyle, USNM 447022 (Arredondo & Olson 1994: figs. 2A [anterior], 3*: A [posterior], B [anterior], C [proximal], Suárez 2020b: fig. 1C [anterior]). Collector and date unknown (Arredondo & Olson 1994: 438, Suárez 2020b: 391; see Mayo 1980: 223).

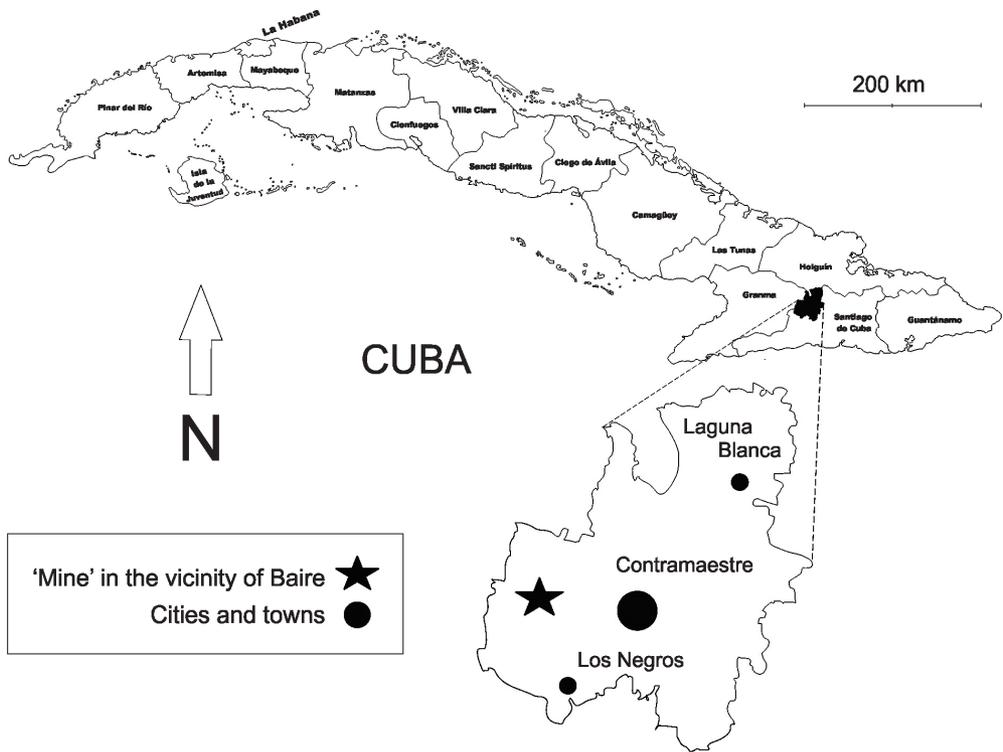


Figure 9. A 'mine' in the vicinity of Baire (SMB), Contramaestre, eastern Cuba. Type locality of †*Ornimegalonyx ewingi* Suárez. Note the star covers Baire and environs, but the precise location of the deposit is currently unknown.

Other material.—**Humerus:** left without proximal end and external part of distal articulation, USNM 447023 (Arredondo & Olson 1994: figs. 3*D [palmar], 4B [palmar], Suárez 2020b: fig. 1B [palmar]). See Suárez (2020b: 391).

Type locality.—A 'mine' in the vicinity of Baire (SMB), municipality of Contramaestre, Santiago de Cuba [formerly Oriente] province, Cuba (Suárez 2020b; see Arredondo & Olson 1994: 438, and 'Notes'). Fig. 9.

Distribution.—Restricted to the type locality in east Cuba (see Appendix). *Santiago de Cuba*. Contramaestre: SMB (Suárez 2020b: 391).

Direct ¹⁴C dating.—None.

Notes.—Extremely rare. The smallest *Ornimegalonyx* (c.30% smaller than *O. oteroi*). The type series of *O. ewingi* represents the first material to be collected of the genus (Suárez 2020b). Apparently, the type locality is the same deposit named by Aguayo & Howell Rivero (1955: 1302) as 'minas de manganeso en Baire, Oriente' ['manganese mines in Baire, Oriente'], from where several mammalian fossils were sent to Museo Felipe Poey in 1942 (see Aguayo 1950: 122). Mayo (1980: 225) considered the locality to be possibly a cave (see Silva Taboada *et al.* 2008: 413). According to a distributional map published by Park (1942: pl. 21), a number of mines of this kind were known at that time not far from Baire. Some specimens from asphalt deposits at Las Breas de San Felipe, western Cuba, perhaps involve this taxon (Suárez 2020a: 32, 2020b: 391).

Order FALCONIFORMES Sharpe
Family FALCONIDAE Leach
Genus *Caracara* Merrem, 1826

Caracara Merrem, 1826, in Ersch & Gruber, *Allg. Encycl. Wiss. Kunste* 15: 159. Type, by subsequent designation, *Falco plancus* J. F. Miller.

30. †*Caracara creightoni* Brodkorb, 1959
Creighton's Caracara (Caraira de Creighton)

Caracara creightoni Brodkorb, 1959, *Bull. Fla. State Mus.* 4: 353.

Polyborus plancus: Olson 1976: 363.

Polyborus creightoni: Olson 1982: 36.

Caracara plancus ssp.: Jiménez Vázquez 1997a: 49.

Caracara creightoni: Suárez 2000a:120 (*lapsus calami*).

Caracara creightoni: Suárez 2004c:1, 10 (*lapsus calami*).

Caracara creightoni: Suárez 2020a: table 1 (*lapsus calami*).

History.—28 August 1958: holotype collected by J. C. Dickinson and W. Auffenberg at a cave deposit in the Bahamas (Brodkorb 1959: 353, 1964: 292). 3 June 1959: original description published (Brodkorb 1959). 22 January 1976: the single specimen known is considered a synonym (Olson 1976: 363) of living *C. plancus* (J. F. Miller, 1777). 5 August 1982: two additional fossils, a left quadrate and a distal end of a left tibiotarsus from the type locality provide characters to support the extinct species' validity (Olson & Hilgartner 1982: 28–31, fig. 2: B = tibiotarsus [anterior], D = idem [distal], F = quadrate [medial], H = idem [ventral]). Winter 1997: first record published from Cuba based on specimens from two cave deposits in the west (Suárez & Arredondo 1997: 101). 25 May 2001: species redescribed on basis of cranial and postcranial material from cave and sinkhole deposits in central and west Cuba (Suárez & Olson 2001a). 11 August 2003: identified in tar seeps at Las Breas de San Felipe, with description of previously unknown skeletal elements (Suárez & Olson 2003c: 307; see Suárez 2020a: 32–35). 11 December 2007: a well-preserved skull and its respective mandible reported from a blue hole, Sawmill Sink, Great Abaco, Bahamas (Steadman *et al.* 2007: fig. 6 [lateral]). 3 October 2014: first direct ¹⁴C dating on material (femur) from Great Abaco, Bahamas (Steadman & Franklin 2015: table 2, fig. 3: a [posterior], b [anterior]). November 2019: mitochondrial genome data obtained from a late Holocene (2,500 yr BP) right femur, Great Abaco, Bahamas (Oswald *et al.* 2019).

Holotype.—Incomplete left carpometacarpus, UF 3153 (Brodkorb 1959: 353, pl. 1, fig. 7 [lateral]). Collected 28 August 1958 by J. C. Dickinson and W. Auffenberg (Brodkorb 1959: 353, 1964: 292).

Type locality.—Banana Hole, New Providence Island, Bahamas (Brodkorb 1959: 351; see Olson & Pregill 1982: 4–5).

Referred material.—**Skull:** incomplete, OA 3928 (Suárez & Olson 2001b: 502, figs. 1B [lateral], 2B [dorsal]); rostrum, MNHNCu 75.4742 (Suárez 2020a: 32, fig. 13: A [lateral], B [dorsal]). **Notarium:** fragmentary, MNHNCu 75.4579. **Humerus:** proximal end of right, WS 1035 (Suárez & Olson 2003c: 305, fig. 2C [anconal]); shaft of right, MNHNCu 75.4759; left lacking proximal end, MNHNCu 75.4817 (Suárez 2020a: 32, fig. 13C [palmar]); proximal half of left, MNHNCu 75.4818 (Suárez 2020a: 32, fig. 13D [palmar]). **Ulna:** left, MPSPG 75 (Suárez & Olson 2001b: 502, fig. 3A: left [internal]). **Carpometacarpus:** right lacking minor metacarpal, MPSPG 77 (Suárez & Olson 2001b: 502, fig. 3B: left [internal]); left, MNHNCu 75.4819 (Suárez 2020a: 32, fig. 13E [internal]); proximal half of left, MPSPG 110. **Femur:** left, WS 1933 (Suárez & Olson 2003c: 305, fig. 2A [anterior], Jones *et al.* 2013, fig. 5*: 5 [posterior]); distal end of left, WS 0209; proximal half of right, WS 0142; proximal end of right, WS 587. **Tibiotarsus:** left lacking internal condyle, MPSPG 79 (Suárez & Olson 2001b: 502, fig. 3D: left

[anterior]); distal end of right lacking posterior rim of internal condyle, MP5G 83; distal halves of right, MNHNCu 75.4852–4853; distal ends of right, MNHNCu 75.4854–4856; shaft of left, MNHNCu 75.4851; distal ends of right, MNHNCu 75.4584–4585; distal ends of left, MNHNCu 75.4580–4583. **Tarsometatarsus:** right, MNHNCu 75.4820 (Suárez 2020a: 32, fig. 13: D [anterior]) and 75.4827–4828; proximal halves of right, MNHNCu 75.4844–4847; proximal ends of right, MNHNCu 75.4848–4850; right lacking proximal ends, MNHNCu 75.4829–4831; distal end of right, MNHNCu 75.4839; left, MP5G 103 (Suárez & Olson 2001b: 502, fig. 3C: left [anterior]); left without distal end, MNHNCu 75.4840; proximal ends of left, MNHNCu 75.4841–4843; distal halves of left, MNHNCu 75.4832–4835, MP5G 106; distal ends of left, MNHNCu 75.4592–4593, MNHNCu 75.4836–4838; distal ends of right, MNHNCu 75.4586–4591.

Distribution.—Cave, asphalt and sinkhole deposits in west and central Cuba (see Appendix). *Artemisa*. Caimito: **ACP** (Suárez & Olson 2003c: 305), **ASA** (Suárez & Arredondo 1997: 101, Suárez 2000b: table 1 [*Caracara* sp.], Suárez & Olson 2003c: 305). *Mayabeque*. Quivicán: **YTU** (Suárez & Olson 2003c: 307 [*Caracara plancus* ssp. of Jiménez Vázquez 1997a: 49]). *Matanzas*. Cárdenas: **MCA** (Suárez & Arredondo 1997: 101, Suárez & Olson 2001b: 502), Martí: **MLB** (Iturralde-Vinent *et al.* 2000: table 2 [*Caracara* sp.], Suárez & Olson 2003c: 307, Suárez 2020a: 32). Jagüey Grande: **MFJ** (*cf.* CLV). *Villa Clara*. Corralillo: **VSM** (Suárez & Olson 2001b: 502, Arredondo Antúnez & Villavicencio Finalet 2006: tables I–II).

Direct ¹⁴C dating.—None from Cuba. Bahamas, Late Holocene (Sawmill Sink): 2,650 to 2,350 Cal BP (Steadman & Franklin 2015: table 2, femur).

Notes.—Common in Quaternary deposits in Cuba, from where the species seems to have originated and subsequently colonised the Lucayan Archipelago. Recorded from Cuba by Suárez & Arredondo (1997: 101), with additional material subsequently reported and the species redescribed (Suárez & Olson 2001b, 2003c, Suárez 2020a). One record from Dolphin Cave on Grand Cayman, Cayman Islands (Morgan 1994: 480 [*Polyborus creightoni*']) is considered erroneous (Suárez & Olson 2001b: 507, Olson 2008: 265). The main features of Creighton's Caracara vs. congeners is the presence of a massive and differently shaped rostrum (Suárez & Olson 2001b: 502, 2014: 308, Suárez 2020a: 33). Orihuela (2019: 61) commented that 'Suárez & Olson (2001a) hypothesised a recent arrival to Cuba [of *C. creightoni*], along with *Cathartes*.' but this is a misinterpretation (see Suárez 2020a: 35). Figueredo (2011: 11) cited the species as 'ave de rapiña sin vuelo' ['flightless bird of prey'], which is incorrect. For material and distribution of *C. creightoni* in the Bahamas, see Brodkorb (1959), Olson (1976), Olson & Hilgartner (1982), Steadman *et al.* (2007) and Steadman & Franklin (2015, 2020).

Genus *Milvago* Spix, 1824

Milvago Spix, 1824, *Avium species novae Brasil*, Bd. 1, p. 12. Type, by monotypy, *Milvago ochrocephalus* Spix = *Polyborus chimachima* Vieillot.

31. †*Milvago carbo* Suárez & Olson, 2003 Cuban Caracara (Caraira Cubana)

Milvago carbo Suárez & Olson, 2003c, *Proc. Biol. Soc. Wash.* 116: 302.

Holotype.—Near-complete right tarsometatarsus, MNHNCu 75.4569, formerly P4569 (Suárez & Olson 2003c: 302, fig. 1: A [anterior], B [medial], C [posterior]; see Herrera-Uria *et al.* 2015: 114–115, not 'P456' [*lapsus calami*] as appears in Díaz-Franco 2004: 157). Collected in San Felipe II during expeditions conducted in 1998 by the Depto. de Geología y Paleontología, MNHNCu [= Stephen Díaz Franco, Manuel Iturralde Vinent and Reinaldo

Rojas Consuegra. Not 'W. Suárez, and S. Díaz-Franco' as indicated by Herrera-Uria *et al.* 2015: 115. See Iturralde-Vinent *et al.* 2000: 301] (Suárez & Olson 2003c: 302).

Other material.—**Notarium:** fragmentary, MNHNCu 75.4567. **Tibiotarsus:** distal ends of left, MNHNCu 75.4568, MNHNCu 75.4570–4571. **Tarsometatarsus:** proximal half of left without part of inner and outer calcaneal ridges, MNHNCu 75.4572; shaft of left, MNHNCu 75.4573; proximal end of right, MNHNCu 75.4574; distal halves of right, MNHNCu 75.4575–4576 (latter with abrasion); distal ends of left, MNHNCu 75.4577–4578. See Suárez & Olson (2003c: 303), Díaz-Franco (2004: 157), Herrera-Uria *et al.* (2015: 115).

Type locality.—Las Breas de San Felipe (**MLB**), c.5.5 km west of the town of Martí, San Felipe Valley, municipality of Martí, Matanzas province, Cuba (Suárez & Olson 2003c: 302–303; for description of this deposit see Iturralde-Vinent *et al.* 2000). Fig. 5.

Distribution.—Asphalt deposits in west Cuba (see Appendix). *Matanzas*. Martí: **MLB** (Suárez & Olson 2003c: 302–303, Suárez 2020a: 35–36).

Direct ¹⁴C dating.—None. For dating of other bird species at the type locality, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct mammals (*Parocnus browni* = 11,880 ± 420 to 4,960 ± 280 years ¹⁴C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005).

Notes.—Very rare, known only from tar seeps in west Cuba. The largest representative of the genus *Milvago*, living or extinct (Suárez & Olson 2003c, Suárez 2020a). The smaller taxon recorded as *Milvago* sp. (see below) by Suárez & Arredondo (1997: 101) is not a synonym of the much larger *M. carbo* (*contra* Kirkconnell *et al.* 2020: table 4).

32. †*Milvago diazfrancoi* Suárez, 2020

Díaz Franco's Caracara (Caraira de Díaz Franco)

Milvago diazfrancoi Suárez, 2020a, *Zootaxa* 4780: 36.

Holotype.—Left tarsometatarsus lacking trochleae II and IV, MNHNCu 75.4610 (Suárez 2020a: 36, fig. 14: A [anterior], B [posterior]). Collected on 14 May 2009 by WS and Stephen Díaz Franco in San Felipe I, at the type locality (Suárez 2020a: 36).

Other material.—**Tibiotarsus:** distal third of left, MNHNCu 75.7021 (fig. 14: F [distal], G [anterior]). **Tarsometatarsus:** distal half of right, MNHNCu 75.7022; distal end of right, MNHNCu 75.4826; proximal half of right, MNHNCu 75.4825 (fig. 14: C [anterior]); distal half of left, MNHNCu 75.7023 (fig. 14: D [posterior], E [anterior]); distal end of left, MNHNCu 75.4824. Cited material and figures are from Suárez (2020a).

Type locality.—Las Breas de San Felipe (**MLB**), c.5.5 km west of the town of Martí, San Felipe Valley, municipality of Martí, Matanzas province, Cuba (Suárez 2020a; for description of locality see Iturralde-Vinent *et al.* 2000). Fig. 5.

Distribution.—Asphalt deposits in west Cuba (see Appendix). *Matanzas*. Martí: **MLB** (Suárez 2020a).

Direct ¹⁴C dating.—None. For dating of other bird species at the type locality, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct mammals (*Parocnus browni* = 11,880 ± 420 to 4,960 ± 280 years ¹⁴C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005).

Notes.—Very rare. *M. diazfrancoi* is about the size of *M. alexandri* [= *Milvago wetmorei* Arredondo 1982: 36 (*lapsus calami*)] Olson, 1976, from Haiti, with a slenderer tarsometatarsus in the former, among other distinguishing characters (Suárez 2020a: 36; see Olson 1976: fig. 1). Both taxa appear related to the continental modern-day Yellow-headed Caracara *M. chimachima* (Olson 1976: 359, Suárez 2020a: 36–37), which is present in the fossil record of Florida (Emslie 1998: 44–46).

33. *Milvago* sp.

Referred material.—**Tarsometatarsus:** proximal left, WS 977.

Distribution.—Cave deposit in west Cuba (see Appendix). *Artemisa*. Caimito: **ACP** (Suárez & Arredondo 1997: 101).

Direct ¹⁴C dating.—None.

Notes.—The rarest and least known of the Cuban extinct caracaras. Orihuela (2019: 60–61) erroneously considered the *Milvago* sp., recorded by Suárez & Arredondo (1997: 101), as another Cuban species in the genus (*M. diazfrancoi*, described a year after Orihuela's paper), indicating 'Type locality: San Felipe tar pits, Martí, Matanzas province...' for it, but the present taxon has never been found in Cuban asphalt deposits (see Suárez 2020a: 36). At the same time, *Milvago* sp. was also incorrectly treated by Orihuela (2019: 60–61) as a synonym of the much larger extinct *Caracara creightoni* (see Suárez 2020a: 35, and 'Notes' under *M. carbo*).

Genus *Falco* Linnaeus, 1758

Falco Linnaeus, 1758, *Syst. Nat.*, edn. 10, vol. 1, p. 88. Type, by subsequent designation, *F. subbuteo* Linnaeus (AOU Comm., 1886).

34. ×*Falco femoralis* Temminck, 1822 Aplomado Falcon (Halcón Aplomado)

Falco femoralis Temminck, 1822, *Color Planches*, livr. 21, pl. 121 and text.

Referred material.—**Carpometacarpus:** right without minor metacarpal, MNHNCu 75.4606 (fig. 1D: right [internal]); right lacking distal end and minor metacarpal, MNHNCu 75.4607. **Tibiotarsus:** distal end of left, MNHNCu 75.4608. **Tarsometatarsus:** proximal end of left, MNHNCu 75.4609 (fig. 1E: right [anterior]). Cited material and figures are from Suárez & Olson (2003b). Collected on 25 February 2001 by Stephen Díaz Franco and WS, in San Felipe I, area C.

Distribution.—Asphalt deposits in west Cuba (see Appendix). *Matanzas*. Martí: **MLB** (Suárez & Olson 2003b: 73).

Direct ¹⁴C dating.—None. For dating of other bird species at MLB, see *Antigone cubensis*, *Gymnogyps varonai* and *Ornimegalonyx oteroi*, and of associated extinct mammals (*Parocnus browni* = 11,880 ± 420 to 4,960 ± 280 years ¹⁴C BP), see Jull *et al.* (2004) and Steadman *et al.* (2005).

Notes.—Very rare. Fossils from Las Breas de San Felipe are the only available material of this falcon in Cuba (Suárez & Olson 2003b). The species has also been reported from a prehistoric deposit on Middle Caicos, Bahamas (Steadman & Franklin 2020).

35. †*Falco kurochkini* Suárez & Olson, 2001 Cuban Falcon (Halcón Cubano)

Falco kurochkini Suárez & Olson, 2001a, *Proc. Biol. Soc. Wash.* 114: 35.

History.—1973: Eugene N. Kurochkin collects the first specimen, an incomplete tarsometatarsus at Cueva de los Fósiles, Camagüey province (Suárez & Olson 2001a: 34; see Olson 1985, Olson & Kurochkin 1987). 4 May 1997: holotype collected by WS in a cave deposit in western Cuba (Suárez & Olson 2001a: 35). Autumn 2000: specimens of the type series from western Cuba recorded as 'Falconidae indeterminate' (Suárez 2000b: table 1). 19 April 2001: original description published (Suárez & Olson 2001a). April 2004: reported from

its westernmost known fossil locality (Suárez 2004b: 156), Cueva El Abrón, an ancient barn owl pellet deposit in mountains of Pinar del Río province (Suárez & Díaz-Franco 2003: 375).

Holotype.—Left tarsometatarsus, MNHNCu 75.3229, formerly P3229, WS 1054 (Suárez & Olson 2001a: 35, fig. 2D [anterior]; see also Díaz-Franco 2004: 157, Herrera-Uria *et al.* 2015: 114). Collected 4 May 1997 by WS in a small sink known as ‘El Sumidero’, at the type locality (Suárez & Olson 2001a; 35; see Suárez 2000b).

Other material.—**Coracoid:** right, MNHNCu 75.3209 (fig. 1A [ventral]); left, USNM 510237. **Humerus:** left, MNHNCu 75.3210 (fig. 1B [anconal]), USNM 510238; left lacking pectoral crest, USNM 510239; incomplete left, MNHNCu 75.3211; proximal left, MNHNCu 75.3212–3214; right lacking proximal end, MNHNCu 75.3215; proximal right, USNM 510238; distal right, USNM 510241. **Ulna:** proximal right, MNHNCu 75.3217, USNM 510242; distal right, MNHNCu 75.3219; proximal left, MNHNCu 75.3216 (fig. 1C [internal]); distal left, MNHNCu 75.3218, USNM 510249 (fig. 1C [internal]). **Carpometacarpus:** proximal right, MNHNCu 75.3220 (fig. 1D [external]). **Notarium:** incomplete, MNHNCu 75.3221 (fig. 2A [ventral]). **Femur:** left, MNHNCu 75.3222 (fig. 2B [anterior]), USNM 510243; distal half of right, MNHNCu 75.3226; left lacking distal end, MNHNCu 75.3223; proximal left, MNHNCu 75.3224–3225, USNM 510244. **Tibiotarsus:** right, MNHNCu 75.3227 (fig. 2C [anterior]); left, USNM 510245; proximal half of left, USNM 510246; right lacking proximal end, MNHNCu 75.3230; distal right, MNHNCu 75.3228. **Tarsometatarsus:** right lacking proximal end, USNM 510247; left lacking distal end, IGP/ACC 406-3 (fig. 2E [anterior]); shaft of left, USNM 510248. Cited material and figures are from Suárez & Olson (2001a). See also Díaz-Franco (2004: 157), Herrera-Uria *et al.* (2015: 114).

Type locality.—Cueva de Sandoval (**ASA**), c.4 km south of the town of Vereda Nueva, municipality of Caimito, Artemisa [formerly La Habana] province, Cuba (Suárez & Olson 2001a: 35). Fig. 6.

Distribution.—Cave deposits in west and central Cuba (see Appendix). *Pinar del Río*. Los Palacios: **PEA** (Suárez 2004b: 156). *Artemisa*. Caimito: **ACP** (Suárez & Olson 2001a: 36), **ASA** = type locality (Suárez 2000b: table 1 [‘Falconidae indeterminate’], Suárez & Olson 2001a: 35–36 [‘*Falco kurochkini*, new species’]). *Mayabeque*. San José de las Lajas: **YCC** (Jiménez & Orihuela 2021: 169). *Camagüey*. Sierra de Cubitas: **CFO** (Suárez & Olson 2001a: 36).

Direct ¹⁴C dating.—None. For dating of associated fauna at PEA (17,406 ± 161 ¹⁴C yr BP), see Suárez & Díaz-Franco (2003: 373).

Notes.—Known by most postcranial elements. Present in some cave deposits (Suárez 2000b: 67, 2004b: 156, Jiménez & Orihuela 2021: 169) containing ancient barn owl pellets (*cf.* *Tyto furcata* and *T. noeli*), as this extinct falcon was frequently predated by tytonids. *F. kurochkini* had marked terrestrial habits with hindlimb elements slenderer than in any congeneric (Suárez & Olson 2001a: 37).

Order Psittaciformes Wagler Family Psittacidae Rafinesque Genus *Ara* Lacépède, 1799

Ara Lacépède, 1799, *Tabl. Oiseaux*, p. 1. Type, by subsequent designation, *Psittacus macao* Linnaeus (see Ridgway 1916: 119).

36. †*Ara tricolor* Bechstein, 1811 Cuban Macaw (Guacamayo Cubano)

Ara tricolor Bechstein, 1811, in Latham, *Allg. Ueber*. 4(1): 64, pl. 1.

Le petit Ara d’Aubenton, 1779, *Planches Enl.* 641.

L’Ara tricolor Levaillant, 1801: 13.

Macrocerus aracanga: Vieillot, 1816: 258.
Macrocerus tricolor: Vieillot, 1816: 262.
Psittacus tricolor: Kuhl, 1820: 16.
Sittace. *tricolor*: Wagler, 1832: 669, 733.
Arara tricolor: Brehm, 1842: 3.
Sittace? lichtensteini: Wagler, *vide* Bonaparte 1856.
Ara cubensis Wetherbee, 1985: 174.

Type specimen.—Neontological material (extinct during second half of 19th century): adult mounted, MNHN CG 2000–726, with no date, precise locality, or collector (see Kirkconnell *et al.* 2020, pl. 58).

Referred material.—**Skull:** lacking zygomatic arches, right portion of frontal area, and most of bone around otic regions, AC-7 (Olson & Suárez 2008b: 287–288, fig. 1B: top [ventral], middle [dorsal], bottom [lateral]); rostrum, IGP/ACC unnumbered, at CZACC (Arredondo 1984: 18). **Carpometacarpus:** proximal half of right, AMNH unnumbered (Wetmore 1928: 4).

Distribution.—Cave and sinkhole deposits in west and central Cuba (see Appendix). *Artemisa*. Caimito: **ACP** (Arredondo 1984: 18, Arredondo & Arredondo 2002a: table 1, 2002b: table 1). *Cienfuegos*. Palmira: **CCM** (Wetmore 1928: 4). *Villa Clara*. Sagua La Grande: **VCB** (Olson & Suárez 2008b: 287–288).

Direct ¹⁴C dating.—None. For two indirect conventional dating from CCM (>30,000 to 25,000 ± 2,000 ¹⁴C yr BP), see Kulp *et al.* (1952: 419, table 2 [two samples: pine cones and wood]).

Notes.—Rare in Cuban Quaternary fossil localities with swampy palaeo-environmental indicators (Olson & Suárez 2008b). One record from a cave deposit in Mayabeque province (Arredondo & Arredondo 2002b: table 1) is erroneous (see section III). Fossils from Long Island, Bahamas, recently referred to Cuban Macaw by Steadman & Franklin (2020: table 1 [*Ara cf. tricolor*]). For archaeological records see Jiménez & Orihuela (2021: 171–172). For a summary of its distribution in historical times, natural history, taxonomy, phylogenetic position and skin specimens in collections, see Wiley & Kirwan (2013), Hume (2017), Johansson *et al.* (2018), Provost *et al.* (2018) and Kirkconnell *et al.* (2020).

II—SPECIES OF DUBIOUS IDENTITY

Geranoaetus melanoleucus (Vieillot, 1819).—Wetmore (1928: 3–4) recorded an incomplete left carpometacarpus ('AM [= AMNH] 6190', figs. 1* [internal], 2* [proximal]) and an ungual phalanx (AMNH unnumbered) as '*Geranoaëtus melanoleucus*' (see also Brodkorb 1964: 281 [= '*Buteo fuscescens* (Vieillot)']) from **CCM**, which material was subsequently referred by Acevedo-González & Arredondo (1982: table 1) and Arredondo (1984: 10) to the extant subspecies *G. m. australis* Swann, 1922. However, this material probably represents *Buteogallus borraisi*, the commonest extinct accipitrid found in Cuban Quaternary deposits (see section I), with a carpometacarpus similar in morphology including size (see Suárez 2020a: 17).

III—MISIDENTIFIED & SYNONYMISED TAXA

†**Phorusrhacidae** Ameghino, 1889.—Extinct family recorded as 'Phororhacidae' from **PPD**, **ACP** and **ALA** by Arredondo (1954: 92, 1955: 25–30, 1956: 5, 1957a: 72, 84, 1957b: 10–13, 1958: 10), based on postcranial elements and a large eggshell from an unidentified bird (Arredondo 1955: 26, unnumbered fig.*: bottom centre). Six species in this family (not 'four' as noted by Brodkorb 1961: 634) were reported by Arredondo (1958: 10, 12) as possibly

present in Cuba. The material was later referred to Strigidae, *Ornimegalonyx oteroi* (Brodkorb 1961, Bond 1964, Arredondo 1975, 1976), and Accipitridae, *Gigantohierax suarezi* (Arredondo & Arredondo 2002a; specimens formerly listed under '*Aquila*' *borrasi*, see Arredondo 1961, 1964, 1970a). Cited by Herrera Fritot (1957: 33), Pérez de Acevedo (1957: 273), Koopman (1958: 2) and Paula Couto (1967: 7). Koopman (1958: 2) reproduced information sent by Arredondo of 'an unknown bird allied to the extinct *Phororacos* of Argentina', but with a footnote: 'this identification maybe is erroneous'. *Coccyzus vetula* (Linnaeus, 1758).—Jamaican Lizard Cuckoo was indicated for Cuba as '*Sarothera* [*sic*] *vetula*' by Olson (1978: 114), based on two specimens, a fragmentary pelvis (Av. 875/67) and a partial left humerus (Av. 876/67), recorded from PPD as '*Saurothera merlini* d'Orbigny, 1839' by Fischer & Stephan (1971b: 597). I have examined additional material of *Coccyzus* from other cave deposits in western Cuba. Comparison with *C. vetula* indicates it is not the Jamaican species. Instead, some of the fossils agree in osteological characters and size with skeletal elements of the modern-day subspecies of Great Lizard Cuckoo *C. merlini decolor* (Bangs & Zappey, 1905), resident on Isla de la Juventud (= Isla de Pinos), and *C. m. santamariae* (Garrido, 1971) on some cays off northern Cuba (Kirkconnell *et al.* 2020: 139–140). Both subspecies seem to be more related taxonomically to these fossils than to the modern-day populations (also present in deposits of Holocene age, or maybe older) in the west of the archipelago. The same seems to be true for Bahamian *C. m. bahamensis* and a fossil humerus identified as '*Saurothera merlini*' from Grand Cayman, Cayman Islands (Morgan 1994: 482). The name *C. bahamensis* (H. Bryant, 1864), the oldest available, probably should be applied to some of these fossils. *C. merlini* apparently evolved in eastern Cuba, from where it colonised the rest of the main island. *Rallus sumiderensis* Fischer & Stephan, 1971.—Invalid species, described as extinct, based on abundant material from PPD (Fischer & Stephan 1971b: 593, table 1), but synonymised by Olson (1974: 445–447, table 2) with the relict Cuban endemic Zapata Rail *Cyanolimnas cerverai* Barbour & Peters, 1927 (see Olson 1977: 372, 1978: 107), which is similar in osteological characters and external morphology to the genus *Neocrex* Sclater & Salvin, 1869, of which *C. cerverai* probably represents only a highly specialised, near-flightless insular representative (WS unpubl.). †*Fulica picapicensis* Fischer & Stephan, 1971 (part).—An incomplete right ulna (Av. 843/67), paratype of *Fulica* (= *Nesotrochis*) *picapicensis* (Fischer & Stephan 1971b: 595), does not represent this taxon, but is probably a columbid (Olson 1974: 441, footnote; see 'Notes' under *N. picapicensis*). *Jabiru mycteria* (M. H. C. Lichtenstein, 1819).—A distal left tibiotarsus and proximal right tarsometatarsus (both AMNH unnumbered) from CCM were identified by Wetmore (1928: 2) as a Jabiru, but later referred to *Ciconia maltha* L. Miller, 1910, by Howard (1942: 202). †*Xenicibis* sp.—Recorded in Cuba by Acevedo-González & Arredondo (1982: table 1) without reference to specimens or a locality, and by Arredondo (1984: 6–7) based on material from PPD (which was incorrectly considered the 'type locality' for '*Xenicibis*' sp. by Gutiérrez Domech *et al.* 2018: 45) including a left humerus (OA 2969), a fragmentary distal left tibiotarsus (OA 2970a), two pieces of a left tarsometatarsus (OA 2971) and a phalanx (OA 2972). These were reidentified (Suárez 2001a) as a Limpkin *Aramus guaraua* Linnaeus, 1766. The extinct flightless ibis *Xenicibis xymptihicus* Olson & Steadman, 1977 (= *Xenicibus xymptihicus* Olson 1978: 115 [*lapsus calami*], *Xenioibis xymptihicus* Arredondo 1984: 6 [typographical error]) is endemic to Jamaica (see Olson & Steadman 1977, 1979, Longrich & Olson 2011), and the genus is unknown in Cuba (Suárez 2001a). †*Teratornis* L. Miller, 1909.—Material of the Cuban Teratorn formerly recorded as '*Teratornis* sp.' by Suárez & Arredondo (1997: 100) and described as '*Teratornis*' *olsoni* Arredondo & Arredondo, 2002, is now relocated under the genus *Oscaravis* (Suárez & Olson 2009a). *Antillovultur* Arredondo, 1972.—Extinct genus erected for Cuban Condor '*A.*' *varonai* Arredondo, but considered a junior synonym of

Gymnogyps Lesson (Emslie 1988, Suárez 2000a, Suárez & Emslie 2003). *Sarcoramphus* sp.?—First mentioned for Cuba in Acevedo-González & Arredondo (1982: table 1) without reference to material or locality. Subsequently, a single specimen (not a ‘Few specimens... were assigned to *Sarcoramphus* (? sp.)’ as reported by Orihuela 2019: 60), a distal fragment of left ulna (OA 2973) collected at **HCI** by O. Arredondo in July 1972, was tentatively recorded as ‘*Sarcoramphus* sp.’ (Arredondo 1984: 9), but reidentified as *Buteogallus borraasi* (Suárez 2001b, see section I). *Sarcoramphus* was not mentioned (*contra* Orihuela 2019: 60), nor were specimens ‘assigned to’ it, by Iturralde-Vinent *et al.* (2000). *Cathartes aura* (Linnaeus, 1758).—A proximal left ulna (OA 2974) from **ALA** was recorded as a Turkey Vulture (Arredondo 1984: 8), but the specimen is of the extinct Cuban Giant Owl *Ornimegalonyx oteroi* (Suárez 2001b: 110). Material from **YCI** reported as *C. aura* by Jiménez Vázquez & Valdés Ruiz (1995: 62) was reidentified as the smaller, extinct *C. emsliei* (Suárez & Olson 2020b: 335). **Cathartidae gen. et sp. indet.**—Comments in Arredondo (1976: 172, table 1) on fossils from **YTU**, identified as a ‘large species of vulture’ and recorded (Arredondo 1976: table 1) as ‘Vulturidae gen. and sp. indet.’, were later considered by him to have been misidentified (Suárez 2001b: 110). *Pandion* sp.—Arredondo Antúnez & Villavicencio Finalet (2006: tables I–II) recorded a ‘*Pandion* sp.’ from **VSM**. I examined the fragmentary material on which this is based and found it does not represent a Pandionidae Sclater & Salvin, but a medium-sized Accipitridae (WS unpubl.). *Aquila* sp.—Cited by Fischer (1977: 214) from **ALA** without specifying material and by Arredondo (1984: 12) from **ACP** and **SPF** based on specimens of *Buteogallus borraasi* (see Suárez & Olson 2008), formerly described in *Aquila* Brisson (see section I). *Tyto alba* (Scopoli, 1769).—A proximal right tarsometatarsus (MNHNCu unnumbered) from **SPL** was identified as ‘*Tyto alba*’ by Aranda *et al.* (2017: 118, fig. 1H [anterior]). Based on characters visible in the published photograph, the bone is of a New World *Cathartes* vulture, and is herein reidentified as *Cathartes* sp. Although by size the specimen probably represents *C. aura*, which is very common in modern late Holocene deposits (being occasionally intrusive in some older cave deposits), the specific identity and age of this bone will be subject to further comparisons and a direct ¹⁴C dating. *Tyto riveroi* Arredondo, 1972.—Described from **MBE** by Arredondo (1972b) based on a distal tarsometatarsus (DPUH 1252) of the large barn owl *Tyto pollens* Wetmore, 1937 (Suárez & Olson 2015: 539–540, see section I). *Ornimegalonyx acevedoi*, *O. minor* and *O. gigas* Arredondo, 1982.—These three supposed taxa were described from **MCQ**, **ACP** and **SPC**, respectively, by Arredondo (1982: 45–47), based on material of *O. oteroi* Arredondo, 1958, exhibiting sexual and individual variations (Suárez 2020b, see section I). *Gymnoglaux* sp.—Mentioned by Arredondo (1972a: table 1, 1972c: table 1, 1975: 150, 1976: 131) and Acevedo-González & Arredondo (1982: table 1), without indicating material or locality, and recorded as different from living ‘*Gymnoglaux*’ (= *Margarobyas*) *lawrencii* (Sclater & Salvin, 1868) by Arredondo (1982: 41–42, 1984: 23–24), on the basis of a complete right (OA 2939) and distal end of left (OA 2940) tarsometatarsus from **ACP**. The validity of this supposed extinct taxon was rejected by Arredondo himself on 2 February 2000, when he and I considered describing it and finally compared the fossils with an adequate series of Bare-legged Owl material (O. Arredondo & WS unpubl.). Specimens referable to *Margarobyas* Olson & Suárez from fossil deposits in western Cuba (e.g., **PEA**, **ACP**, **ASA**), were compared with partial skeletons and isolated elements (representing >30 individuals) of *M. lawrencii* obtained from fresh pellets of *Tyto furcata* (WS unpubl.) throughout the main island, in which the endemic owl is its principal avian prey in some habitats (see Suárez 1998). Both fossil and modern specimens are indistinguishable in size and osteological characters. Material from fossil deposits in eastern Cuba is also variable (S. L. Olson pers. comm.), as is true of *Glaucidium siju* (d’Orbigny, 1839). External morphology in *M. lawrencii* is equally

subject to considerable variation across the Cuban archipelago, where the subspecies *M. l. 'exsul'* described by Bangs (1913: 91) for western Cuba and Isla de Pinos (= Isla de la Juventud), is considered invalid (Ripley & Watson 1956: 4, Bond 1957: 12, Parkes 1963: 130; see Kirkconnell *et al.* 2020: 240). *Margarobyas abronensis* Zelenkov & González 2021.—A species recently described based on fossils derived from barn owl predation in PEA and identified by the authors as the same taxon (= '*Gymnoglaux* sp.', see above) recorded by Arredondo (1984). Material from lower levels in El Abrón (= Late Pleistocene; Suárez & Díaz-Franco 2003: 373), including humeri, femora, tibiotarsi and tarsometatarsi, was collected, compared and identified as '*Gymnoglaux* *lawrencii*' by Suárez & Díaz-Franco (2011). Characters described as specific to '*M. abronensis*', including those of the tarsometatarsus, based on comparison apparently with a single skeleton of *M. lawrencii*, are present (and highly variable) in the living species, especially when examining both sexes. The fossil taxon was diagnosed as 'slightly smaller than extant *M. lawrencii*'. Although a chronocline consisting of a post-Pleistocene increase in size is present in some vertebrates from El Abrón (WS & S. Díaz-Franco unpubl.) and other Cuban stratified Quaternary deposits (see Silva Taboada 1974, 1979: 368), a modern tarsometatarsus (total length 33.7 mm) of *M. lawrencii* reported by Arredondo (1982: 42, 1984: 24) from Isla de la Juventud, western Cuba, is smaller than in '*M. abronensis*' (total length 35.7 mm, see Zelenkov & González 2021: table 1). Material (tarsometatarsi) originally identified as '*Gymnoglaux* sp.' by O. Arredondo from ACP is, contrarily, larger (total length 37.5 mm) than '*M. abronensis*' and near the largest limit of *M. lawrencii* recorded by Arredondo (1982: 42, 1984: 24). In addition, some paratypes of '*M. abronensis*' (Zelenkov & González 2021, figs. 1: K = quadrate [caudal], 3: J = ulna [ventral]) are more similar in size and characters to equivalent elements of the modern individual used for comparisons, and figured in the original description, but measurements were not presented. *Margarobyas abronensis* Zelenkov & González, 2021, is considered herein a junior subjective synonym of *Margarobyas lawrencii* (Sclater & Salvin, 1868). See section IV for the fossil record of *M. lawrencii*. †*Amplibuteo woodwardi* (L. Miller, 1911).—Originally recorded as *Amplibuteo* sp. from ASA (Suárez & Arredondo 1997: 100–101), based on a partial skeleton (later numbered WS 365). Subsequently, it was identified as *A. woodwardi* by Suárez (2004a), albeit with some differences from the continental taxon. The extinct genus *Amplibuteo* Campbell is now considered a junior synonym of *Buteogallus* Lesson and the Cuban material, along with a fossil from Hispaniola, was described (Suárez & Olson 2021) as the Antillean extinct species *B. irpus*. Navarro (2022: table 5) erroneously included both *A. woodwardi* and *B. irpus* as present in the fossil record of Cuba, overlooking the taxonomic history of the latter (see section I). †*Titanohierax* Wetmore, 1937.—Extinct genus described from the Bahamas (Wetmore 1937), combined for some time in the binomen *Titanohierax borraisi* (*cf.* Olson & Hilgartner 1982). The Cuban species (see section I) was redescribed in *Buteogallus* Lesson on the basis of abundant and more complete material (Suárez & Olson 2008). *Caracara plancus* ssp.—The left tarsometatarsus (GEPAB-P294) that constituted this record (Jiménez Vázquez 1997a: 49) from YTU was reidentified as the extinct *Caracara creightoni* (Suárez & Olson 2003c: 36). *Milvago* sp.—Although *Milvago* is well represented in the Cuban fossil record (Suárez & Olson 2003c, Suárez 2020a), the first indication by Acevedo-González & Arredondo (1982: table 1) was in error (O. Arredondo pers. comm.). The subsequent deletion of this record (*cf.* Arredondo 1984) was made without comment (see Suárez 2020a: 36), and the material (or taxon) on which it was based is currently unknown. †*Ara tricolor* Bechstein, 1811.—One record from YBL (Arredondo & Arredondo 2002b: table 1 [*Ara cubensis*']) based on a tibiotarsus collected by O. Jiménez Vázquez, but the specimen is a Cuban Parrot *Amazona leucocephala* (Linnaeus, 1758) (O. Jiménez Vázquez *in litt.* 2021). ?*Scytalopus* sp.—A supposed extinct tapaculo (Rhinocryptidae

Wetmore) was recorded from cave deposits in western (ISC) and central (CFO) Cuba (Olson & Kurochkin 1987), and from Mayabeque (YBL) province (Jiménez Vázquez *et al.* 2005), based on specimens of the endemic Zapata Wren *Ferminia cerverai* Barbour (see Suárez & Olson 2020a: 559). *Dolichonyx kruegeri* Fischer & Stephan, 1971.—Described from PPD by Fischer & Stephan (1971b: 597) on a composite type series (Olson & Hilgartner MS), including the endemic Cuban Oriole *Icterus melanopsis* (Wagler, 1829) and migrant Bobolink *Dolichonyx oryzivorus* (Linnaeus, 1758). The latter was a common bird in Cuba in the past, migrating in large numbers throughout the archipelago (Gundlach 1876: 87–88, 1893: 117–118), with remains found in some fossil deposits derived from barn owl pellets (WS pers. obs.). Treated as a synonym of '*Agelaius phoeniceus* (Linnaeus)' by Brodkorb (1978: 201). Acevedo-González & Arredondo (1982: table 1) and Arredondo (1984: 31–32), supposedly refined the identification to '*Agelaius phoeniceus assimilis* Lembeye'—which is currently considered a species, Red-shouldered Blackbird (see Kirkconnell *et al.* 2020: 319)—but skeletal elements of the latter taxon seem too large to match the fossil material (Olson & Hilgartner MS). Orihuela (2019: 64) incorrectly considered *D. kruegeri* as a 'Forgotten record since the original description', ignoring its taxonomic history as a synonym, and going further, as 'Likely extirpated or accidental record'. Following Orihuela (2019: 64), this invalid taxon was erroneously listed again in two consecutive lists of Cuban fossil birds compiled by Navarro (2020: 42, 2021: table 4). 'Unidentified bird'.—MacPhee & Iturralde-Vinent (1994: table 2, 1995: table 1) recorded an 'unidentified bird' from Domo de Zaza (Early Miocene, Lagunitas Formation), Sancti Spiritus province, south-central Cuba, a locality with terrestrial and marine vertebrate remains. About two decades ago (*cf.* Suárez 2004c: 7), I examined the heavily worn, undiagnostic small specimen on which this record was based; although its identity remains uncertain, its morphology differs from any skeletal element in members of the class Aves.

IV—CUBAN NEOSPECIES IN FOSSIL DEPOSITS

(^Eendemic, ^Iintrusive)

ANATIDAE.—*Dendrocygna arborea* (Linnaeus, 1758): **MLB** (Suárez 2020a: 6). *Anas platyrhynchos* Linnaeus, 1758: **CCM** (Wetmore 1928: 3 [*Anas platyrhyncha*']).
PODICIPEDIDAE.—*Podilymbus cf. podiceps* (Linnaeus, 1758): ^I**ASC** (*cf.* Acevedo-González & Arredondo 1982: table 1 [*P[odilymbus]. cf. podiceps antillarum*'], Arredondo 1984: 3–4 [*Podilymbus cf. podiceps antillarum*']).
COLUMBIDAE.—*Patagioenas inornata* (Vigors, 1827): **ACP** and **ASA** (WS unpubl.). *Columbina passerina* (Linnaeus, 1758): **ACP** (WS unpubl.), **YBL** (Jiménez Vázquez *et al.* 2005: 98), **YCC** (Jiménez & Orihuela 2021: 169), **MAF** (*cf.* CLV). *Columbina cf. passerina*: **ACP** (*cf.* Acevedo-González & Arredondo 1982: table 1 [*C[olumbina]. cf. passerina aflavida*'], Arredondo 1984: 17–18 [*Columbina cf. passerina aflavida*']). *Zenaida aurita* (Temminck, 1809): **ASA** (Suárez & Arredondo 1997: 101 [*Zenaida aurita zenaida*'], Suárez 2000b: table 1). *Zenaida cf. aurita*: **YBL** (Jiménez Vázquez *et al.* 2005: 98). *Zenaida macroura* (Linnaeus, 1758): **ACP** (*cf.* Acevedo-González & Arredondo 1982: table 1 [*Z[enaida]. cf. macroura*'], Arredondo 1984: 17).
Columbidae indet.: **PPD** (Olson 1974: 441 [footnote: 'possibly columbid'], **YBL** (Jiménez Vázquez *et al.* 1995: 25 [*Bolumbidae [sic] ind.*'], Jiménez Vázquez *et al.* 2005: 98 [*Columbidae indeterminado*']), **YCC** (Jiménez & Orihuela 2021: 169), **YCI** (Jiménez Vázquez & Valdés Ruiz 1995: 62 [*Columbidae ind.*']).
CUCULIDAE.—*Crotophaga ani* Linnaeus, 1758: **ACP** and **ASA** (Suárez & Arredondo 1997: 101, Suárez 2000b: table 1), **YBL** (Jiménez Vázquez *et al.* 2005: 99). *Coccyzus merlini* d'Orbigny, 1839: **PPD** (Fischer & Stephan 1971b [*Saurothera merlini*']), **YBL** (Jiménez Vázquez *et al.* 2005: 99 [*Saurothera merlini*']), **YCI** (Jiménez Vázquez & Valdés Ruiz 1995: 62 [*Sauruthera [sic] merlini*'], Rojas Consuegra *et al.* 2012: 10 [*Saurothera merlini*']), **MCP** (Díaz

Franco 1999: 13 [*Saurothera merlini* ssp.'], **MFJ** (cf. CLV). *Coccyzus* cf. *merlini*: **ACP** (cf. Acevedo-González & Arredondo 1982: table 1 [*S[aurothera]. cf. merlini'*], Arredondo 1984: 19 [*Saurothera* cf. *merlini'*]). *Coccyzus* sp.: **ACP**, **ACT** (WS unpubl.), **ASA** (Suárez 2000b: table 1 [*Saurothera* sp.']), **YTU** and **YCI** (WS unpubl.). See *Coccyzus vetula* in section III.

CAPRIMULGIDAE.—*Chordeiles gundlachi* Lawrence, 1856: **ASA** (Suárez 2000b: table 1). *Chordeiles* cf. *gundlachi*: **ACP** (cf. Acevedo-González & Arredondo 1982: table 1 [*Ch[ordeiles]. cf. minor gundlachi'*], Arredondo 1984: 30 [*Chordeiles* cf. *minor gundlachi'*]).

APODIDAE.—*Streptoprocne zonaris* (Shaw, 1796): **ACP** (WS unpubl.). **Apodidae** indet.: **PEA** (Suárez & Olson 2020b: 559 [*a large species of swift' = Cypseloides/Streptoprocne*]).

RALLIDAE.—^E*Cyanolimnas cerverai* Barbour & Peters, 1927: **PPD** (Fischer & Stephan 1971b: 593 [*Rallus sumiderensis'*, see section III]), **PEA** (Suárez MS), **ISC** (Olson 1974: 445, table 2), **ACP** (Suárez MS), **ASA** (Suárez 2000b: table 1), **HGA** (Arredondo 1984: 15), **YIN** (Suárez MS), **YCC** (Jiménez & Orihuela 2021: 169), **YCI** (Jiménez Vázquez & Valdés Ruiz 1995: 62, Rojas Consuegra et al. 2012: 10), **MFJ** (cf. CLV), **SPH** and **SPS** (Suárez MS). *Rallus crepitans* J. F. Gmelin, 1789: **PEA** (Suárez & Díaz-Franco 2011 [*Rallus longirostris'*]). *Rallus* sp.: **YCC** (Jiménez & Orihuela 2021: 169), **SPS** (Suárez 2004b: 157). *Gallinula galeata* (M. H. C. Lichtenstein, 1818): **CCM** (Wetmore 1928: 4 [*Gallinula chloropus'*], Brodkorb 1967: 135 [*Gallinula chloropus'*], Acevedo-González & Arredondo 1982: table 1 [*G[allinula]. chloropus cerceris'*], Arredondo 1984: 14 [*Gallinula chloropus cerceris'*]).

ARAMIDAE.—*Aramus guarauna* (Linnaeus, 1766): **PPD** (Arredondo 1984: 6–7 [*Xenicibis* sp.']), Suárez 2001a: 109. See *Xenicibis* sp. in section III).

CICONIIDAE.—*Mycteria americana* Linnaeus, 1758: **MLB** (Suárez & Olson 2003a: 151, Suárez 2020a: 10).

ARDEIDAE.—*Ixobrychus exilis* (J. F. Gmelin, 1789): **ACP** (WS unpubl.), **CCM** (Wetmore 1928: 2). *Ardea alba* Linnaeus, 1758: **CCM** (Wetmore 1928: 1 [*Casmerodius albus'*], 2 [*Casmerodius albus egretta'*], Arredondo 1984: 4–5 [*Egretta alba egretta'*]).

CATHARTIDAE.—*Cathartes aura* (Linnaeus, 1758): **YTU** (Arredondo & Varona 1974: 5, Acevedo González et al. 1975: 18–19 [*Cathartes aura aura'*], Arredondo 1975: 18, 1976: table 1, Acevedo-González & Arredondo 1982: table 1, Arredondo 1984: 8–9), **YCN** (Orihuela 2019: 59). See *Ornimegalonyx oteroi* section I and *Tyto alba* section III.

ACCIPITRIDAE.—*Accipiter striatus* Vieillot, 1808: **ACP** (Suárez & Arredondo 1997: 100 [*Accipiter striatus fringilloides'*]), **YCI** (Rojas Consuegra et al. 2012: 10 [*Accipiter striatus* ssp.']), **MLB** (Iturralde-Vinent et al. 2000: table 2 [*Accipiter* sp.']), Suárez 2020a: 16). ^E*Accipiter gundlachi* Lawrence, 1860: **ASA** (Suárez 2000b: table 1), **YTU** (Suárez & Arredondo 1997: 100 [*Accipiter gundlachi gundlachi'*]). *Buteo platypterus* (Vieillot, 1823): **PEA** (Suárez & Díaz-Franco 2011), **ACP** (Suárez & Arredondo 1997: 100 [*Buteo platypterus cubanensis'*]), **ASA** (Suárez 2000b: table 1), **MLB** (Suárez & Olson 2003b: 73 [*B[uteo]. platypterus cubanensis'*], Suárez 2020a: 27). *Buteo jamaicensis* (J. F. Gmelin, 1788): **YCI** (Jiménez Vázquez & Valdés Ruiz 1995: 62, Jiménez Vázquez 1997a: 49 [*Buteo jamaicensis* ssp.']), Rojas Consuegra et al. 2012: 10 [*Buteo jamaicensis solitudinis'*]), **MLB** (Suárez 2020a: 28). *Buteo* sp.: **PPD** (Fischer & Stephan 1971b: 593 [*Buteo'*]).

TYTONIDAE.—*Tyto furcata* (Temminck, 1827): **PEA** (Suárez & Díaz-Franco 2003: 375 [*Tyto alba'*]), **ACP** (Arredondo 1972a: table 1 [*Tyto alba* ssp.'], 1972c: table 1 [*Tyto alba* ssp.'], 1975: 150 [*Tyto alba* ssp.'], 1976: 171 [*Tyto alba furcata'*], 1982: 40–41 [*Tyto alba* ssp.'], 1984: 19 [*Tyto alba furcata'*], 20 [*Tyto alba* ssp.']), **ASA** (Suárez 2000b: table 1 [*Tyto alba'*]), **YBL** (Jiménez Vázquez et al. 2005: 89 [*Tyto alba'*]), **MLB** (Suárez 2020a: 29).

STRIGIDAE.—^E*Margarobyas laurencii* (Sclater & Salvin, 1868): **PEA** (Suárez & Díaz-Franco 2011 [*Gymnoglaux laurencii'*], Zelenkov & González 2021 [*Margarobyas abronensis*, sp. nov.']), **ACP** (Arredondo 1972a: table 1 [*Gymnoglaux* sp.'], 1972c: table 1 [*Gymnoglaux* sp.'], 1975: 150 [*Gymnoglaux* sp.'], 1976: table 1 [*Gymnoglaux* sp.'], 1982: 41 [*Gymnoglaux* sp.'], 1984: 23 [*Gymnoglaux* sp.'], see *Gymnoglaux* sp. in section III), Arredondo & Arredondo 2002a: table 1 [*Gymnoglaux* sp.'], 2002b: table 1 [*Gymnoglaux* sp.']), **ASA**, **APR** and **ACH**

(WS unpubl.), **YBL** (Jiménez Vázquez *et al.* 2005: 98 [*Gymnoglaux lawrencii*']), **YCI** (Jiménez Vázquez & Valdés Ruiz 1995: 62 [*Gymnoglaux lawrencii*']), Jiménez Vázquez 1997a: 49 [*Gymnoglaux lawrencii* ssp.'], Rojas Consuegra *et al.* 2012: 10 [*Otus lawrencii* ssp.']), **YCN** (Orihuela *et al.* 2020b: table 4), **MCP** (Díaz Franco 1999: 13 [*Otus lawrencii*']), **MLB** (Suárez 2020a: 31), **MFJ** and **MAF** (*cf.* CLV), **VSM** (Arredondo Antúnez & Villavicencio Finalet 2006: tables I–II [*Gymnoglaux lawrencii*']). ^E**Glauucidium siju** (d'Orbigny, 1839): **PCA** (*cf.* Acevedo-González & Arredondo 1982: table 1, Arredondo 1984: 24–25), **PEA**, **ACP** and **ACH** (WS unpubl.), **YBL** (Jiménez Vázquez *et al.* 2005: 98), **YCI** (Jiménez Vázquez & Valdés Ruiz 1995: 62 [*Cf. Glauucidium*']), Rojas Consuegra *et al.* 2012: 10 [*Glauucidium siju* ssp.']). **Athene cunicularia** (Molina, 1782): **PEA** (Suárez 2004b: 156), **ACP** (*cf.* Suárez & Arredondo 1997: 101 [*Athene [Speotyto] cunicularia*']), **ASA** (Suárez 2000b: table 1 [*Speotyto cunicularia*']). **TROGONIDAE.**—^E**Priotelus temnurus** (Temminck, 1825): **PEA** (WS unpubl.), **ACP** and **ACH** (WS unpubl.), **MCP** (Díaz Franco 1999: 13 [*Priotelus temnurus* ssp.']). **TODIDAE.**—^E**Todus multicolor** Gould, 1837: **PEA** (Zelenkov & González 2020), **YBL** (Jiménez Vázquez *et al.* 2005: 98). **PICIDAE.**—**Melanerpes superciliaris** (Temminck, 1827): **YBL** (Jiménez Vázquez 1997a: 49 [*Melanerpes superciliaris* ssp.']), Jiménez Vázquez *et al.* 2005: 98). **Sphyrapicus varius** (Linnaeus, 1766): **YBL** (Jiménez Vázquez 1997a: 49 [*Sphyrapicus varius* ssp.']). ^E**Xiphidiopicus percussus** (Temminck, 1826): **PEA** (WS unpubl.), **ASA** (Suárez 2000b: table 1), **APR** and **ACH** (WS unpubl.), **YBL** (Jiménez Vázquez *et al.* 2005: 98). **Xiphidiopicus cf. percussus**: **ACP** (*cf.* Acevedo-González & Arredondo 1982: table 1, Arredondo 1984: 30–31). ^E**Colaptes fernandinae** Vigors, 1827: **ASA** (Suárez & Arredondo 1997: 101, Suárez 2000b: table 1). **Colaptes sp.**: **YBL** (Jiménez Vázquez *et al.* 2005: 98). **Campephilus principalis** (Linnaeus, 1758): **YCA** (Jiménez & Orihuela 2021: 170). **Picidae indet.** **YBL** (Jiménez Vázquez *et al.* 2005: 98 [*Picidae indeterminado*']). **FALCONIDAE.**—**Falco sparverius** Linnaeus, 1758: **ACP** (Suárez & Olson 2001a: 37), **ASA** (Suárez 2000b: table 1), **YBL** (Jiménez Vázquez 1997a: 49 [*Falco sparverius* ssp.']), **MLB** (Suárez 2020a: 38). **PSITTACIDAE.**—^E**Psittacara euops** (Wagler, 1832): **PEA** (Suárez & Díaz-Franco 2011 [*Aratinga euops*']), Suárez & Olson 2020a: 559), **YCN** (Orihuela *et al.* 2020b: 17, table 4 [*Psittacara eups* [sic]']). **Amazona leucocephala** (Linnaeus, 1758): **PEA** (Suárez & Díaz-Franco 2011), **YBL** (Arredondo & Arredondo 2002b: table 1 [*Ara cubensis*']), see *Ara tricolor* section III), **MCP** (Díaz Franco 1999: 13 [*Amazona leucocephala* ssp.']). **CORVIDAE.**—**Corvus palmarum** (Württemberg, 1835): **ASA** (Suárez & Arredondo 1997: 101 [*Corvus palmarum cf. minutus*']), Suárez 2000b: table 1 [*Corvus minutus*']), **MLB** (Suárez 2020a: 38). **Corvus nasicus** Temminck, 1826: **MLB** (Iturralde-Vinent *et al.* 2000: table 2, Suárez 2020a: 39). **Corvus cf. nasicus**: **MCE** (Orihuela 2013: 13). **Corvus sp.**: **YCI** (Rojas Consuegra *et al.* 2012: 11). **HIRUNDINIDAE.**—**Petrochelidon fulva** (Vieillot, 1808): **ASA** (Suárez & Arredondo 1997: 101 [*Hirundo fulva cavicola*']), Suárez 2000b: table 1), **YBL** (Jiménez Vázquez *et al.* 2005: 98). **TROGLODYTIDAE.**—^E**Ferminia cerverai** Barbour, 1926: **PEA** (Suárez & Olson 2020a: 559), **ACP** and **ASA** (WS unpubl.), **ISC** (Olson & Kurochkin 1987: 353 [*?Scytalopus* sp.']), **YBL** (Jiménez Vázquez *et al.* 2005: 99 [*?Scytalopus* sp.']), **CFO** (Olson & Kurochkin 1987: 354 [*?Scytalopus* sp.']). See *?Scytalopus* sp. section III. **MIMIDAE.**—**Mimus polyglottos** (Linnaeus, 1758): **YBL** (Jiménez Vázquez *et al.* 2005: 99). **Mimus cf. polyglottos**: **ACP** (*cf.* Acevedo-González & Arredondo 1982: table 1 [*M[imus]. cf. polyglottos orpheus*']), Arredondo 1984: 33–34 [*Mimus cf. polyglottos orpheus*']). **Mimus sp.**: **ASA** (Suárez 2000b: table 1). **PASSERELLIDAE.**—^E**Torreornis inexpectata** Barbour & Peters, 1927: **PEA** (Suárez 2004b: 156), **ACP** (*cf.* Pregill & Olson 1981: 85, Acevedo-González & Arredondo 1982: table 1 [*Torreornis* sp.']), Suárez & Arredondo 1997: 101), **ASA** (Suárez 2000b: table 1), **YBL** (Jiménez Vázquez *et al.* 2005: 99), **MCP** (Díaz Franco 1999: 13 [*Torreornis inexpectata* ssp.']), **SPH** (Suárez MS), **SPS** (Suárez 2004b: 157), **SCI** (*cf.* Pregill & Olson 1981: 85, González Alonso *et al.* 1986: 7). **ICTERIDAE.**—**Dolichonyx**

oryzivorus (Linnaeus, 1758): PPD (Fischer & Stephan 1971b: 597 [*Dolichonyx kruegeri*, n. sp.' (part)], Brodkorb 1978: 201 [*Agelaius phoeniceus*'], Acevedo-González & Arredondo 1982: table 1 [*A[gelaius]. phoeniceus assimilis*'], Arredondo 1984: 31 [*Agelaius phoeniceus assimilis*']. See *Dolichonyx kruegeri* section III), ACP, ASA and YIN (WS unpubl.), SCI (Olson & Hilgartner MS). *Sturnella magna* (Linnaeus, 1758): ASA (Suárez & Arredondo 1997: 101 [*Sturnella magna hippocrepis*'], Suárez 2000b: table 1), YBL (Jiménez Vázquez *et al.* 2005: 99). ^E*Icterus melanopsis* (Wagler, 1829): PPD (Fischer & Stephan 1971b: 597 [*Dolichonyx kruegeri*, n. sp.' (part), see section III]). *Agelaius humeralis* (Vigors, 1827): ACP (cf. Acevedo-González & Arredondo 1982: table 1, Arredondo 1984: 32). *Agelaius* sp.: YBL (Jiménez Vázquez *et al.* 2005: 99). ^E*Ptiloxena atroviolacea* (d'Orbigny, 1839): ACP and HCI (cf. Acevedo-González & Arredondo 1982: table 1 [*A[gelaius]. atroviolaceus*'], Arredondo 1984: 32–33 [*Dives* cf. *atroviolaceus*']), YBL (Jiménez Vázquez *et al.* 2005: 99 [*Dives atroviolacea*']), YCI (Jiménez Vázquez & Valdés Ruiz 1995: 62 [*Dives atroviolacea* [sic]'], Rojas Consuegra *et al.* 2012: 11 [*Dives atroviolacea*']). **THRAUPIDAE.**—*Tiaris* sp.: YBL (Jiménez Vázquez *et al.* 2005: 99). ^E*Melopyrrha nigra* (Linnaeus, 1758): YBL (Jiménez Vázquez *et al.* 2005: 99).

Notes.—The woodpeckers *Xiphidiopicus percussus* and *Colaptes fernandinae*, considered Cuban endemics in the modern era (see Kirkconnell *et al.* 2020) have been identified, or material referred to them, from Quaternary deposits in the Bahamas (Steadman & Franklin 2020).

Acknowledgements

The following persons deserve special mention for their support and help: the late Storrs L. Olson, the late Oscar Arredondo, Steven D. Emslie, Stephen Díaz Franco, Osvaldo Jiménez Vázquez, Carlos Arredondo Antúnez, Antonio Suárez, Aida Duque, Yuriel Urrea, the late James W. Wiley, Helen F. James, Orlando H. Garrido, Arturo Kirkconnell, Jesús Martínez, Yadira Alegre, Gabino La Rosa, Kenneth Campbell Jr., Fritz Hertel, Christopher Milensky, Brian Schmidt, Steven J. Parry, William Hilgartner, the late Gilberto Silva Taboada, Lazaro W. Viñola, Manuel Iturralde Vinent, Eduardo Abreu, Néstor Gómez, Lorenzo Morales, Raul Villavicencio Finalet, Joao G. Martínez, René Dekker, Douglas Causey, Aisling Farrell, George Barrowclough, Paul Sweet, Peter Capainolo, Kevin Seymour, Gary Graves, Brad Millen, Allan Baker, Leosdany Lima, Irving Himel, Freda Papoff, Janet Hinshaw, Julie Craves, Darrin O'Brien, Douglas Causey, Pamela Rasmussen, Luis M. Díaz, Luis M. Rodríguez, Angela Ortega, Catherine Levy, Ascanio Rincón, Fernando Rojas, Paolo Viscardi, Angel Nieves, Seriocha Amaro and Robert K. McAfee. The North American institutions and collections were visited thanks to funding provided by the Virginia Y. Hendry Fund, Alexander Wetmore Endowment Fund (USNM) and the Frank M. Chapman Memorial Fund (AMNH). The manuscript was greatly improved through critical review by Steven D. Emslie, Stephen Díaz Franco, Julian P. Hume, Helen F. James and Guy Kirwan.

References:

- Acevedo González, M. 1971. Geomorfología de la región de Sumidero, Sierra de los Órganos, Pinar del Río, Cuba. *Tecnológica* 9(3–4): 33–54.
- Acevedo-González, M. & Arredondo, O. 1982. Paleozoogeografía y geología del Cuaternario de Cuba: características y distribución geográfica de los depósitos con restos de vertebrados. Pp. 59–70 in *Resúmenes IX Jornada Científica del Instituto de Geología y Paleontología, La Habana*.
- Acevedo González, M., Arredondo, O. & González Gotera, N. 1975. *La Cueva del Túnel*. Pueblo y Educación, La Habana.
- Agnolin, F. 2009. El registro fósil de *Ciconia lydekkeri* Ameghino, 1891 [sic] en el Pleistoceno de Sudamérica. *Stud. Geol. Salmant.* 45(1): 53–58.
- Aguayo, C. G. 1950. Observaciones sobre algunos mamíferos cubanos extinguidos. *Bol. Hist. Nat. Soc. 'Felipe Poey'* 1: 121–134.
- Aguayo, C. G. & Howell Rivero, L. 1955. Sinopsis de los mamíferos cubanos. *Circ. Mus. Bibl. Zool. La Habana*: 1283–1324.
- Alcover, J. A., Bover, P. & Seguí, B. 1999. Una aproximació a la paleoecología de les illes. Pp. 169–204 in Alcover, J. A. (ed.) *Ecologia de les illes. Monografies de la Societat d'Història Natural de les Balears* 6.
- Alegre Lago, Y. 2002. Análisis morfofuncional de la locomoción del Búho Gigante *Ornimegalonyx oteroi* (Aves: Strigidae) del Cuaternario de Cuba. Tesis de diploma. Facultad de Biología, Univ. de La Habana.
- Alvarenga, H. M. F. & Olson, S. L. 2004. A new genus of tiny condor from the Pleistocene of Brazil (Aves: Vulturidae). *Proc. Biol. Soc. Wash.* 117: 1–9.

- Álvarez Conde, J. 1951. *Los perezosos cubanos; sus relaciones con el indio*. Imprenta La Milagrosa, La Habana.
- Álvarez Conde, J. 1957. Datos biográficos de los principales investigadores que han realizados [sic] estudios geológicos, mineralógicos y paleontológicos en Cuba. Pp. 187–248 in Álvarez Conde, J. (ed.) *Historia de la geología, mineralogía y paleontología en Cuba*. Junta Nacional de Arqueología y Etnología, La Habana.
- Ameghino, F. 1889. *Contribución al conocimiento de los mamíferos fósiles de la República Argentina*. Ac. Nac. Cienc. Rep. Arg. (Córdoba).
- American Ornithologists' Union (AOU). 1998. *Check-list of North American birds*. Seventh edn. American Ornithologists' Union, Washington DC.
- Anthony, H. E. 1917. A new rabbit and a new bat from Neotropical regions. *Bull. Amer. Mus. Nat. Hist.* 37: 335–337.
- Anthony, H. E. 1919. Mammals collected in eastern Cuba in 1917. With descriptions of two new species. *Bull. Amer. Mus. Nat. Hist.* 41: 625–643.
- Aranda, E., Viñola-López, L. W. & Álvarez-Lajonchere, L. 2020. New insights on the Quaternary fossil record of Isla de la Juventud, Cuba. *J. South Amer. Earth Sci.* 102: 102656.
- Aranda, E., Martínez-López, J. G., Jiménez, O., Alemán, C. & Viñola, L. W. 2017. Nuevos registros fósiles de vertebrados terrestres para Las Llanadas, Sancti Spiritus, Cuba. *Novit. Carib.* 11: 115–123.
- Arredondo Antúnez, C. 1997. Composición de la fauna de vertebrados terrestres extintos del Cuaternario de Cuba. *Rev. Elec. Órbita Cient., I.S.P.E.J.V.* 8(2): 1–13.
- Arredondo Antúnez, C. 2007. Oscar Paulino Arredondo de la Mata [obituary]. *Orn. Neotrop.* 18: 149–154.
- Arredondo, C. & Arredondo, O. 2000. Nuevo género y especie de perezoso (Edentata: Megalonychidae) del Pleistoceno de Cuba. *Rev. Biol.* 14: 66–72.
- Arredondo Antúnez, C. & Arredondo de la Mata, O. 2012. Geographic distribution and other considerations on the species of the Megalonychidae in Cuba. Pp. 295–303 in Borroto-Páez, R., Woods, C. A. & Sergile, F. (eds.) *Terrestrial mammals of the West Indies, Contributions*. Florida Museum of Natural History & Wacahoota Press, Gainesville, FL.
- Arredondo Antúnez, C. & Villavicencio Finalet, R. 2006 [for 2004]. Tafonomía del depósito arqueológico Solapa del Megalocnus en el noroeste de Villa Clara, Cuba. *Rev. Biol.* 18: 160–172.
- Arredondo, O. 1954. Toda una fauna extinguida hallada en las montañas de Pinar del Río. *Bohemia* 46(35): 46–48, 92.
- Arredondo de la Mata, O. 1955. Contribuciones a la paleontología de la Sociedad Espeleológica de Cuba. *Bol. Soc. Espeleol. Cuba* 1(2): 3–31.
- Arredondo, O. 1956. Como identificar los restos óseos de algunos mamíferos cubanos extinguidos que resultan de suma importancia en las investigaciones arqueológicas y antropológicas. *Bol. Soc. Espeleol. Cuba* 2(5): 4–10.
- Arredondo, O. 1957a. El trágico fin de los vampiros cubanos. *Bohemia* 49(43): 70–72, 84–85.
- Arredondo, O. 1957b. Origen y antigüedad de nuestra fauna extinguida y la unión de Cuba con el continente americano. *El Cartero Cubano* 16(12): 10–13.
- Arredondo, O. 1958. Aves gigantes de nuestro pasado prehistórico. *El Cartero Cubano* 17(7): 10–12.
- Arredondo, O. 1961. Descripciones preliminares de dos nuevos géneros y especies de edentados del Pleistoceno cubano. *Bol. Grupo Expl. Cient.* 1(1): 19–40.
- Arredondo, O. 1964. La lechuza gigante de la prehistoria cubana. *Bohemia* 56(27): 18–21, 90.
- Arredondo, O. 1970a. Nueva especie de ave pleistocénica del orden Accipitriformes (Accipitridae) y nuevo género para las Antillas. *Cienc. Biol. Univ. La Habana* 4(8): 1–19.
- Arredondo, O. 1970b. Dos nuevas especies subfósiles de mamíferos (Insectivora: Nesophontidae) del Holoceno precolombino de Cuba. *Mem. Soc. Cienc. Nat. La Salle* 30(86): 122–152.
- Arredondo, O. 1971. El Águila Cubana de la prehistoria. *Bohemia* 63(6): 94–97.
- Arredondo, O. 1972a. Nueva especie de ave fósil (Strigiformes: Tytonidae) del Pleistoceno superior de Cuba. *Bol. Soc. Venez. Cienc. Nat.* 29(122–123): 415–431.
- Arredondo, O. 1972b. Especie nueva de lechuza gigante (Strigiformes: Tytonidae) del Pleistoceno cubano. *Bol. Soc. Venez. Cienc. Nat.* 30(124–125): 129–140.
- Arredondo, O. 1972c [for 1971]. Nuevo género y especie de ave fósil (Accipitriformes: Vulturidae) del Pleistoceno de Cuba. *Mem. Soc. Cienc. Nat. La Salle* 31(90): 309–323.
- Arredondo, O. 1975. Distribución geográfica y descripción de algunos huesos de *Ornimegalonyx oteroi* Arredondo, 1958 (Strigiformes: Strigidae) del Pleistoceno superior de Cuba. *Mem. Soc. Cienc. Nat. La Salle* 35(101): 133–190.
- Arredondo, O. 1976. The great predatory birds of the Pleistocene of Cuba. Pp. 169–187 in Olson, S. L. (ed.) *Collected papers in avian paleontology honoring the 90th birthday of Alexander Wetmore*. *Smiths. Contrib. Paleobiol.* 27.
- Arredondo, O. 1982. Los Strigiformes fósiles del Pleistoceno cubano. *Bol. Soc. Venez. Cienc. Nat.* 37(140): 33–55.
- Arredondo, O. 1984. Sinopsis de las aves halladas en depósitos fosilíferos pleisto-holocénicos de Cuba. *Rep. Invest. Inst. Zool.* 17: 1–35.
- Arredondo, O. 1996. Lista de las especies extinguidas de vertebrados halladas en las provincias orientales de Cuba. *Garciana* 24–25: 1–2.

- Arredondo, O. & Arredondo, C. 2002a [for 1999]. Nuevos género y especie de ave fósil (Falconiformes: Accipitridae) del Cuaternario de Cuba. *Poeyana* 470–475: 9–14.
- Arredondo, O. & Arredondo, C. 2002b [for 1999]. Nueva especie de ave (Falconiformes: Teratornithidae) del Pleistoceno de Cuba. *Poeyana* 470–475: 15–21.
- Arredondo de la Mata, O. & Arredondo Antúnez, C. 2012. West Indian canids and prey bird ecological control on the Quaternary mammals of Cuba. Pp. 287–293 in Borroto-Páez, R., Woods, C. A. & Sergile, F. (eds.) *Terrestrial mammals of the West Indies, Contributions*. Florida Museum of Natural History & Wacahoota Press, Gainesville, FL.
- Arredondo, O. & González Gotera, N. 1982. Nuevo hallazgo de *Pulsatrix arredondo* Brodkorb (Aves: Strigidae) del Pleistoceno de Cuba. *Misc. Zool.* 16: 1–2.
- Arredondo, O. & Rivero, M. 1997. Nuevo género y especie de Megalonychidae del Cuaternario cubano. *Rev. Biol.* 11: 105–112.
- Arredondo, O. & Olson, S. L. 1994. A new species of owl of the genus *Bubo* from the Pleistocene of Cuba (Aves: Strigiformes). *Proc. Biol. Soc. Wash.* 107: 436–444.
- Arredondo, O. & Varona, L. S. 1974. Nuevos género y especie de mamífero (Carnivora: Canidae) del Cuaternario de Cuba. *Poeyana* 131: 1–12.
- Bangs, O. 1903. New birds from Cuba and the Isle of Pines. *Proc. New England Zool. Cl.* 4: 89–92.
- Bangs, O. & Zappey, W. R. 1905. Birds of the Isle of Pines. *Amer. Natur.* 39: 179–215.
- Barbour, T. 1926. A remarkable new bird from Cuba. *Proc. New England Zool. Cl.* 9: 73–75.
- Barbour, T. & Peters, J. L. 1927. Two more remarkable new birds from Cuba. *Proc. New England Zool. Cl.* 9: 95–97.
- Bechstein, U. 1793. *Johann Lathams allgemeine Uebersicht der Vögel*, Bd. 1. A. C. Weigels & Schneiders, Nürnberg.
- Bechstein, U. 1811. *Johann Lathams allgemeine Uebersicht der Vögel*, Bd. 4. A. C. Weigels & Schneiders, Nürnberg.
- Berry, E. W. 1934. Pleistocene plants from Cuba. *Bull. Torrey Bot. Cl.* 61: 237–240.
- Bolufé Torres, R. 2016. Mamíferos del Cuaternario y su vinculación con los sitios arqueológicos aborígenes cubanos. Estudio del caso Cueva Calero. *Geoinformativa* 10(1): 37–44.
- Bonaparte, C. L. 1838. *A geographical and comparative list of the birds of Europe and North America*. John Van Voorst, London.
- Bond, J. 1957. Second supplement to the *Check-list of birds of the West Indies* (1956). Academy of Natural Sciences, Philadelphia.
- Bond, J. 1964. Ninth supplement to the *Check-list of birds of the West Indies* (1956). Academy of Natural Sciences, Philadelphia.
- Brehm, C. L. 1842–55. *Monographie der Papageien*. August Schmid, Jena.
- Brodkorb, P. 1959. Pleistocene birds from New Providence Island, Bahamas. *Bull. Fla. State Mus.* 4: 349–371.
- Brodkorb, P. 1961. Recently described birds and mammals from Cuban caves. *J. Paleontol.* 35: 633–635.
- Brodkorb, P. 1963. Catalogue of fossil birds [:] part 1 (Archaeopterygiformes through Ardeiformes). *Bull. Fla. State Mus.* 7: 179–293.
- Brodkorb, P. 1964. Catalogue of fossil birds: part 2 (Anseriformes through Galliformes). *Bull. Fla. State Mus.* 8: 195–335.
- Brodkorb, P. 1967. Catalogue of fossil birds: part 3 (Ralliformes, Ichthyornithiformes, Charadriiformes). *Bull. Fla. State Mus.* 11: 99–220.
- Brodkorb, P. 1969 [for 1968]. An extinct Pleistocene owl from Cuba. *Quart. J. Florida Acad. Sci.* 31: 112–114.
- Brodkorb, P. 1971. Catalogue of fossil birds: part 4 (Columbiformes through Piciformes). *Bull. Fla. State Mus.* 15: 163–266.
- Brodkorb, P. 1978. Catalogue of fossil birds [:] part 5 (Passeriformes). *Bull. Fla. State Mus.* 23: 139–228.
- Brown, B. 1913. Some Cuban fossils. A hot spring yields up the bones of animals that lived before the advent of man. *Amer. Mus. J.* 13: 221–228.
- Campbell, K. E. 1979. The non-passerine Pleistocene avifauna of the Talara Tar Seeps, northwestern Peru. *Life Sci. Contrib. Roy. Ontario Mus.* 118: 1–203.
- Campbell, K. E. 1980. A review of the Rancholabrean avifauna of the Itchtucknee River, Florida. *Contrib. Sci. Nat. Hist. Mus. Los Angeles Co.* 330: 119–129.
- Carlson, L. A. & Steadman, D. W. 2009. Faunal exploitation at two prehistoric inland villages from different time periods in Puerto Rico. *J. Island & Coastal Archaeol.* 4: 207–222.
- Castellanos, E. S. 1968. Halla restos fósiles expedición científica cubano-alemana. *El Mundo del Domingo (abril 14)*: 4–5.
- Chapman, F. M. 1917. Descriptions of new birds from Santo Domingo and remarks on others in the Brewster-Sanford collection. *Bull. Amer. Mus. Nat. Hist.* 37: 327–334.
- Chawner, W. D. 1932. Geology and petroleum possibilities of northern Matanzas and Santa Clara provinces. Oficina Nacional, Recursos Minerales, Inv. 2520. Unpubl.
- Córdova Medina, A. P., Crespo Díaz, R. & Jiménez Vázquez, O. 1997. Importancia arqueológica y zoológica del sitio Solapa del Sílex. *El Caribe Arqueol.* 2: 78–83.
- Cory, C. B. 1883. Descriptions of three new species of birds from Santo Domingo. *Quart. J. Boston Zool. Soc.* 2: 45–46.

- Cuello, J. P. 1988. Lista de las aves fósiles de la región neotropical y las islas antillanas. *Paula-Coutiana* 2: 3–79.
- d'Aubenton, E.-L. 1779. *Planches enluminées d'histoire naturelle*, vol. 7. Paris.
- d'Orbigny, A. D. 1839. Aves. Pp. [1]–220 in de la Sagra, R. (ed.) *Historia física política y natural de la isla de Cuba*, pt. 2, vol. 3. Arthus Bertrand, Paris.
- Díaz Franco, S. 1999. Dos registros nuevos de aves endémicas en depósitos fosilíferos de Cuba. *El Pitirre* 12: 12–13.
- Díaz-Franco, S. 2004. Type specimens of fossil vertebrates housed in the Museo Nacional de Historia Natural, Cuba. *Rev. Biol.* 18: 155–159.
- Downer, A. & Sutton, R. 1990. *Birds of Jamaica*. Cambridge Univ. Press, Cambridge, UK.
- Dykstra, C. R., Hays, J. L. & Crocoll, S. T. 2020. Red-shouldered Hawk (*Buteo lineatus*), version 1.0. In Poole, A. F. (ed.) *Birds of the world*. Cornell Lab. of Ornithology, Ithaca, NY. <https://doi.org/10.2173/bow.reshaw.01>.
- Emslie, S. D. 1988. The fossil history and phylogenetic relationships of condors (Ciconiiformes: Vulturidae) in the New World. *J. Vert. Paleontol.* 8: 212–228.
- Emslie, S. D. 1998. Avian community, climate, and sea-level changes in the Plio-Pleistocene of the Florida peninsula. *Orn. Monogr.* 50: 1–113.
- Feduccia, A. 1980. A thick-knee (Aves: Burhinidae) from the Pleistocene of North America, and its bearing on ice age climates. *Contrib. Sci. Nat. Hist. Mus. Los Angeles Co.* 330: 115–118.
- Figueredo, A. E. 2011. Patrones de asentamiento y uso del paisaje en el carso antillano por los agroalfareros prehistóricos. *Cuba Arqueol.* IV(1): 9–23.
- Fischer, K.-H. 1968. Ein flugunfähiger kranich aus dem Pleistozän von Cuba. *Der Falke* 15: 270–271.
- Fischer, K. 1970. Quartärpaläontologische Grabungsexpedition 1967 in Cuba. *Wiss. Zeitsch. Humboldt-Univ. Berlin, Math.-Nat. R.* 19: 232–236.
- Fischer, K. 1977. Quartäre Mikromammalia Cubas, vorwiegend aus der Höhle San José de la Lamas, Santa Fé, Provinz Habana. *Z. geol. Wiss.* 5: 213–255.
- Fischer, K. & Stephan, B. 1971a. Ein flugunfähiger Kranich (*Grus cubensis* n. sp.) aus dem Pleistozän von Kuba — eine Osteologie der Familie der Kraniche (Gruidae). *Wiss. Zeitsch. Humboldt-Univ. Berlin, Math.-Nat. R.* 20: 541–592.
- Fischer, K. & Stephan, B. 1971b. Weitere Vogelreste aus dem Pleistozän der Pio-Domingo-Höhle in Kuba. *Wiss. Zeitsch. Humboldt-Univ. Berlin, Math.-Nat. R.* 20: 593–607.
- Garrido, O. H. 1971. Nueva raza del arriero, *Saurothera merlini* (Aves: Cuculidae) para Cuba. *Poeyana* 87: 1–12.
- Garrido, O. H. 2003. A new subspecies of the Least Pauraque (*Siphonorhis brewsteri*) (Aves: Caprimulgidae) from Gonave island, Haiti, with comments on the genus. *Solenodon* 3: 61–67.
- Gmelin, J. F. 1788. *Systema naturae*, vol. 1(1). Georg Emanuel Beer, Leipzig.
- Gmelin, J. F. 1789. *Systema naturae*, vol. 1(2). Georg Emanuel Beer, Leipzig.
- Goldberg, S. L., Novacek, M. J. & Alayón, G. 2017. *The history of scientific relations between Cuba and the American Museum of Natural History (AMNH), 160 years of collecting and collaborating (1857–2017)*. Amer. Mus. Nat. Hist. Spec. Publ.
- González Alonso, H. 2011. Aves. Pp. 270–291 in Larramendi, J. A. & Viña Dávila, N. (eds.) *Rostros en peligro. Especies cubanas amenazadas*. Ed. Polymita, Ciudad de Guatemala.
- González Alonso, H. 2012. Aves: Introducción. Pp. 207–208 in González Alonso, H., Rodríguez Schettino, L., Rodríguez, A., Mancina, C. A. & Ramos García, I. (eds.) *Libro Rojo de los vertebrados de Cuba*. Ed. Academia, La Habana.
- González Alonso, H., González Bermúdez, F. & Quesada, M. 1986. Distribución y alimentación del Cabrerito de la Ciénaga (*Torreornis inexpectata*) (Aves: Fringillidae). *Poeyana* 310: 1–24.
- Gundlach, J. 1876. *Contribución a la ornitología cubana*. Imprenta La Antilla, La Habana.
- Gundlach, J. 1893. *Ornitología cubana, o catálogo descriptivo de todas las especies tanto indígenas como de paso anual o accidental observadas en 53 años*. Archivos de la Policlínica, Imprenta La Moderna, La Habana.
- Gutiérrez Domech, M. R. 2010. Protecting the Cuban geological heritage. *Open J. Geol.* 4: 1–14.
- Gutiérrez Domech, M. R., Balado Piedra, E. J., Delgado Carballo, I., Oliva Martín, A., Cardona Muñiz, C. L. & Domínguez Samalea, Y. 2018. Las cuevas de Paredones y del túnel y la caverna de Pío Domingo: principales yacimientos fosilíferos de vertebrados del Pleistoceno en Cuba occidental. *Geoinformativa* 12(2): 37–48.
- Hecht, M. K. 1955. The comparison of recent and fossil amphibian, reptilian, and mammalian faunas in the Bahamas. *Yb. Amer. Philos. Soc.* 1954: 133–135.
- Herrera Fritot, R. 1957. Lección introductiva sobre la Arqueología antillana en el Museo Nacional. Pp. 30–40 in *Los museos y la educación*. Publicación del Comité Cubano de Museos, La Habana.
- Herrera-Uria, J., Aranda, E., Gutiérrez, E., Rojas, R., Garrido, O. H., Alayón, G. & Díaz, L. M. 2015. Type specimens housed in the National Museum of Natural History of Cuba. *Solenodon* 12: 84–123.
- Holland, W. J. 1917. The mammals of the Isle of Pines. *Ann. Carnegie Mus.* 11: 356–358.
- Howard, H. 1929. The avifauna of Emeryville Shellmound. *Univ. Calif. Publ. Zool.* 32: 301–394.
- Howard, H. 1932. Eagles and eagle-like vultures of the Pleistocene of Rancho La Brea. *Carnegie Inst. Wash. Publ.* 429: 1–82.
- Howard, H. 1935. The Rancho La Brea Wood Ibis. *Condor* 37: 251–253.

- Howard, H. 1942. A review of the American fossil storks. *Carnegie Inst. Wash. Publ.* 530: 187–203.
- Howard, H. 1946. A review of the Pleistocene birds of Fossil Lake, Oregon. *Carnegie Inst. Wash. Publ.* 551: 141–195.
- Hume, J. P. 2017. *Extinct birds*. Second edn. Bloomsbury, London.
- Hunt, A. P. & Lucas, S. G. 2018. The record of sloth coprolites in North and South America: implications for terminal Pleistocene extinctions. Pp. 277–298 in Lucas, S. G. & Sullivan, R. M. (eds.) Fossil record 6. *New Mex. Mus. Nat. Hist. Sci. Bull.* 79.
- Iturralde-Vinent, M. 1998. A small “Rancho La Brea” site discovered in Cuba, Manantiales de Asfalto de San Vicente: a fossiliferous tar spring. *Cocuyo* 7: 3–4.
- Iturralde-Vinent, M. A., MacPhee, R. D. E., Díaz Franco, S. & Rojas Consuegra, R. 1999. A small “Rancho La Brea” site discovered in Cuba. *J. Geol. Soc. Jamaica* 33: 20.
- Iturralde-Vinent, M. A., MacPhee, R. D. E., Díaz-Franco, S., Rojas-Consuegra, R., Suárez, W. & Lomba, A. 2000. Las Breas de San Felipe, a Quaternary fossiliferous asphalt seep near Martí (Matanzas Province, Cuba). *Carib. J. Sci.* 36: 300–313.
- International Commission on Zoological Nomenclature (ICZN). 1999. *International code of zoological nomenclature*. Fourth edn. International Trust for Zoological Nomenclature, London.
- Jiménez Vázquez, O. 1997a. Seis nuevos registros de aves fósiles en Cuba. *El Pitirre* 10: 49.
- Jiménez Vázquez, O. 1997b. La Biaya o Bambiaya de los indocubanos. *El Pitirre* 10: 96–97.
- Jiménez-Vázquez, O. 2001. Registros ornitológicos en residuarios de dieta de aborígenes precerámicos cubanos. *El Pitirre* 14: 120–126.
- Jiménez Vázquez, O. 2005. La cueva del Infierno: tafonomía de un sitio arqueológico del arcaico de Cuba. *Bol. Gabinete Arqueol.* 4(4): 73–87.
- Jiménez Vázquez, O. & Arrazcaeta Delgado, R. 2008. Las aves en la arqueología histórica de La Habana Vieja. *Bol. Gabinete Arqueol.* 7(7): 17–29.
- Jiménez Vázquez, O. & Arrazcaeta Delgado, R. 2015. Las aves y su relación con las culturas precolombinas de Cuba. *Bol. Gabinete Arqueol.* 11(11): 141–157.
- Jiménez, O. & Orihuela, J. 2021. Nuevos hallazgos de aves en contextos paleontológicos y arqueológicos de Cuba. *Novit. Carib.* 17: 163–176.
- Jiménez Vázquez, O. & Valdés Ruiz, P. 1995. Los vertebrados fósiles de la Cueva del Indio, San José de las Lajas, Habana, Cuba. Pp. 62–63 in Resúmenes Congr. Intern. LV Aniversario de la Sociedad Espeleológica de Cuba, La Habana.
- Jiménez Vázquez, O., Condis, M. M. & García Cancio, E. 2005. Vertebrados post-glaciales en un residuario fósil de *Tyto alba scopoli* [sic] (Aves: Tytonidae) en el occidente de Cuba. *Rev. Mex. Mastozool.* 9: 85–112.
- Jiménez Vázquez, O., Jaimez Salgado, E. & Crespo Díaz, R. 1995. Estudio de las espeluncas habaneras conocidas como “Cuevas Blancas”. Cuba. Pp. 24–25 in Resúmenes Congr. Intern. LV Aniversario de la Sociedad Espeleológica de Cuba, La Habana.
- Johansson, U. S., Ericson, P. G. P., Blom, M. P. K. & Irestedt, M. 2018. The phylogenetic position of the extinct Cuban Macaw *Ara tricolor* based on complete mitochondrial genome sequences. *Ibis* 160: 666–672.
- Jones O’Day, S. 2002. Late prehistoric Lucayan occupation and subsistence on Middle Caicos Island, northern West Indies. *Carib. J. Sci.* 38: 1–10.
- Jones, W. W., Rinderknecht, A., Migotto, R. & Blanco, R. E. 2013. Body mass estimations and paleobiological inferences on a new species of large caracara (Aves, Falconidae) from the late Pleistocene of Uruguay. *J. Vert. Paleontol.* 87: 151–158.
- Jull, A. J. T., Iturralde-Vinent, M., O’Malley, J. M., MacPhee, R. D. E., McDonald, H. G., Martin, P. S., Moody, J. & Rincón, A. 2004. Radiocarbon dating of extinct fauna in the Americas recovered from tar pits. *Nucl. Instrum. Methods Phys. Res. B* 223–224: 668–671.
- Kaup, J. J. 1852. Monograph of the owls-Strigidae. Part 2. Pp. 103–122 in Jardine, W. (ed.) *Contributions to Ornithology for 1852*. W. H. Lizars, Edinburgh.
- Keith, A. R., Wiley, J. W., Latta, S. C. & Ottenwalder, J. A. 2003. *The birds of Hispaniola: an annotated checklist*. BOU Checklist No. 21. British Ornithologists’ Union & British Ornithologists’ Club, Tring.
- Kilmer, J. A. & Steadman, D. W. 2016. A middle Pleistocene bird community from Saint Lucie County, Florida. *Bull. Fla. State Mus.* 55: 1–38.
- Kirkconnell, A., Kirwan, G. M., Garrido, O. H., Mitchell, A. D. & Wiley, J. W. 2020. *The birds of Cuba: an annotated checklist*. BOC Checklist No. 26. British Ornithologists’ Club, Tring.
- Koopman, K. F. 1958. A fossil vampire bat from Cuba. *Breviora* 90: 1–4.
- Kuhl, H. 1820. *Conspetus Psittacorum*. *Nova Acta Phys.-Med.* 10: 1–104.
- Kulp, J. L., Tryon, L. E., Eckelman, W. R. & Snell, W. A. 1952. Lamont natural radiocarbon measurements, II. *Science* 116(3016): 409–414.
- Kurotchkin [sic = Kurochkin], E. & Mayo, N. A. 1973. Las lechuzas gigantes del Pleistoceno Superior de Cuba. *Actas, Res., Com. y Notas V Consejo Cient., Inst. Geol. A.C.C.* 3: 56–60.
- Latta, S., Rimmer, C., Keith, A., Wiley, J., Raffaele, H., MacFarland, K. & Fernández, E. 2006. *Birds of the Dominican Republic and Haiti*. Princeton Univ. Press.

- Lawrence, G. N. 1856. Descriptions of new species of birds of the genera *Chordeiles*, Swainson, and *Poliophtila*, Sclater. *Ann. Lyc. Nat. Hist. NY* 6: 165–169.
- Lawrence, G. N. 1860. Notes on some Cuban birds, with descriptions of new species. *Ann. Lyc. Nat. Hist. NY* 7: 247–275.
- Levaillant, F. O. 1801–05. *Histoire naturelle des perroquets*, 2 vols. Levrault frères & Levrault, Schoell & Co. Paris.
- Levy, C. 2008. History of ornithology in the Caribbean. *Orn. Neotrop.* 19 (suppl.): 415–426.
- Levy, C. 2013. William Thomas March, 1804–1872. *BirdLife Jamaica Broadsh.* 96 [originally published 2012; updated version https://www.academia.edu/3993413/William_Thomas_March_1804_1872].
- Lichtenstein, H. [= M. H. C.] 1819. Die Werke von Marcgrave und Piso über die Naturgeschichte Brasiliens, erläutert aus den wieder aufgefundenen Original-Abbildungen. Pp.155–178 in *Abh. Königl. Akad. Wiss. 1816–1817*. Berlin.
- Linnaeus, C. 1758. *Systema naturae*, vol. 1. Tenth edn. Laurentii Salvii, Holmiae.
- Linnaeus, C. 1766. *Systema naturae*, vol. 1. 12th edn. Laurentii Salvii, Holmiae.
- Livezey, B. C. 1998. A phylogenetic analysis of the Gruiformes (Aves) based on morphological characters, with an emphasis on the rails (Rallidae). *Philos. Trans. Roy. Soc. Lond.* 353: 2077–2151.
- Livezey, B. C. 2003. Evolution of flightlessness in rails (Gruiformes: Rallidae): phylogenetic, ecomorphological, and ontogenetic perspectives. *Orn. Monogr.* 53: 1–654.
- Longrich, N. R. & Olson, S. L. 2011. The bizarre wing of the Jamaican flightless ibis *Xenicibis xympthecus*: a unique vertebrate adaptation. *Proc. Roy. Soc. B Biol. Sci.* 278(1716): 2333–2337.
- Louchart, A. 2005. Integrating the fossil record in the study of insular body size evolution: example of owls (Aves, Strigiformes). Pp. 155–174 in Alcover, J. A. & Bover, P. (eds.) *Proc. Intern. Symp. "Insular vertebrate evolution: the palaeontological approach"*. Monografies de la Societat d'Història Natural de les Balears 12.
- MacPhee, R. D. E. & Iturralde-Vinent, M. A. 1994. First Tertiary land mammal from Greater Antilles: an early Miocene sloth (Xenarthra, Megalonychidae) from Cuba. *Amer. Mus. Novit.* 3094: 1–13.
- MacPhee, R. D. E. & Iturralde-Vinent, M. A. 1995. Origin of the Greater Antillean land mammal fauna, 1: new Tertiary fossils from Cuba and Puerto Rico. *Amer. Mus. Novit.* 3141: 1–30.
- March, W. T. 1863. Notes on the birds of Jamaica. *Proc. Acad. Nat. Sci. Phil.* 15: 150–154.
- Martínez-López, J. G. 2019. Natural and anthropogenic factors as taphonomic agents in the differential preservation of paleontological remains from the fossil deposit "Las Llanadas", central Cuba. *Novit. Carib.* 13: 92–114.
- Matthew, W. D. 1931. Genera and new species of ground sloths from the Pleistocene of Cuba. *Amer. Mus. Novit.* 511: 1–5.
- Mayo, N. A. 1980. Nueva especie de *Neocnus* (Edentata: Megalonychidae de Cuba) y consideraciones sobre la evolución, edad y paleoecología de las especies de este género. *Actas II Congr. Argentino Paleontología y Bioestratigrafía y I Congr. Latinoamericano Paleontología* 3: 223–236.
- Mayr, G. 2019. Hypotarsus morphology of the Ralloidea supports a clade comprising *Sarothrura* and *Mentocrex* to the exclusion of *Canirallus*. *Acta Orn.* 54: 51–58.
- Mayr, G., Lechner, T. & Böhme, M. 2020. A skull of a very large crane from the late Miocene of southern Germany, with notes on the phylogenetic interrelationships of extant Gruinae. *J. Orn.* 161: 923–933.
- Milberg, P. & Tyrberg, T. 1993. Naïve birds and noble savages—a review of man-caused prehistoric extinctions of island birds. *Ecography* 16: 229–250.
- Miller, J. F. 1777. *Various subjects of natural history, wherein are delineated birds, animals and many curious plants*, pt. 3. London.
- Miller, L. H. 1909. *Teratornis*, a new avian genus from Rancho La Brea. *Univ. Calif. Publ. Bull. Dept. Geol.* 5: 305–317.
- Miller, L. H. 1910. Wading birds from the Quaternary asphalt beds of Rancho La Brea. *Univ. Calif. Publ. Bull. Dept. Geol.* 5: 439–448.
- Miller, L. H. 1911. A series of eagle tarsi from the Pleistocene of Rancho La Brea. *Univ. Calif. Publ. Bull. Dept. Geol.* 6: 305–316.
- Morejón, G. Y. 1974. ¿Cóndores en los cielos de Cuba? *Bohemia* 66(16): 84–85.
- Morgan, G. S. 1977a. Late Pleistocene fossil vertebrates from the Cayman Island, British West Indies. M.Sc. thesis. Univ. of Florida, Gainesville.
- Morgan, G. S. 1977b. Late Pleistocene fossil vertebrates from the Cayman Island, British West Indies. *Abstract. Fla. Sci.* 40 (Suppl. 1): 21.
- Morgan, G. S. 1994. Late Quaternary fossil vertebrates from the Cayman Islands. Pp. 465–508 in Brunt, M. A. & Davies, J. E. (eds.) *The Cayman Islands: natural history and biogeography*. Kluwer Academic, Dordrecht.
- Morgan, G. S. & Albury, N. A. 2013. The Cuban crocodile (*Crocodylus rhombifer*) from Late Quaternary fossil deposits in the Bahamas and Cayman Islands. *Bull. Fla. Mus. Nat. Hist.* 52: 161–236.
- Morgan, G. S. & Ottenwalder, J. A. 1993. A new extinct species of *Solenodon* (Mammalia: Insectivora: Solenodontidae) from the Late Quaternary of Cuba. *Ann. Carnegie Mus.* 62: 151–164.
- Morgan, G. S., Ray, C. E. & Arredondo, O. 1980. A giant extinct insectivore from Cuba (Mammalia: Insectivora: Solenodontidae). *Proc. Biol. Soc. Wash.* 93: 597–608.

- Morgan, G. S., MacPhee, R. D. E., Woods, R. & Turvey, S. T. 2019. Late Quaternary fossil mammals from the Cayman Islands, West Indies. *Bull. Amer. Mus. Nat. Hist.* 428: 1–79.
- Nascimento, R. & Silveira, L. F. 2020. The fossil birds of Peter Lund. *Zootaxa* 4743: 480–510.
- Navarro, N. 2020. *Annotated checklist of the birds of Cuba*. Third edn. Ed. Nuevos Mundos.
- Navarro, N. 2021. *Annotated checklist of the birds of Cuba*. Fourth edn. Ed. Nuevos Mundos.
- Navarro, N. 2022. *Annotated Checklist of the Birds of Cuba*. Fifth edn. Ed. Nuevos Mundos.
- Newton, I. 2003. *The speciation & biogeography of birds*. Academic Press, London.
- Olson, S. L. 1974. A new species of *Nesotrochis* from Hispaniola, with notes on other fossil rails from the West Indies (Aves: Rallidae). *Proc. Biol. Soc. Wash.* 87: 439–450.
- Olson, S. L. 1976. A new species of *Mitlago* from Hispaniola, with notes on other fossil caracaras from the West Indies (Aves: Falconidae). *Proc. Biol. Soc. Wash.* 88: 355–366.
- Olson, S. L. 1977. A synopsis of the fossil Rallidae. Pp. 509–525 in Ripley, S. D. *Rails of the world: a monograph of the family Rallidae*. D. R. Godine, Boston, A.
- Olson, S. L. 1978. A paleontological perspective of West Indian birds and mammals. Pp. 99–117 in Gill, F. B. (ed.) *Zoogeography in the Caribbean. The 1975 Leidy Medal Symposium. Publ. Acad. Nat. Sci. Phil.* 13.
- Olson, S. L. 1982. Fossil birds of the Bahamas. *Bahamas Natur.* 6(1): 33–37.
- Olson, S. L. 1984. A very large enigmatic owl (Aves: Strigidae) from the late Pleistocene at Ladds, Georgia. Pp. 44–46 in Genoways, H. H. & Dawson, M. R. (eds.) *Contributions in Quaternary vertebrate paleontology: a volume in memorial to John E. Guilday. Carnegie Mus. Nat. Hist. Spec. Publ.* 8.
- Olson, S. L. 1985. A new species of *Siphonorhis* from Quaternary cave deposits in Cuba (Aves: Caprimulgidae). *Proc. Biol. Soc. Wash.* 98: 526–532.
- Olson, S. L. 1991. The fossil record of the genus *Mycteria* (Ciconiidae) in North America. *Condor* 93: 1004–1006.
- Olson, S. L. 2000. Fossil Red-shouldered Hawk in the Bahamas: *Calohierax quadratus* Wetmore synonymized with *Buteo lineatus* (Gmelin). *Proc. Biol. Soc. Wash.* 113: 298–301.
- Olson, S. L. 2008. A new species of large, terrestrial caracara from Holocene deposits in southern Jamaica (Aves: Falconidae). *J. Raptor Res.* 42: 265–272.
- Olson, S. L. & Alvarenga, H. M. F. 2002. A new genus of small teratorn from the Middle Tertiary of the Taubaté Basin, Brazil (Aves: Teratornithidae). *Proc. Biol. Soc. Wash.* 115: 701–705.
- Olson, S. L. & Hilgartner, W. B. 1982. Fossil and subfossil birds from the Bahamas. Pp. 22–56 in Olson, S. L. (ed.) *Fossil vertebrates from the Bahamas. Smiths. Contrib. Paleobiol.* 48.
- Olson, S. L. & Hilgartner, W. B. MS. Late Quaternary birds from a cave deposit in eastern Cuba. Unpubl.
- Olson, S. L. & Kurochkin, E. N. 1987. Fossil evidence of a tapaculo in the Quaternary of Cuba (Aves: Passeriformes: Scytalopodidae). *Proc. Biol. Soc. Wash.* 100: 353–357.
- Olson, S. L. & Pregill, G. K. 1982. Introduction to the paleontology of Bahaman vertebrates. Pp. 1–7 in Olson, S. L. (ed.) *Fossil vertebrates from the Bahamas. Smiths. Contrib. Paleobiol.* 48.
- Olson, S. L. & Steadman, D. W. 1977. A new genus of flightless ibis (Threskiornithidae) and other fossil birds from cave deposits in Jamaica. *Proc. Biol. Soc. Wash.* 90: 447–457.
- Olson, S. L. & Steadman, D. W. 1979. The humerus of *Xenicibis*, the extinct flightless ibis of Jamaica. *Proc. Biol. Soc. Wash.* 92: 23–27.
- Olson, S. L. & Suárez, W. 2008a. Bare-throated Tiger-Heron (*Tigrisoma mexicanum*) from the Pleistocene of Cuba: a new subfamily for the West Indies. *Waterbirds* 31: 285–288.
- Olson, S. L. & Suárez, W. 2008b. A fossil cranium of the Cuban Macaw *Ara tricolor* (Aves: Psittacidae) from Villa Clara province, Cuba. *Carib. J. Sci.* 44: 287–290.
- Olson, S. L. & Wingate, D. B. 2000. Two new species of flightless rails (Aves: Rallidae) from the Middle Pleistocene “crane fauna” of Bermuda. *Proc. Biol. Soc. Wash.* 113: 356–368.
- Orihuela, J. 2012. Late Holocene fauna from a cave deposit in western Cuba: post-Columbian occurrence of the vampire bat *Desmodus rotundus* (Phyllostomidae: Desmodontinae). *Carib. J. Sci.* 46: 297–312.
- Orihuela, J. 2013. Fossil Cuban Crow *Corvus* cf. *nasicus* from a Late Quaternary cave deposit in northern Matanzas, Cuba. *J. Carib. Orn.* 26: 12–16.
- Orihuela, J. 2019. An annotated list of Late Quaternary extinct birds of Cuba. *Orn. Neotrop.* 30: 57–67.
- Orihuela, J., Pérez Orozco, L., Álvarez Licourt, J. L., Viera Muñoz, R. A. & Santana Barani, C. 2020a. Late Holocene land vertebrate fauna from Cueva de los Nesofontes, western Cuba: stratigraphy, chronology, diversity, and paleoecology. *Palaeontol. Elec.* 23(3): a57. <https://doi.org/10.26879/995>.
- Orihuela, J., Viñola, L. W., Jiménez Vázquez, O., Mychajliw, A. M., Hernández de Lara, O., Lorenzo, L. & Soto-Centeno, J. A. 2020b. Assessing the role of humans in Greater Antillean land vertebrate extinctions: new insights from Cuba. *Quart. Sci. Rev.* 249: 106597.
- Oswald, J. A. & Steadman, D. W. 2018. The late Quaternary bird community of New Providence, Bahamas. *Auk* 135: 359–377.
- Oswald, J. A., Allen, J. M., Witt, K. E., Folk, R. A., Albury, N. A., Steadman, D. W. & Guralnick, R. P. 2019. Ancient DNA from a 2,500-year-old Caribbean fossil places an extinct bird (*Caracara creightoni*) in a phylogenetic context. *Mol. Phylo. & Evol.* 140: 106576.

- Oswald, J. A., Terrill, R. S., Stucky, B. J., LeFebvre, M. J., Steadman, D. W., Guralnick, R. P. & Allen, J. M. 2021. Ancient DNA from the extinct Haitian cave-rail (*Nesotrochis steganinos*) suggests a biogeographic connection between the Caribbean and Old World. *Biol. Lett.* 17(3): 20200760.
- Park, C. F. 1942. Manganese deposits of Cuba. *Bull. US Geol. Survey* 935B: 75–97.
- Parkes, K. C. 1963. Notes on some birds from Cuba and the Isle of Pines. *Ann. Carnegie Mus.* 36: 129–132.
- Paula Couto, C. de 1967. Pleistocene edentates of the West Indies. *Amer. Mus. Novit.* 2304: 1–55.
- Pérez de Acevedo, R. 1957. *El respetable e inquietante Arcaico II cubano*. Imprenta El Arte, La Habana.
- Peterson, O. A. 1917. Report upon the fossil material collected in 1913 by the Messrs. Link in a cave in the Isle of Pines. *Ann. Carnegie Mus.* 11: 359–361.
- Pontoppidan, E. 1763. *Den danske atlas, eller Konge-riiget Danmark*, vol. 1. Godiche, Copenhagen.
- Pradas, T. 1998. ¿Hubo un Neanderthal en Cuba? *Bohemia* 90(20): 4–13.
- Pregill, G. K. & Olson, S. L. 1981. Zoogeography of West Indian vertebrates in relation to Pleistocene climatic cycles. *Ann. Rev. Ecol. Syst.* 12: 75–98.
- Provost, K. L., Joseph, L. & Smith, B. T. 2018. Resolving a phylogenetic hypothesis for parrots: implications from systematics to conservation. *Emu–Austral Orn.* 118: 7–21.
- Raffaele, H., Wiley, J., Garrido, O., Keith, A. & Raffaele, J. 1998. *A guide to the birds of the West Indies*. Princeton Univ. Press.
- Raffaele, H., Wiley, J., Garrido, O., Keith, A. & Raffaele, J. 2003. *Birds of the West Indies*. Princeton Univ. Press.
- Richards, H. G. 1935. Pleistocene mollusks from western Cuba. *J. Paleontol.* 9: 253–258.
- Ridgway, R. 1916. The birds of North and Middle America. *Bull. US Natl. Mus.* 50(7)
- Ripley, S. D. & Watson, G. E. 1956. Cuban bird notes. *Postilla* 26: 1–6.
- Rivero, M. & Arredondo, O. 1991. *Paralouatta varonai*, a new Quaternary platyrrhine from Cuba. *J. Human Evol.* 21: 1–11.
- Reichenbach, H. G. L. 1852. *Avium systema naturale*. Expedition der vollständigsten Naturgeschichte, Dresden & Leipzig.
- Rojas Consuegra, R., Jiménez Vázquez, O., Condis Fernández, M. M. & Díaz Franco, S. 2012. Tafonomía y paleoecología de un yacimiento paleontológico del Cuaternario en la Cueva del Indio, La Habana, Cuba. *Espelunca digital* 12: 1–12.
- Salgado, E. J., Calvache, D. G., MacPhee, R. D. E. & Gould, G. C. 1992. The monkey caves of Cuba. *Cave Sci.* 19: 25–28.
- Slater, P. L. 1861. List of a collection of birds made by the late Mr. W. Osburn in Jamaica, with notes. *Proc. Zool. Soc. Lond.* 1861: 69–82.
- Slater, P. L. & Salvin, O. 1868. Descriptions of new or little-known American birds of the families Fringillidae, Oxyrhamphidae, Bucconidae, and Strigidae. *Proc. Zool. Soc. Lond.* 1868: 322–329.
- Scopoli, J. A. 1769. *Annus historico-naturalis*. C. G. Hilscher, Leipzig.
- Silva Taboada, G. 1974. Fossil Chiroptera from cave deposits in central Cuba, with description of two new species (genera *Pteronotus* and *Mormoops*) and the first West Indian record of *Mormoops megalophylla*. *Acta Zool. Cracov.* 19(3): 33–73.
- Silva Taboada, G. 1979. *Los murciélagos de Cuba*. Ed. Academia, La Habana.
- Silva Taboada, G., Suárez Duque, W. & Díaz Franco, S. 2008. *Compendio de los mamíferos terrestres autóctonos de Cuba, vivientes y extinguidos*. Ed. Boloña, La Habana.
- Steadman, D. W. & Franklin, J. 2015. Changes in a West Indian bird community since the late Pleistocene. *J. Biogeogr.* 42: 426–438.
- Steadman, D. W. & Franklin, J. 2020. Bird populations and species lost to Late Quaternary environmental change and human impact in the Bahamas. *Proc. Natl. Acad. Sci. USA* 117: 26833–26841.
- Steadman, D. W. & Hilgartner, W. B. 1999. A new species of extinct barn owl (Aves: *Tyto*) from Barbuda, Lesser Antilles. Pp. 75–83 in Olson, S. L., Wellnhofer, P., Mourer-Chauviré, C., Steadman, D. W. & Martin, L. D. (eds.) *Avian paleontology at the close of the 20th century: Proc. 4th Intern. Meet. Soc. Avian Paleontology & Evolution*, Washington, DC, 1996. *Smiths. Contrib. Paleobiol.* 89.
- Steadman, D. W. & Takano, O. M. 2016. A new extinct species of snipe (Aves: Scolopacidae: *Gallinago*) from the West Indies. *Zootaxa* 4109: 345–358.
- Steadman, D. W., Martin, P. S., MacPhee, R. D. E., Jull, A. J. T., McDonald, H. G., Woods, C. A., Iturralde-Vinent, M. & Hodgins, G. W. L. 2005. Asynchronous extinction of late Quaternary sloths on continents and islands. *Proc. Natl. Acad. Sci. USA* 102: 11763–11768.
- Steadman, D. W., Franz, R., Morgan, G. S., Albury, N. A., Kakuk, B., Broad, K., Franz, S. E., Tinker, K., Pateman, M. P., Lott, T. A., Jarzen, D. M. & Dilcher, D. L. 2007. Exceptionally well preserved late Quaternary plant and vertebrate fossils from a blue hole on Abaco, the Bahamas. *Proc. Natl. Acad. Sci. USA* 104: 19897–19902.
- Steadman, D. W., Morris, J. R. & Wright, N. A. 2013. A new species of Late Pleistocene rail (Aves: Rallidae) from Abaco, the Bahamas. *Paleontol. J.* 47: 1355–1364.
- Steadman, D. W., Almonte Milan, J. N. & Mychajliw, A. M. 2019. An extinct eagle (Aves: Accipitridae) from the Quaternary of Hispaniola. *J. Raptor Res.* 53: 319–333.

- Suárez, W. 1998. Lista preliminar de las aves cubanas depredadas por *Tyto alba furcata* (Aves: Tytonidae). *El Pitirre* 11: 12–13.
- Suárez, W. 2000a. Contribución al conocimiento del estatus genérico del cóndor extinto (Ciconiiformes: Vulturidae) del Cuaternario cubano. *Orn. Neotrop.* 11: 109–122.
- Suárez, W. 2000b. Fossil evidence for the occurrence of Cuban Poorwill *Siphonorhis daiquiri* in western Cuba. *Cotinga* 14: 66–68.
- Suárez, W. 2001a. Deletion of the flightless ibis *Xenicibis* from the fossil record of Cuba. *Carib. J. Sci.* 37: 109–110.
- Suárez, W. 2001b. A reevaluation of some fossils identified as vultures (Aves: Vulturidae) from Quaternary cave deposits of Cuba. *Carib. J. Sci.* 37: 110–111.
- Suárez, W. 2004a. The identity of the fossil raptor of the genus *Amplibuteo* (Aves: Accipitridae) from the Quaternary of Cuba. *Carib. J. Sci.* 40: 120–125.
- Suárez, W. 2004b. The enigmatic snipe *Capella* sp. (Aves: Scolopacidae) in the fossil record of Cuba. *Carib. J. Sci.* 40: 155–157.
- Suárez, W. 2004c. Biogeografía de las aves fósiles de Cuba. In Iturralde-Vinent, M. A. (ed.) *Origen y evolución del Caribe y sus biotas marinas y terrestres*. CD. Centro Nacional de Información Geológica, La Habana.
- Suárez, W. 2020a. The fossil avifauna of the tar seeps Las Breas de San Felipe, Matanzas, Cuba. *Zootaxa* 4780: 1–53.
- Suárez, W. 2020b. Remarks on extinct giant owls (Strigidae) from Cuba, with description of a new species of *Ornimegalonyx* Arredondo. *Bull. Brit. Orn. Cl.* 140: 387–392.
- Suárez, W. MS. Registro fósil de la Gallinuela de Santo Tomás, *Cyanolimnas cerverai*, y el Cabrerito de la Ciénaga, *Torreornis inexpectata*, con análisis de su evolución post-pleistocénica. Unpubl.
- Suárez, W. & Arredondo, O. 1997. Nuevas adiciones a la paleornitología cubana. *El Pitirre* 10: 100–102.
- Suárez, W. & Díaz-Franco, S. 2003. A new fossil bat (Chiroptera: Phyllostomidae) from a Quaternary cave deposit in Cuba. *Carib. J. Sci.* 39: 371–377.
- Suárez, W. & Díaz-Franco, S. 2011. Estudio paleontológico del depósito fosilífero El Abrón, Pinar del Río (sinopsis de las aves fósiles de Cueva El Abrón, Pinar del Río, Cuba). Informe final del proyecto 022 AMA-CITMA, 074 MNHN: Biodiversidad Paleontológica del Archipiélago Cubano: bases cartográficas y conservacionistas. Mus. Nac. Hist. Nat. La Habana.
- Suárez, W. & Emslie, S. D. 2003. New fossil material with a redescription of the extinct condor *Gymnogyps varonai* (Arredondo, 1971) from the Quaternary of Cuba (Aves: Vulturidae). *Proc. Biol. Soc. Wash.* 116: 29–37.
- Suárez, W. & Olson, S. L. 2001a. A remarkable new species of small falcon from the Quaternary of Cuba (Aves: Falconidae: *Falco*). *Proc. Biol. Soc. Wash.* 114: 34–41.
- Suárez, W. & Olson, S. L. 2001b. Further characterization of *Caracara creightoni* Brodkorb based on fossils from the Quaternary of Cuba (Aves: Falconidae). *Proc. Biol. Soc. Wash.* 114: 501–508.
- Suárez, W. & Olson, S. L. 2003a. New records of storks (Ciconiidae) from Quaternary asphalt deposits in Cuba. *Condor* 105: 150–154.
- Suárez, W. & Olson, S. L. 2003b. Red-shouldered Hawk and Aplomado Falcon from Quaternary asphalt deposits in Cuba. *J. Raptor Res.* 37: 71–75.
- Suárez, W. & Olson, S. L. 2003c. A new species of caracara (*Mitroago*) from Quaternary asphalt deposits in Cuba, with notes on new material of *Caracara creightoni* Brodkorb (Aves: Falconidae). *Proc. Biol. Soc. Wash.* 116: 301–307.
- Suárez, W. & Olson, S. L. 2008 [for 2007]. The Cuban fossil eagle *Aquila borraisi* Arredondo: a scaled-up version of the Great Black-Hawk *Buteogallus urubitinga* (Gmelin). *J. Raptor Res.* 41: 288–298.
- Suárez, W. & Olson, S. L. 2009a. A new genus for the Cuban teratorn (Aves: Teratornithidae). *Proc. Biol. Soc. Wash.* 122: 103–116.
- Suárez, W. & Olson, S. L. 2009b. The generic position of *Miraquila terrestris* Campbell: another addition to the buteogalline radiation from the Pleistocene of Peru. *J. Raptor Res.* 43: 249–253.
- Suárez, W. & Olson, S. L. 2014. A new fossil species of small crested caracara (Aves: Falconidae: *Caracara*) from the Pacific lowlands of western South America. *Proc. Biol. Soc. Wash.* 127: 299–310.
- Suárez, W. & Olson, S. L. 2015. Systematics and distribution of the giant fossil barn owls of the West Indies (Aves: Strigiformes: Tytonidae). *Zootaxa* 4020: 533–553.
- Suárez, W. & Olson, S. L. 2020a. Systematics and distribution of the living and fossil small barn owls of the West Indies (Aves: Strigiformes: Tytonidae). *Zootaxa* 4830: 544–564.
- Suárez, W. & Olson, S. L. 2020b. A new fossil vulture (Cathartidae: *Cathartes*) from Quaternary asphalt and cave deposits in Cuba. *Bull. Brit. Orn. Cl.* 140: 335–343.
- Suárez, W. & Olson, S. L. 2021. A new fossil raptor (Accipitridae: *Buteogallus*) from Quaternary cave deposits in Cuba and Hispaniola, West Indies. *Bull. Brit. Orn. Cl.* 141: 256–266.
- Swainson, W. 1827. On several groups and forms in ornithology, not hitherto defined. *Zool. J.* 3: 343–363.
- Swainson, W. 1834. Mexico. Natural geography. Zoology. Pp. 1382–1384 in Murray, H. (ed.) *An encyclopaedia of geography*. Longman, Rees, Orme, Brown, Green, & Longman, London.
- Temminck, C. J. 1809. *Histoire naturelle générale des pigeons*, livraison 6. Paris.

- Temminck, C. J. & Laugier, M. 1820–1839. *Nouveau recueil de planches coloriées d'oiseaux*, 102 livraisons. F. G. Levrault, Paris.
- Vergara, R. R. 2003. Relaciones biogeográficas de la avifauna cubana. II. Biogeografía descriptiva. *Orn. Neotrop.* 14: 441–467.
- Vigors, N. A. 1827. Sketches in ornithology: on some species of birds from Cuba. *Zool. J.* 3: 432–448.
- Vieillot, L. P. 1808 [1807]. *Histoire naturelle des oiseaux de l'Amérique septentrionale*, vol. 1. Desray, Paris.
- Vieillot, L. P. 1816–19. *Nouveau dictionnaire d'histoire naturelle appliquée aux arts*, vol. 2. Second edn. Paris.
- Vieillot, L. P. 1823. *Tableau encyclopédique et méthodique des trois règnes de la nature. Ornithologie*, pt. 3. Second edn. Paris.
- Wagler, J. G. 1829. Beiträge und Bemerkungen zu dem ersten Band seines Systema Avium. *Isis von Oken* 22: 645–664.
- Wagler, J. G. 1832. Monographia Psittacorum. *Abh. Math.-phys. Kl. König. Bayer. Akad. Wiss.* 1: 464–750.
- Weesie, P. D. M. 1988. The Quaternary avifauna of Crete, Greece. *Palaeovertebrata* 18: 1–94.
- Wetherbee, D. K. 1985. The extinct Cuban and Hispaniolan macaws (*Ara*, Psittacidae), and description of a new species, *Ara cubensis*. *Carib. J. Sci.* 21: 169–175.
- Wetmore, A. 1918. Bones of birds collected by Theodoor de Booy from kitchen midden deposits in the islands of St. Thomas and St. Croix. *Proc. US Natl. Mus.* 54: 513–522.
- Wetmore, A. 1920. Five new species of birds from cave deposits in Porto Rico. *Proc. Biol. Soc. Wash.* 33: 77–82.
- Wetmore, A. 1922. Bird remains from the caves of Porto Rico. *Bull. Amer. Mus. Nat. Hist.* 46: 297–333.
- Wetmore, A. 1928. Bones of birds from the Ciego Montero deposit of Cuba. *Amer. Mus. Novit.* 301: 1–5.
- Wetmore, A. 1937. Bird remains from cave deposits on Great Exuma Island in the Bahamas. *Bull. Mus. Comp. Zool.* 80: 427–441.
- Wetmore, A. 1956. A check-list of the fossil and prehistoric birds of North America and the West Indies. *Smiths. Misc. Coll.* 131(5): 1–105.
- Wetmore, A. 1959. Birds of the Pleistocene in North America. *Smiths. Misc. Coll.* 138(4): 1–24.
- Wetmore, A. 1960. Pleistocene birds in Bermuda. *Smiths. Misc. Coll.* 140(2): 1–11.
- Wiley, J. W. & Kirwan, G. M. 2013. The extinct macaws of the West Indies, with special reference to Cuban Macaw *Ara tricolor*. *Bull. Brit. Orn. Cl.* 133: 125–156.
- Williams, E. 1950. *Testudo cubensis* and the evolution of Western Hemisphere tortoises. *Bull. Amer. Mus. Nat. Hist.* 95: 1–36.
- Woods, C. A. 1980. Collecting fossil mammals in the Greater Antilles: an immense journey. *The Plaster Jacket* 34: 1–13.
- Württemberg, P. W. 1835. *Erste Reise nach dem nördlichen Amerika in den Jahren 1822 bis 1824*. Stuttgart.
- Zeiger, J. M., Proctor, J. & Inman, S. E. 2017. Observations of leucistic Turkey Vultures (*Cathartes aura*) in Jamaica. *J. Carib. Orn.* 30: 128–133.
- Zelenkov, N. V. & Gonzalez [sic = González], S. F. 2020. The first fossil tody (Aves: Todidae) from Cuba. *Paleontol. J.* 54: 414–419.
- Zelenkov, N. V. & González, S. F. 2021. A new extinct species of *Margarobyas* (Strigiformes) and the evolutionary history of the endemic Cuban bare-legged owl (*M. lawrencii*). *J. Vert. Paleontol.* [https://doi: 10.1080/02724634.2021.1995869](https://doi.org/10.1080/02724634.2021.1995869).

Address: P.O. Box 16477, West Palm Beach, FL 33416, USA, e-mail: ws@wsbirdingtours.com

Appendix: Cuban Quaternary deposits with avian remains

Ordered from west to east —the special municipality (*sm*) of Isla de La Juventud (= Isla de Pinos) is at the end—by provinces, including municipality (*m*), near location (*l*) and locality (with its respective acronym). For map of localities, see Fig. 1.

1. Pinar del Río

- Guane (*m*). Sierra de San Carlos (*l*): **PCA**.—Cueva de los Carabalies, **PCH**.—Cueva de Chefa [Sistema Cavernario Majaguas-Canteras].
- Minas de Matahambre (*m*). Sumidero (*l*): **PPD**.—Caverna [or 'Cueva'] de Pío Domingo.
- Viñales (*m*). Sierra de Galeras (*l*): **PMF**.—Cueva del Mono Fósil.
- Los Palacios (*m*). Sierra de La Güira (*l*): **PEA**.—Cueva El Abrón.

2. Artemisa

- Caimito (*m*). Sierra de Anafe (*l*): **ACA**.—'Cueva de la Sierra de Anafe' (*cf.* Arredondo 1958: 11. This uncertain locality, a cave formerly in the municipality of Guanajay and province of Pinar del Río, is the same mentioned by Arredondo 1955: 4, 30, 1976: 177, 1982: 42, 1984: 26, according to O. Arredondo pers. comm. Not 'Abra de San Andrés' or 'Abra de Andrés', which is a different deposit in Sierra de Anafe, *contra* Morgan & Ottenwalder 1993: 160), **APR**.—Cueva Prieta, **ACH**.—Cueva del Ahorcado, **ACT**.—Cueva del Campo de Tiro. Ceiba del Agua (*l*): **ACP**.—Cueva de Paredones, **ASC**.—Cueva Siete Caballerías. Vereda Nueva (*l*): **ACF**.—Cueva del Fósil, **ASA**.—Cueva de Sandoval, **AQS**.—Cueva de Quito Suárez.

Bauta (*m*). Near [c.2 km south-west] Playa Santa Fé [La Habana] (*l*): **ALA**.—Cueva Lamas, **ACL**.—‘Cueva próxima a la Cueva Lamas’ [*cf.* Arredondo 1984: 8].

3. La Habana

Marianao (*m*). Marianao (*l*): **HFT**.—Fisuras en Túnel Popular.

Boyeros (*m*). Calabazar [Reperto América] (*l*): **HGA**.—Gruta del Reparto América. Calabazar [Reperto El Globo] (*l*): **HCI**.—Cueva del Indio.

4. Mayabeque

Bejucal (*m*). Cuatro Caminos (*l*): **YCT**.—Cueva La Trampa.

Quivicán (*m*). La Salud (*l*): **YTU**.—Cueva del Túnel, **YIN**.—Cueva de Insunsa, **YCH**.—Cueva del Chicharrón. Aguacate (*l*): **YBL**.—Cuevas Blancas.

San José de las Lajas (*m*). Las Charcas (*l*): **YCC**.—Cuevas de Las Charcas, **YCA**.—Cueva del Aguacate, **YCM**.—Cueva de los Muertos. Tapaste (*l*): **YCI**.—Cueva del Indio.

Madrugá (*m*). Loma del Palenque (*l*): **YCN**.—Cueva de los Nesofontes.

5. Matanzas

Matanzas (*m*). Matanzas (*l*): **MBE**.—Cueva de Bellamar [Sistema Cavernario Bellamar].

Cárdenas (*m*). Carbonera (*l*): **MCE**.—Cueva La Centella (or ‘Cueva Centella’), **MCP**.—Cueva del Campamento. Camarioca (*l*): **MCQ**.—Cueva de Quinto. Cantel (*l*): **MCA**.—Cueva Calero.

Jagüey Grande (*m*). Jagüey Grande (*l*): **MFJ**.—Fisuras en Canteras J-4. Agramonte (*l*): **MCB**.—Cueva Beruvides, **MAF**.—Cueva Afán.

Martí (*m*). Valle de San Felipe (*l*): **MLB**.—Las Breas de San Felipe.

6. Cienfuegos

Palmira (*m*). Ciego Montero (*l*): **CCM**.—Baños de Ciego Montero.

7. Villa Clara

Corralillo (*m*). El Charcón (*l*): **VSM**.—Solapa del Megalocnus.

Sagua La Grande/Quemado de Güines [shared territory] (*m*). Mal Páez (*l*): **VHC**.—Casimba Hueco Chico, **VCB**.—Casimba en los Buentes.

8. Sancti Spiritus

Yaguajay (*m*). Cayo Salinas (*l*): **SPF**.—Cueva Funeraria de Los Niños [= ‘Cueva de los Niños’ or ‘Cueva de los Sacrificios’ (Arredondo 1984: 12)]. Cayo Palma (*l*): **SPS**.—Cueva del Salón. Caguanes (*l*): **SPH**.—Cueva de Humboldt.

Sancti Spiritus (*m*). Sancti Spiritus (*l*): **SPC**.—Cantera de los Hornos de Cal, **SPM**.—‘Cantera situada cerca de la Loma de Mozas’ [= Moza] (*cf.* Arredondo 1984: 21, Suárez & Olson 2015: 542. Perhaps the same as **SPC** and formerly recorded as ‘quarries near Sancti Spiritus [*sic*]’ or ‘Canteras de Sancti Spiritus’ by Arredondo 1976: 183, 1982: 38–39).

Jatibonico (*m*). Sierra de Jatibonico (*l*): **SPL**.—Casimba de Las Llanadas.

9. Ciego de Ávila

Florencia (*m*). Loma de los Rubíes (*l*): **GCJ**.—Cueva de la Jutía.

10. Camagüey

Sierra de Cubitas (*m*). Sierra de Cubitas (*l*): **CFO**.—Cueva de los Fósiles, **CEN**.—Cueva del Centenario.

11. Holguín

Gibara (*m*). Polja del Cementerio (*l*): **OCB**.—Cueva La Bandera.

Mayarí (*m*). Seborúco (*l*): **OCS**.—Cueva de Seborúco.

12. Santiago de Cuba

Contramaestre (*m*). Baire (*l*): **SMB**.—‘Mina’ [or ‘Cueva’] cerca de Baire.

Santiago de Cuba (*m*). Daiquirí (*l*): **SCI**.—Cueva de los Indios.

13. Isla de La Juventud [= Isla de Pinos]

Isla de la Juventud (*sm*). Sierra de Caballos (*l*): **ISC**.—Cueva en Sierra de Caballos. Punta del Este (*l*): **IPE**.—Cueva de Isla (or ‘Cueva de las Pictografías’).

Temminck's new bird names introduced in the early parts of the *Nouveau recueil de planches coloriées d'oiseaux* in 1820–22

By Edward C. Dickinson, Pepijn Kamminga & Steven van der Mije

Received 15 July 2021; revised January 2022; published 11 March 2022

<http://zoobank.org/urn:lsid:zoobank.org:pub:2F4CAD52-4A8B-46AC-AD31-97FBF3605600>

SUMMARY.—In deciding to provide a complement to Buffon's *Histoire naturelle des oiseaux*, Temminck, who had not previously published a 'part work' on this scale undertook to do so under the name *Nouveau recueil de planches coloriées d'oiseaux*. At the start Temminck did not provide texts; each part included six plates. Of the many problems to solve the three main ones seemed to be: (i) the number of plates per part, (ii) the dates of publication, and (iii) the need to discover the wrappers issued with parts 1–20. The plates carried French names, but for these 20 parts the wrappers provided the new scientific names and attributed authorship. From previous studies we conclude that the *Nouveau recueil de planches coloriées* must be considered as two works, and that the first of these (livraisons 1–20) must be seen as complete with the inclusion of the wrappers. We then examine all names applicable to images in these 120 plates, assessing authorship, date of publication and date precedence. We identified three cases where names long in prevailing usage require application to the ICZN for a ruling on reversal of precedence. We list 15 names that have been in widespread use over the last 60 years that risk changes if the names on the wrappers are judged unacceptable. Our Appendix deals with the 86 names Temminck thought new: (a) 27 of Temminck's own names with precedence; (b) 19 manuscript names for which Temminck is the author; (c) 27 Temminck names which are junior synonyms; (d) 12 manuscript names from Temminck that are also junior synonyms; (e) one name used for two specimens Temminck thought were of the same species but proved different.

Coenraad Temminck and the creation of the *Planches coloriées*

Coenraad Jacob Temminck (1778–1858) was the son of Jacob Temminck, the aristocratic treasurer of the Vereenigde Oost-Indische Compagnie (the Dutch East India Company, established in 1602, and nationalised in 1790). The company welcomed naturalists and other travellers to the East Indies to assist in its exploration, and this continued with the Dutch colonies that were formed by the company's nationalisation. In this context Coenraad inherited and extended these relationships; he was devoted to expanding our knowledge of the world's fauna (especially birds and mammals), and he substantially expanded the private collection started by his father in 1770, publishing a catalogue of the collection in 1807 (Temminck 1807). He was particularly aware that paintings were necessary to expand knowledge at a time when the art of preserving specimens was in its infancy.

Temminck (1815) published his *Manuel d'ornithologie* dealing mainly with the birds of Europe carefully providing scientific names. This work established him in the eyes of his peers. The Dutch government saw the need for a national museum and agreed that Temminck should become its director in return for donating his collection to it. A decree establishing the Rijks Museum van Natuurlijk Historie was promulgated on 9 August 1820.

In parallel with this, Temminck, with some help from his French colleague Meiffren de Laugier¹, began to add significantly to the public interest in birds by complementing the seminal work of the Comte de Buffon—of which Temminck, of course, had a copy—by creating a sister work to illustrate birds not depicted in the ‘Daubenton’ plates included in the *Histoire naturelle des oiseaux* (Buffon 1771–86). Temminck’s complement, the *Nouveau recueil de planches coloriées d’oiseaux*, for which Cuvier (1820) authored a prospectus, was eventually completed in 101 parts in 1836, followed in 1839 by an index, the *Tableau méthodique*, which also served as a plan for binding the many parts in an appropriate sequence. Although Laugier was listed as a co-author of the work as a whole, Temminck was to be accepted as the author of any newly introduced names (see Cuvier 1820: 9)².

Each part was supposed to comprise six plates, but after 100 parts only 595 plates had appeared. This anomaly was not explained until Dickinson (2001), following advice from the late Gerlof Mees, solved the mystery with help from Temminck’s handwritten list rediscovered in the Naturalis Biodiversity Center, Leiden, archives. Temminck on five occasions needed two printing plates to create his images, typically of birds with long tails, and, in such instances, he counted both halves as plates, so that each of the affected parts was issued with five plates not six.

Throughout the work the plate captions provided only vernacular names, and each part was issued with a wrapper. The wrappers for the first 20 parts seem to have been intended to be bound in, because printed on the back of each wrapper was a list of the plates and the details of them including their scientific names.

However, the character of the work changed dramatically in 1821 when Temminck started to provide texts along with the plates. It is due to this change in character that we view *Planches coloriées* as two distinct works.

Why two works?

The second work begins with part 21 which included, for the first time, original text pages relevant to each plate. Quoy (1824) suggested that the introduction of texts was in response to decisions by customs officials that plates without texts must be treated as works of art, whereas texts with plates were accepted as scientific works. This view was accepted by Dickinson (2001). Sherborn (1898) reported that with effect from part 21 Temminck’s prices increased to cover the texts³.

The practice of publishing in parts began no later than the 17th century and allowed purchasers to spread the cost over time, as well as being advantageous to the printers; see Dickinson *et al.* (2011: 34–35). Colour printing, which came later and was costly, made this even more attractive.

Temminck recognised the value of being the author of new scientific names and from the start of the *Planches coloriées* in 1820 credited himself as author when he was, although when using someone’s manuscript name he credited that author. Temminck undoubtedly wanted scientific names to be included throughout this work, so the wrappers bearing these names were critical to the value of the work. Writing in 1820, more than 20 years before Strickland (1843) began to promote the need for rules of nomenclature, Temminck could not have anticipated that his names for new taxa might be rejected on legalistic grounds.

¹ Guillaum Michel Jérôme Meiffren de Laugier, Baron de Chartrouse (1772–1843).

² Zimmer (1926: 628) mentioned the prospectus and the explanation in that of Temminck’s role as the sole author of new names.

³ In the quarto edition the original price of Frs. 9 increased to Frs. 10.50 on account of the texts, and in the ‘folio’ edition it increased from Frs. 12 to 15 (Dickinson 2001: 12).

In Temminck's eyes the 20 parts issued without texts were sufficient for those of his audience demanding scientific names, because he provided these on the back page (i.e. p. 4) of each wrapper (after these 20 parts, wrappers continued but, as texts accompanied the plates no scientific names, names of authors or geographical source details appeared on the back of these wrappers). Figs. 1–2 show the front page of the wrapper of part 1 and, from another part, of a typical back page.

Dickinson (2001) reported that the only wrappers then known to be extant were two examined by Sherborn (1898), found in Newton's copy in the library of the Dept. of Zoology of the University of Cambridge. Since then, the remaining 18 have been found and images of all 20 have been published. Lebossé & Bour (2011) provided images of parts 7, 10–14, 16, 18, 19 and 20—two of these from Cambridge and the other eight newly discovered. Subsequently, Lebossé obtained specimens of the rest (parts 1–6, 8, 9, 15 and 17) and these were published by Dickinson (2012).

TABLE 1
Dates of availability of the delayed texts compared
with the dates of publication of wrappers and plates.

Livraisons (or parts) numbers with plates	Dates for texts		Dates for plates	
	Per Stresemann (1922a) receipt of texts for the parts	Per Bibliographie de la France (parts 1–10 based on text pages)	Per Sherborn (1898) and accepted by Zimmer (1926: 627)	Recommended dates. (As Zimmer, except parts 9–10)
1 (1–6)	25.06.1823	07.10.1820	August 1820	August 1820
2 (7–12)	25.06.1823	25.12.1824	September 1820	September 1820
3 (13–18)	25.06.1823	25.12.1824	October 1820	October 1820
4 (19–24)	25.06.1823	25.12.1824	November 1820	November 1820
5 (25–30)	25.06.1823	25.12.1824	December 1820	December 1820
6 (31–36)	25.06.1823	25.12.1824	January 1821	January 1821
7 (37–42)	25.06.1823	26.07.1823	February 1821	February 1821
8 (43–48)	25.06.1823	26.07.1823	March 1821	March 1821
9 (49–54)	25.06.1823	26.07.1823	April 1821	18 April 1821 ^a
10 (55–60)	25.06.1823	26.07.1823	May 1821	18 April 1821 ^a
11 (61–66)	25.12.1823	30.08.1823	June 1821	June 1821
12 (67–72)	25.12.1823	27.09.1823	July 1821	July 1821
13 (73–78)	25.12.1823	25.10.1823	August 1821	August 1821
14 (79–84)	25.12.1823	06.12.1823	September 1821	September 1821
15 (85–90)	25.12.1823	28.02.1824	October 1821	October 1821
16 (91–96)	22.08.1822	27.03.1824	November 1821	November 1821
17 (97–102)	22.08.1822	01.05.1824	December 1821	December 1821
18 (103–108)	22.08.1822	22.05.1824	January 1822	January 1822
19 (109–114)	22.08.1822	26.06.1824	February 1822	February 1822
20 (115–120)	22.08.1822	26.06.1824	March 1822	March 1822

^a This date for parts 9 and 10 was provided by Stresemann (1951) and relates to a despatch to the Berlin Museum.

Temminck's decision to provide texts inevitably led to demands from his original customers to furnish texts in respect of plates 1–120. Concerning the first of the two differing works that we identify we strongly believe that the combined evidence from the plate and the wrapper substantiates valid publication. The delayed texts, wherein the descriptions are sometimes based in part, and perhaps sometimes entirely, on specimens not available when

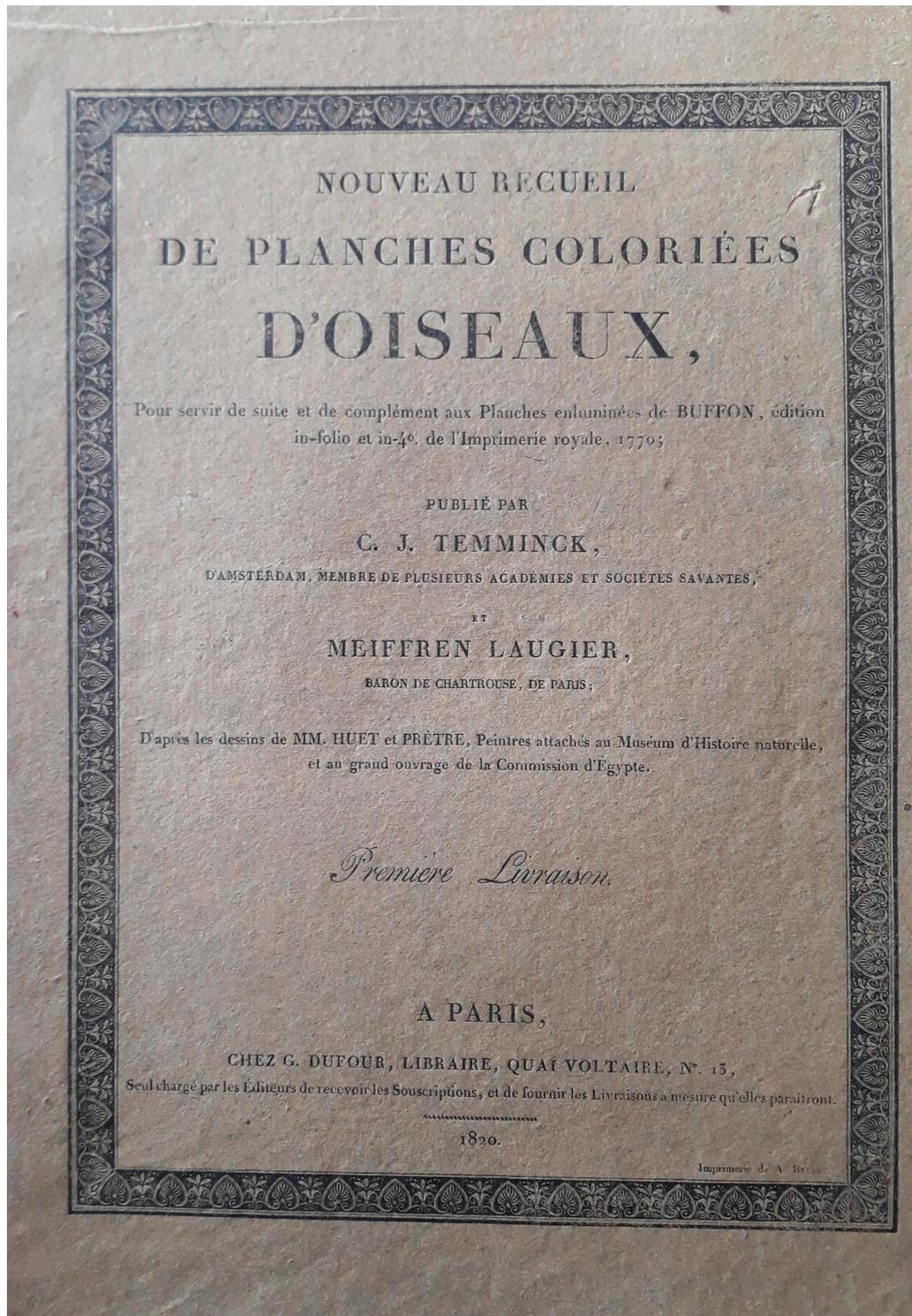


Figure 1. Part 1 front of wrapper of livraison 1 (apart from part number and date, the same for all 20 parts).

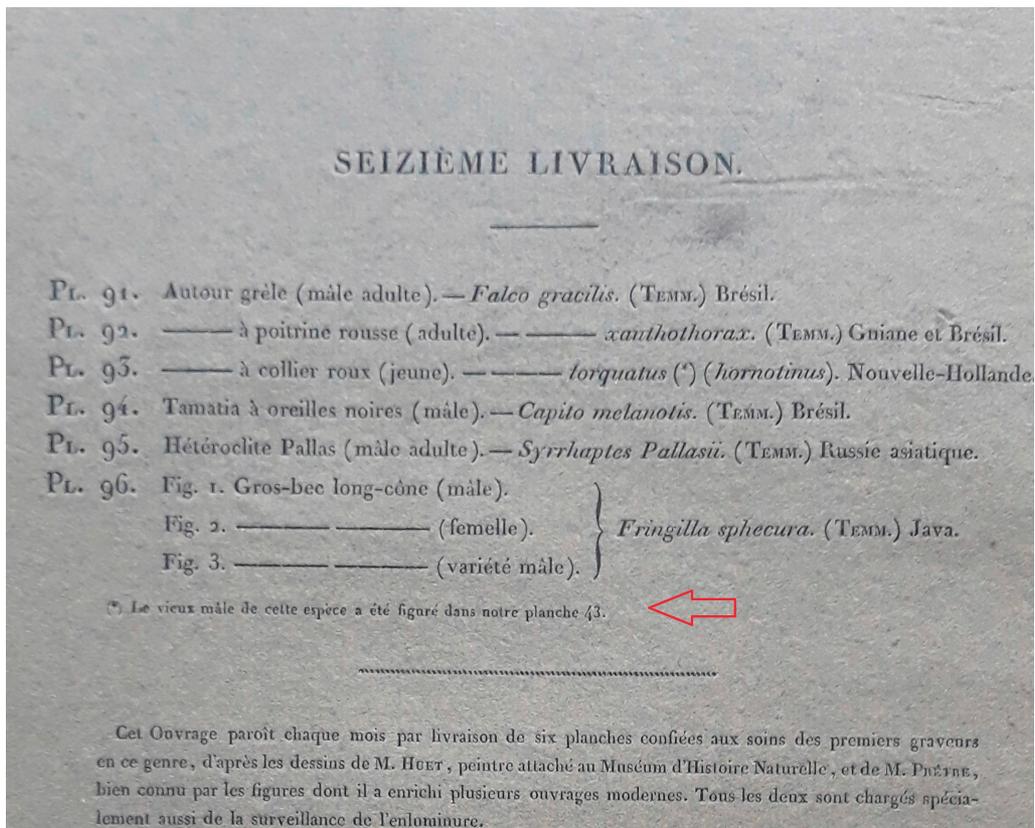


Figure 2. Part 2 back of wrapper of livraison 16 (showing list of included plates with scientific names and an important footnote).

the plate was published, complicate things. Treating the wrapper as part of the original work is not only recommended practice (J. van Tol pers. comm.), but is also in the interest of nomenclatural and thus taxonomic stability. A contrary view would unevenly affect stability. However, in our Appendix, we provide evidence of when these names and any competing names were introduced and, in so doing, we demonstrate the value of accepting wrapper-derived date precedence⁴.

The dates given by Sherborn (1898) had little influence on the dating he used in the *Index animalium*. The principal reason for this is revealed by Sherborn (1922: viii–ix):

'In the case of plates which appeared before the text, the date of each is given if ascertainable; but in no case is the date of a plate accepted in preference to the date of text for the reasons which follow: –

The figure depicted on the plate may, or may not, be the drawing intended by the author: it is the work of the artist, who is responsible also for the descriptive legend. In numerous instances the descriptive legend on a plate is quite erroneous and has been repudiated by the author in his text. Therefore, until the text descriptive of a plate appears, the names on the plate must be considered as *nomina nuda*, and it is open to anyone to describe and rename such *nomina nuda*.'

⁴ Although in two complex cases we advocate acceptance of a junior name which has been consistently used for many years.

At the foot of p. ix is the following footnote: ‘This paragraph is reprinted from vol. 1 [1902]. The practice now obtains, that names combined with recognisable figures must be accepted as valid.’

Nor was Sherborn entirely consistent in using information on the dates of publication of the delayed texts: he often reported ‘Ap. 1822’ (which suggests that he may have understood that all the delayed texts appeared in April 1822 simultaneously with the publication of livr. 21). However, there are cases where he used a date that is evidently earlier, and in two such cases he identified his informants (once R. B. Sharpe and once P. L. Sclater).

The *Catalogue of the birds in the British Museum*—mostly completed before Sherborn (1898)—took dates that appear to be from library records made available to Sherborn by R. B. Sharpe or P. L. Sclater. The 15-volume *Check-list of birds of the world* initiated by J. L. Peters, completed by multiple successors over its long period of compilation (1931–87), and which has been very influential, clearly used the dates of publication of the plates more consistently than earlier seminal checklists. This was because there was broad acceptance of the view footnoted by Sherborn (1922: ix) who wrote, on the subject of recognition of plates as published before a descriptive text: ‘The practice now obtains that names combined with recognisable figures must be accepted as valid’.

New names and their authorship

Despite the publications referred to above there remains a requirement to justify, and provide support for, a global decision that the new names in the wrappers are validly published. Those familiar with the *International code of zoological nomenclature* (ICZN 1999) are aware that the criteria of publication set out in Art. 8.1 must be met. Wrappers, like those used for ‘part works’, are usually, and rightly, seen as valuable for the information on them, especially dates of issue. However, such wrappers were very often discarded when the work was bound, and in many cases Art. 8.1.1 can logically be applied to reach a judgement that they were not ‘issued for the purpose of providing a public and permanent scientific record’.

However, we consider Temminck was deliberately providing such a record. As an experienced and published naturalist, Temminck knew, at a time when even the French had largely accepted that Linnaeus had provided a baseline for zoological nomenclature, that scientific names should be provided. So, we believe that these wrappers must be seen as part of this work, i.e. in its first form, where the content of the wrappers completed the publication as Temminck then saw it. Given how widely these names have been accepted, to argue otherwise would be a serious failure to optimise recognition of prevailing usage. However, acceptance, in any case where another author published at about the same time, must come from clear supporting detail, firmly establishing the authorship and the precedence.

Temminck was seeking to depict taxa that had not been figured in Daubenton’s plates; the species might therefore be new, or they might have been overlooked by Buffon or already named after 1786. Looking at this today, it is apparent that news of novelties was slow to spread: Temminck created 38 synonyms presumably because he had not seen the evidence of prior description, or because, faced with a description but no depiction and no access to source material, he believed that his material differed.

TABLE 2

The distribution of Temminck's plates (a) according to whether the subjects were newly described, were given synonyms, or depicted birds described by earlier authors.

Livr. no.	Newly described		Synonyms created		Author not given	Earlier names
	Temminck (f = fig.)	Ex MS names	Temminck (f = fig.)	Ex MS names		
1	1, 4, 6f3	6f1, 6f2	3	5		2
2	7, 11f1, 11f2, 12f1, 12f2			8, 9		10
3	16, 18f3	17f1&2	15			13, 14, 18f1&2
4	20		21	22, 23		19, 24f1, 24f2, 24f3
5	28 (b), 29f2, 30		29f1			25, 26, 27
6			34, 36f1	32		31, 33, 35, 36f2
7		39,	37, 41f2, 42f1, 42f2			38, 40, 41f1
8	44, 47f2	43 (c), 45	46, 48f1&2	47f1		
9	50	54f3		54f1&2		49, 51, 52, 53
10		59f1	56			55, 57, 58, 59f2, 60f1, 60f2
11		61, 66f1, 66f2	62	65f2		63, 64, 65f1, 66f3
12	68, 72f1, 72f3	72f2	69			67, 70, 71
13	76					73, 74, 75, 77f1&2, 78f1&2
14			84f2			79, 80, 81, 82, 83f1, 83f2, 84f1
15	88, 89f1	85, 90f1&2	87	89f2		86
16	91		92, 94, 96f1, 2&3		93 (d)	95
17				98, 99, 102f2,		97f1&2, 100, 101, 102f1
18	107, 108f1	103, 104, 106	108f2&3			105
19	114f1	109	110, 113, 114f2			111, 112
20		117, 119f1&2, 120f1	116			115, 118, 120f2

Notes (in bold type):

(a) All the images in these 120 plates are accounted for. They are grouped so that columns 2 and 3 list the images of birds Temminck correctly named as new. Columns 4 and 5 list the images of birds for which Temminck provided unnecessary names (i.e. would eventually be seen as synonyms). Column 7 lists the images of birds named earlier by others, but which Temminck included to complement Buffon's work.

(b) Pl. 28 *Dendrocolaptes procurus* is a senior name which we place in the synonymy of *Campylorhamphus falcularius* (Vieillot, 1822) because the junior name has been used extensively and almost universally for more than 50 years, and we believe stability is best served by maintaining its use. This requires an application to the Commission to suppress the senior name under Art. 23.9.3 of the Code (ICZN 1999: 28), and one or more of us will submit this.

(c) Pl. 43 *Falco torquatus* credited to Cuvier, was identified as new, but the name Temminck supplied was preoccupied; its status as a valid taxon was recognised only in 1922.

(d) For Pl. 93 *Falco torquatus (hornotinus)*, the wrapper omitted an author's name, but a footnote on the wrapper (see our Fig. 2) explains that Temminck (wrongly) considered this image to be of the old male of the species he had depicted in Pl. 43.

Judging precedence

While Art. 23 of the Code (ICZN 1999) provides strong backing for prevailing usage, we are aware of considerable support for prevailing usage for names that have been in use for decades. We have discussed this with Commissioners, and we have felt it appropriate to detail the policy we adopt here.

In the belief that the community (a) has already accepted almost all the new names that we discuss and, in such cases, has applied dates based on the plates and the relevant wrappers, and (b) has appropriately ignored the lists of Froriep (1821, 1822) giving the names Temminck used in the wrappers, we seek: (1) to recognise the wrappers as valid publications and to accept the new names thus introduced, unless there is a strong reason to differ; and (2) to suppress three senior names and to make appropriate applications to the Commission under Art. 23.9 (ICZN 1999: 28).

In the Appendix, we provide details relevant to all names Temminck used in the wrappers, including the MS names of others which he introduced. We first give the appropriate date for the name in the wrapper. We close each comment with the date of publication of the eventual text. For the benefit of future students of Temminck's work we also separate those of his new names that immediately fell into synonymy.

Although we are convinced that precedence belongs to many of the new names introduced in the wrappers, it is clear that those that fell directly into synonymy must remain there. It should be no surprise that there are cases where another author introduced a name for a taxon named in a wrapper—either using an identical name to that of Temminck or a different name⁵—and that this occurred before Temminck provided the delayed texts. Below each such case is examined and these names are traced to their origins and dates of publication.

Based on the above, we briefly set out here the consequences that would follow a decision to reject all of the names Temminck provided in the wrappers. In the interests of brevity, the references are not included here, they can be found in our Appendix:

1. *Sylvia conspicillata* (Pl. 6, fig. 1) [August 1820]: this name would remain unchanged except that it would need to be cited from Temminck's *Manuel d'ornithologie* in October 1820.
2. *Sylvia subalpina* (Pl. 6, fig. 2) [August 1820]: this name would remain unchanged except that it would need to be cited from Temminck's *Manuel d'ornithologie* in October 1820.
3. *Sylvia cisticola* (Pl. 6, fig. 3) [August 1820]: this name would remain unchanged except that it would need to be cited from Temminck's *Manuel d'ornithologie* in October 1820.
4. *Pyrrhula cinereola* (Pl. 11, fig. 1) [September 1820]: this name would fall into the synonymy of *Fringilla hypoleuca* M. H. C. Lichtenstein, 1823.
5. *Platyrrhynchus olivaceus* (Pl. 12, fig. 1) [September 1820]: would fall into the synonymy of *Todus olivaceus* M. H. C. Lichtenstein, 1823.
6. *Platyrrhynchus cancrumus* (Pl. 12, fig. 2) [September 1820]: would fall into the synonymy of *Platyrrhynchus cancrumus* Swainson, 1822.
7. *Muscicapa caesia* (Pl. 17, figs. 1–2) [October 1820]: would fall into the synonymy of *Lanius caesius* M. H. C. Lichtenstein, 1823.
8. *Trochilus bilophus* (Pl. 18, fig. 3) [October 1820]: would fall into the synonymy of *Trochilus cornutus* zu Wied-Neuwied, 1821.
9. *Picus aurulentus* (Pl. 59, fig. 1) [May 1821]: was given the same name by M. H. C. Lichtenstein, 1823, and his name would take precedence.
10. *Trochilus langsdorffi* (Pl. 66, fig. 1) [June 1821]: was given the same name by Vieillot, 1822, and his name would take precedence.
11. *Trochilus chalybeus* (Pl. 66, fig. 2) [June 1821]: was given the same name again by Vieillot (1822). The earlier name *Trochilus chalybeus* Bechstein, 1811, is regarded as

⁵ Which occasionally yield different spellings, names or information.

unidentifiable and was ignored by Salvin (1892) and Cory (1918). So Vieillot's name would take precedence.

12. *Dendrocolaptes sylviellus* (Pl. 72, fig. 1) [July 1821]: would fall into the synonymy of *Dendrocolaptes erithacus* M. H. C. Lichtenstein, 1822, and his name would take precedence.
13. *Xenops rutilus* (Pl. 72, fig. 2) [July 1821]: is not preoccupied by the *nomen nudum* introduced by Lichtenstein (1819) and Temminck's text antedates Lichtenstein (1823).
14. *Falco riocouri* (Pl. 85) [October 1821]: would fall into the synonymy of *Elanoides riocourii* Vieillot, 1822, and his name would take precedence. Note the spelling difference.
15. *Criniger barbatus* (Pl. 88) [November 1821]: would date from Temminck's text and use the binomen *Trichophorus barbatus*.

Special comments

Temminck introduced the name *Enicurus* on the wrapper of livr. 19. This was dated 1824 by Sharpe (1883: 312), who cited *Enicurus* as the original spelling but 'corrected' that to *Henicurus* for his usage⁶, but it was dated 'Ap. 1822'⁷ by Sherborn (1926: 2156), and Ripley (1964: 85) used *Enicurus* and dated it 1822. We date it from February 1822, based on Table 1, column 4.

Type specimens.—When a name is dated from a plate the specimens depicted limit the type series, and where just one subject of the taxon concerned was depicted then that specimen is a holotype. If it were to be considered that the names introduced in the wrappers are not validly introduced the specimens depicted would no longer restrict the type series. It would then sometimes be necessary to bring all the potentially eligible specimens together to determine which specimens are correctly identified and which are not truly representative types.

The case of *Dendrocolaptes procurvus* (see note in the Appendix) demonstrates the potential problems of accepting names from later texts: the specimens may not be the same. In this context it should also be remembered that plates were painted by artists employed by the Muséum national d'Histoire naturelle in Paris to whom Temminck supplied specimens (although he may not have done so if he believed there was a good specimen in Paris); see Dickinson (2001: 12). Clearly there was also the potential for Temminck to write his delayed descriptions based on specimens he had received since the plate was painted.

Acknowledgements

We are particularly grateful to Jan van Tol and René Dekker for their help and advice, to Alain Lebossé for again allowing us to use photographs taken from his set of original wrappers and to Paul Smith for help with information regarding the Pereyra reference. Thanks also go to two current Commissioners of the ICZN who helped us to develop our arguments in favour of accepting the wrappers as part of the work and to our anonymous referees including a third ICZN Commissioner.

References:

- Bechstein, J. M. 1811. *Johann Lathams allgemeine Übersicht der Vogel*, Bd. 4. Nürnberg.
 Brisson, A. D. 1760. *Ornithologia sive synopsis methodica sistens Avium visionem in ordines Sectiones, Genera, Species ipsarumque Varietates*. Paris.
 Buffon, G. C. L. 1771–86. *Histoire naturelle des oiseaux*, 10 vols. Imprimerie Royale, Paris.

⁶ Those accustomed to studying the volumes of the *Catalogue of birds of the British Museum* should be aware that during his work Sharpe, a strong supporter of correct Latin, 'corrected' numerous spellings (even sometimes when listing the original usage and doing so incorrectly).

⁷ Implying, incorrectly, that all the delayed texts appeared in April 1822.

- Cory, C. B. 1918. Catalogue of birds of the Americas and the adjacent islands, pt. 2(1). *Publ. Field Mus. Nat. Hist. Zool. Ser.* 13(2).
- Cuvier, G. 1820. Prospectus [for the *Nouveau recueil de planches coloriées*]. G. Dufour & E. d'Ocagne, Paris.
- Dekker, R. W. R. J. 2003. Type specimens of birds in the National Museum of Natural History, Leiden. Part 2. Passerines: Eurylaimidae – Eopsaltridae (Peters's sequence). *NNM Tech. Bull.* 6: 1–142.
- Dickinson, E. C. 2001. Systematic notes on Asian birds. 9. The “*Nouveau recueil de planches coloriées*” of Temminck & Laugier (1820–1839). *Zool. Verhand.* 335: 7–54.
- Dickinson, E. C. 2012. The first twenty livraisons of “*Les planches coloriées d'oiseaux*” of Temminck & Laugier (1820–1839). IV. Discovery of the remaining wrappers. *Zool. Bibliogr.* 2: 35–49.
- Dickinson, E. C. & Christidis, L. 2014. *The Howard and Moore complete checklist of the birds of the world*, vol. 2. Aves Press, Eastbourne.
- Dickinson, E. C. & Remsen, J. V. 2013. *The Howard and Moore complete checklist of the birds of the world*, vol. 1. Aves Press, Eastbourne.
- Dickinson, E. C., Overstreet, L. K., Dowsett, R. J. & Bruce, M. D. 2011. *Priority! The dating of scientific names in ornithology*. Aves Press, Northampton.
- Evenhuis, N. L. 2003. Dating and publication of the *Encyclopédie Méthodique* (1782–1832), with special reference to the parts of the *Histoire Naturelle* and details on the *Histoire Naturelle des Insectes*. *Zootaxa* 166: 1–48.
- Froriep, L. F. 1821. *Notizen aus dem Gebiete der Natur- und Heilkunde*, no. 2, cols. 16–31. Landes-Industrie-Comptoir, Weimar.
- Froriep, L. F. 1822. *Notizen aus dem Gebiete der Natur- und Heilkunde*, no. 53, cols. 130–132. Landes-Industrie-Comptoir, Weimar.
- Hartert, E. 1892. *Catalogue of the birds in the British Museum*, vol. 16. Trustees of the Brit. Mus. (Nat. Hist.), London.
- Hellmayr, C. E. 1925. Catalogue of birds of the Americas and the adjacent islands, pt. 4. *Publ. Field Mus. Nat. Hist. Zool. Ser.* 13(4).
- Hellmayr, C. E. 1927. Catalogue of birds of the Americas and the adjacent islands, pt. 5. *Publ. Field Mus. Nat. Hist. Zool. Ser.* 13(5).
- Hellmayr, C. E. 1929. Catalogue of birds of the Americas and the adjacent islands, pt. 6. *Publ. Field Mus. Nat. Hist. Zool. Ser.* 13(6).
- Hellmayr, C. E. & Conover, B. 1949. Catalogue of birds of the Americas and the adjacent islands, pt. 1(4). *Publ. Field Mus. Nat. Hist. Zool. Ser.* 13(1).
- van den Hoek Ostende, L. W., Dekker, R. W. R. J. & Keijl, G. O. 1997. Type-specimens of birds in the National Museum of Natural History, Leiden. *NNM Tech. Bull.* 1: 1–248.
- Hume, A. 1875. A first list of the birds of Upper Pegu. *Stray Feathers* 3: 1–194.
- International Commission on Zoological Nomenclature (ICZN). 1999. *International code of zoological nomenclature*. Fourth edn. International Trust for Zoological Nomenclature, London
- Lebossé, A. & Bour, R. 2011. The first twenty livraisons of “*Les Planches Coloriées d'Oiseaux*” of Temminck & Laugier (1820–1839). I. The ten wrappers now known. *Zool. Bibliogr.* 1: 141–150.
- Lebossé, A. & Dickinson, E. C. 2014. Fresh information relevant to the make-up of the livraisons of the “*Galerie des Oiseaux*” by Vieillot (1748–1831) & Oudart (1796–1860). *Zool. Bibliogr.* 3: 25–58.
- Lichtenstein, M. H. C. 1819. Preis Verzeichnisse der Säugethier und Vögel Doubletten des Zoologischen Museums der Universität zu Berlin. *Isis Encyclopädische Zeitung von Oken, Litterarischer Anzeiger* XX, 5: 77–84.
- Lichtenstein, M. H. C. 1820. Die Gattung *Dendrocolaptes*. *Abh. Phys. Kl. K.-Preuss. Akad. Wiss.* 5: 197–210.
- Lichtenstein, M. H. C. 1822. Die Gattung *Dendrocolaptes*. *Abh. K. Press. Akad. Wiss. Berlin* 7: 255–266.
- Lichtenstein, M. H. C. 1823. *Verzeichniss der Doubletten des zoologischen Museums der Königl. Universität zu Berlin nebst Beschreibung vieler bisher unbekannter Arten von Säugethieren, Vögeln, Amphibien und Fischen*. T. Trautwein, Berlin.
- Linnaeus, C. 1766. *Systema naturae*, vol. 1(1). Twelfth edn. Laurentii Salvii, Holmiae.
- Neumann, O. 1914. Über einige afrikanische Uhus. II, Die Zugehörigkeit von *Bubo ascalaphus trothae* Rchw. *J. Orn.* 62: 36–38.
- Ogilvie-Grant, W. R. 1893. *Catalogue of the birds in the British Museum*, vol. 22. Trustees of the Brit. Mus. (Nat. Hist.), London.
- Pereyra, J. A. 1945. *La obra ornitológica de Don Félix de Azara*. Biblioteca Americana, Buenos Aires.
- Peters, J. L. 1940. *Check-list of birds of the world*, vol. 4. Harvard Univ. Press, Cambridge, MA.
- Peters, J. L. 1945. *Check-list of birds of the world*, vol. 5. Harvard Univ. Press, Cambridge, MA.
- Pucheran, J. 1850. Etudes sur les types peu connus du Musée de Paris. *Rev. Mag. Zool.* (2)2: 81–104.
- Quoy, J. R. C. 1824. *Bulletin général et universel des annonces et des nouvelles scientifiques, publiée sous la direction du baron de Férussac* 1: 207–208.
- Raphael, S. 1970. The publication dates of the Transactions of the Linnean Society, Series I, 1791–1875. *Biol. J. Linn. Soc.* 2: 61–76.

- Ripley, S. D. 1964. Subfamily Turdinae. Pp. 13–227 in Mayr, E. & Paynter, R. A. (eds.) *Check-list of birds of the world*, vol. 10. Mus. Comp. Zool., Cambridge, MA.
- Salvin, O. 1892. Upupae and Trochili. Pp. 1–433 in Salvin, O. & Hartert, E. *Catalogue of the birds in the British Museum*, vol. 16. Trustees of the Brit. Mus., London.
- Sclater, P. L. 1890. *Catalogue of the birds in the British Museum*, vol. 15. Trustees of the Brit. Mus., London.
- Sharpe, R. B. 1874. *Catalogue of the birds in the British Museum*, vol. 1. Trustees of the Brit. Mus., London.
- Sharpe, R. B. 1875. *Catalogue of the birds in the British Museum*, vol. 2. Trustees of the Brit. Mus., London.
- Sharpe, R. B. 1883. *Catalogue of the birds in the British Museum*, vol. 7. Trustees of the Brit. Mus., London.
- Shaw, G. 1809. *Vivarium naturae, or The naturalist's miscellany*, vol. 20. London.
- Shelley, G. E. 1891. *Catalogue of the birds in the British Museum*, vol. 19. Trustees of the Brit. Mus. (Nat. Hist.), London.
- Sherborn, C. D. 1898. On the dates of Temminck's and Laugier's "Planches coloriées". *Ibis* (7)4: 485–488.
- Sherborn, C. D. 1922. *Index animalium sive index nominum quae ab A.D. MDCCLVIII generibus et speciebus animalium imposita sunt*, pt. 1. Trustees of the Brit. Mus., London.
- Sherborn, C. D. 1923. *Index animalium sive index nominum quae ab A.D. MDCCLVIII generibus et speciebus animalium imposita sunt*. 1801–1850, pt. 2. Trustees of the Brit. Mus., London.
- Sherborn, C. D. 1925a. *Index animalium sive index nominum quae ab A.D. MDCCLVIII generibus et speciebus animalium imposita sunt*. 1801–1850, pt. 4, pp. 129–384. Trustees of the Brit. Mus., London.
- Sherborn, C. D. 1925b. *Index animalium sive index nominum quae ab A.D. MDCCLVIII generibus et speciebus animalium imposita sunt*. 1801–1850, pt. 7, pp. 1453–1771. Trustees of the Brit. Mus., London.
- Sherborn, C. D. 1926. *Index animalium sive index nominum quae ab A.D. MDCCLVIII generibus et speciebus animalium imposita sunt*. 1801–1850, pt. 9, pp. 2000–2248. Trustees of the Brit. Mus., London.
- Sherborn, C. D. 1927. *Index animalium sive index nominum quae ab A.D. MDCCLVIII generibus et speciebus animalium imposita sunt*. 1801–1850, pt. 14, pp. 3393–3746. Trustees of the Brit. Mus., London.
- Sherborn, C. D. 1930. *Index animalium sive index nominum quae ab A.D. MDCCLVIII generibus et speciebus animalium imposita sunt*. 1801–1850, pt. 22, pp. 5349–5702. Trustees of the Brit. Mus., London.
- Steinheimer, F. D. 2009. The type specimens of Corvidae (Aves) in the Museum für Naturkunde at the Humboldt-University of Berlin, with the description of a new subspecies of *Dendrocitta vagabunda*. *Zootaxa* 2149: 1–49.
- Stresemann, E. 1922a. Erscheinungsdaten von Temminck und Laugiers "Planches Coloriées". *Anz. Orn. Ges. Bayern* 1: 54–55.
- Stresemann, E. 1922b. Rafinesque's Benennungen sizilianischer Vögel. *J. Orn.* 70: 128–129.
- Stresemann, E. 1951. Histoire des origines des 'Planches Coloriées' de Temminck et Laugier. *L'Oiseau* 21: 33–47.
- Stresemann, E. & Amadon, D. 1979. Order Falconiformes. Pp. 271–425 in Mayr, E. & Cottrell, G. W. (eds.) *Check-list of birds of the world*, vol. 1. Second edn. Mus. Comp. Zool., Cambridge, MA.
- Strickland, H. E., Phillips, J., Richardson, J., Owen, R., Jenyns, L., Broderip, W. J., Henslow, J. S., Shuckard, W. E., Waterhouse, G. R., Yarrell, W., Darwin, C. & Westwood, J. O. 1843. Report of a Committee appointed to consider of the Rules by which the nomenclature of zoology may be established on a uniform and permanent basis. *Rep. 12th Meet. Brit. Assoc. Advancement Sci. (Manchester, 1842)*: 105–121.
- Svensson, L. 2013. Subalpine Warbler: variation and taxonomy. *Brit. Birds* 106: 651–668.
- Swainson, W. 1822–23. *Zoological illustrations, or Original figures and descriptions of new, rare, or interesting animals*, (1)3 [unnumbered]. London.
- Temminck, C. J. 1807. *Catalogue systématique du cabinet d'ornithologie et de la collection de quadrumanes de C. J. Temminck*. C. Sepp, Amsterdam.
- Temminck, C. J. 1815. *Manuel d'ornithologie ou tableau systématique des oiseaux qui se trouvent en Europe*. Amsterdam & Paris.
- Temminck, C. J. 1820. *Manuel d'ornithologie ou tableau systématique des oiseaux qui se trouvent en Europe*, pt. 1. Gabriel Dufour, Paris.
- Temminck, C. J. & Laugier, M. 1820–39. *Nouveau recueil de planches coloriées d'oiseaux*, 102 livraisons (600 pl.). Levrault; Dufour et d'Ocagne, Paris.
- Temminck, C. J. & Laugier, M. 1820a. *Nouveau recueil de planches coloriées d'oiseaux*, Livraison 1. Levrault; Dufour et d'Ocagne, Paris. [Pl. 1–6 (August). Delayed texts published 25 December 1824.]⁸
- Temminck, C. J. & Laugier, M. 1820b. *Nouveau recueil de planches coloriées d'oiseaux*, Livr. 2. Levrault; Dufour et d'Ocagne, Paris. [Pl. 7–12 (September). Delayed texts published 25 December 1824.]
- Temminck, C. J. & Laugier, M. 1820c. *Nouveau recueil de planches coloriées d'oiseaux*, livr. 3. Levrault; Dufour et d'Ocagne, Paris. [Pl. 13–18 (October). Delayed texts published 25 December 1824.]
- Temminck, C. J. & Laugier, M. 1820d. *Nouveau recueil de planches coloriées d'oiseaux*, livr. 4. Levrault; Dufour et d'Ocagne, Paris. [Pl. 19–24 (November). Delayed texts published 25 December 1824.]
- Temminck, C. J. & Laugier, M. 1820e. *Nouveaux recueil de planches coloriées d'oiseaux*, 5. Levrault; Dufour et d'Ocagne, Paris. [Pl. 25–30 (December). Delayed texts published 25 December 1824.]

⁸ All dates of publications for these livraisons based on the *Bibliographie de la France* (see Dickinson 2012).

- Temminck, C. J. & Laugier, M. 1821a. *Nouveau recueil de planches coloriées d'oiseaux*, livr. 6. Levrault; Dufour et d'Ocagne, Paris. [Pl. 31–36 (January). Delayed texts published 25 December 1824.]
- Temminck, C. J. & Laugier, M. 1821b. *Nouveau recueil de planches coloriées d'oiseaux*, livr. 7. Levrault; Dufour et d'Ocagne, Paris. [Pl. 37–42 (February). Delayed texts published 26 July 1823.]
- Temminck, C. J. & Laugier, M. 1821c. *Nouveau recueil de planches coloriées d'oiseaux*, livr. 8. Levrault; Dufour et d'Ocagne, Paris. [Pl. 43–48 (March). Delayed texts published 26 July 1823.]
- Temminck, C. J. & Laugier, M. 1821d. *Nouveau recueil de planches coloriées d'oiseaux*, livr. 9. Levrault; Dufour et d'Ocagne, Paris. [Pl. 49–54 (18 April). Delayed texts published 26 July 1823.]
- Temminck, C. J. & Laugier, M. 1821e. *Nouveau recueil de planches coloriées d'oiseaux*, livr. 10. Levrault; Dufour et d'Ocagne, Paris. [Pl. 55–60 (18 April). Delayed texts published 26 July 1823.]
- Temminck, C. J. & Laugier, M. 1821f. *Nouveau recueil de planches coloriées d'oiseaux*, livr. 11. Levrault; Dufour et d'Ocagne, Paris. [Pl. 61–66 (June). Delayed texts published 30 August 1823.]
- Temminck, C. J. & Laugier, M. 1821g. *Nouveau recueil de planches coloriées d'oiseaux*, livr. 12. Levrault; Dufour et d'Ocagne, Paris. [Pl. 67–72 (July). Delayed texts published 27 September 1823.]
- Temminck, C. J. & Laugier, M. 1821h. *Nouveau recueil de planches coloriées d'oiseaux*, livr. 13. Levrault; Dufour et d'Ocagne, Paris. [Pl. 73–78 (August). Delayed texts published 25 October 1823.]
- Temminck, C. J. & Laugier, M. 1821i. *Nouveau recueil de planches coloriées d'oiseaux*, livr. 14. Levrault; Dufour et d'Ocagne, Paris. [Pl. 79–84 (September). Delayed texts published 6 December 1823.]
- Temminck, C. J. & Laugier, M. 1821j. *Nouveau recueil de planches coloriées d'oiseaux*, livr. 15. Levrault; Dufour et d'Ocagne, Paris. [Pl. 85–90 (October). Delayed texts published 28 February 1824.]
- Temminck, C. J. & Laugier, M. 1821k. *Nouveau recueil de planches coloriées d'oiseaux*, livr. 16. Levrault; Dufour et d'Ocagne, Paris. [Pl. 91–96 (November). Delayed texts published 27 March 1824.]
- Temminck, C. J. & Laugier, M. 1821l. *Nouveau recueil de planches coloriées d'oiseaux*, livr. 17. Levrault; Dufour et d'Ocagne, Paris. [Pl. 97–102 (December). Delayed texts published 1 May 1824.]
- Temminck, C. J. & Laugier, M. 1822a. *Nouveau recueil de planches coloriées d'oiseaux*, livr. 18. Levrault; Dufour et d'Ocagne, Paris. [Pl. 103–108 (January). Delayed texts published 22 May 1824.]
- Temminck, C. J. & Laugier, M. 1822b. *Nouveau recueil de planches coloriées d'oiseaux*, livr. 19. Levrault; Dufour et d'Ocagne, Paris. [Pl. 109–114 (February). Delayed texts published 24 June 1824.]
- Temminck, C. J. & Laugier, M. 1822c. *Nouveau recueil de planches coloriées d'oiseaux*, livr. 20. Levrault; Dufour et d'Ocagne, Paris. [Pl. 115–120 (March). Delayed texts published 24 June 1824.]
- Traylor, M. A. 1979. Subfamily Elaeniinae. Pp. 3–112 in Traylor, M. A. (ed.) *Check-list of birds of the world*, vol. 8. Mus. Comp. Zool., Cambridge, MA.
- Vieillot, L. P. 1816a. *Analyse d'une nouvelle ornithologie élémentaire*. Deterville, Paris.
- Vieillot, L. P. 1816b. *Nouveau dictionnaire d'Histoire naturelle*, vol. 3. Paris.
- Vieillot, L. P. 1816c. *Nouveau dictionnaire d'Histoire naturelle*, vol. 4. Paris.
- Vieillot, L. P. 1817a. *Nouveau dictionnaire d'Histoire naturelle*, vol. 7. Paris.
- Vieillot, L. P. 1817b. *Nouveau dictionnaire d'Histoire naturelle*, vol. 8. Paris.
- Vieillot, L. P. 1817c. *Nouveau dictionnaire d'Histoire naturelle*, vol. 10. Paris.
- Vieillot, L. P. 1817d. *Nouveau dictionnaire d'Histoire naturelle*, vol. 11. Paris.
- Vieillot, L. P. 1817e. *Nouveau dictionnaire d'Histoire naturelle*, vol. 14. Paris.
- Vieillot, L. P. 1817f. *Nouveau dictionnaire d'Histoire naturelle*, vol. 18. Paris.
- Vieillot, L. P. 1818a. *Nouveau dictionnaire d'Histoire naturelle*, vol. 20. Paris.
- Vieillot, L. P. 1818b. *Nouveau dictionnaire d'Histoire naturelle*, vol. 22. Paris.
- Vieillot, L. P. 1818c. *Nouveau dictionnaire d'Histoire naturelle*, vol. 25. Paris.
- Vieillot, L. P. 1818d. *Nouveau dictionnaire d'Histoire naturelle*, vol. 27. Paris.
- Vieillot, L. P. 1819a. *Nouveau dictionnaire d'Histoire naturelle*, vol. 32. Paris.
- Vieillot, L. P. 1819b. *Nouveau dictionnaire d'Histoire naturelle*, vol. 34. Paris.
- Vieillot, L. P. 1822. *Tableau encyclopédique et méthodique des trois règnes de la nature. Ornithologie*. Livraison 91, 529–848. Paris.
- Vieillot, L. P. 1823. *Tableau encyclopédique et méthodique des trois règnes de la nature. Ornithologie*. Livraison 93, 849–1460. Paris.
- Voisin, C. & Voisin, J.-F. 2001. Liste des types d'oiseaux des collections du Muséum national d'Histoire naturelle de Paris. 8: Rapaces diurnes (Accipitridés), première partie. *Zoosystema* 23: 173–190.
- Zimmer, J. T. 1926. Catalogue of the Edward E. Ayer Ornithological Library. *Publ. Field Mus. Nat. Hist. Zool. Ser.* 16: 1–706.
- Zimmer, J. T. 1950. Studies of Peruvian birds. No. 57. The genera *Colibri*, *Anthracothorax*, *Klais*, *Lophornis* and *Chlorestes*. *Amer. Mus. Novit.* 1463: 1–28.
- zu Wied-Neuwied, M. 1821. *Reise nach Brasilien in den Jahren 1815–17*. Bd. 2. Frankfurt am Main.
- Addresses:* Edward C. Dickinson, Flat 19, Marlborough Court, Southfields Road, Eastbourne, East Sussex BN21 1BT, UK; and Naturalis Biodiversity Center, Darwinweg 2, 2333 CR, Leiden, the Netherlands, e-mail: ecddickinson13@gmail.com. Pepijn Kamminga, Naturalis Biodiversity Center, Darwinweg 2, 2333 CR, Leiden, the Netherlands, e-mail: pepijn.kamminga@naturalis.nl. Steven van der Mije, Naturalis

Biodiversity Center, Darwinweg 2, 2333 CR, Leiden, the Netherlands, e-mail: steven.vandermije@naturalis.nl

Appendix

Throughout we provide taxon names in current use (i.e. in Dickinson & Remsen 2013, or Dickinson & Christidis 2014) preceded by 'Now'; if such a phrase is lacking it implies that the original specific epithet and authorship is that used in those volumes.

A. Details of names proposed by Temminck and not potentially in synonymy

Livr. 1, Pl. 1: *Lophophorus cuvieri* Temminck, 1820 (August). Treated as a hybrid (see Ogilvie-Grant, 1893: 303) and not in use for a valid taxon.⁹ Temminck's text dates from 25 December 1824 (see Dickinson 2012: 47).

Livr. 1, Pl. 4: *Strix lactea* Temminck, 1820 (August). Now: *Bubo lacteus*. Temminck's text dates from 25 December 1824 (see Dickinson 2012: 47).

Livr. 1, Pl. 6, fig. 3: *Sylvia cisticola* Temminck, 1820 (August). Now *Cisticola juncidis cisticola*. **Competing names** This name reappears in Temminck's *Manuel d'ornithologie* in October 1820 (see Sherborn 1925a: 1330), well before 25 December 1824 when Temminck's text appeared (see Dickinson 2012: 47).

Livr. 2, Pl. 7: *Coccyzus Geoffroyi* Temminck, 1820 (September). Now *Neomorphus geoffroyi*. Temminck's text dates from 25 December 1824 (see Dickinson 2012: 47).

Livr. 2, Pl. 11, fig. 1: *Pyrrhula cinereola* Temminck, 1820 (September). Now *Sporophila leucoptera cinereola*. **Competing names** *Fringilla hypoleuca* M. H. C. Lichtenstein, 1823, published in his *Verzeichniss der Doubletten* which has a preface dated September 1823 and is generally accepted as published by end 1823 (see Steinheimer 2009). Temminck's text dates from 25 December 1824 (see Dickinson 2012: 47) and is later.

Livr. 2, Pl. 11, fig. 2: *Pyrrhula falcirostris* Temminck, 1820 (September). Now *Sporophila falcirostris*. Temminck's text dates from 25 December 1824 (see Dickinson 2012: 47).

Livr. 2, pl. 12, fig. 1: *Platyrynchos olivaceus* Temminck, 1820 (September). Now *Rhynchocyclus olivaceus olivaceus*. **Competing names** *Todus olivaceus* M. H. C. Lichtenstein, 1823, published in his *Verzeichniss der Doubletten* which has a preface dated September 1823 and is generally accepted as published by end 1823 (see Steinheimer 2009). Temminck's text dates from 25 December 1824 (see Dickinson 2012: 47).

Livr. 2, Pl. 12, fig. 2: *Platyrynchos canromus* Temminck, 1820 (September). Now *Platyrinchus mystaceus canromus*. **Competing names** Swainson (1822) in his *Zoological illustrations* (ser. 1) provided a plate [115] of a female of *Platyrhynchus [sic] canromus*, which dates from about August. Hellmayr (1927: 266) accepted that this depiction is of the female of the species; he also placed *canromus* Temminck in the synonymy of nominate *mystaceus*, but Traylor (1979: 110) restored it to recognition. Temminck's text dates from 25 December 1824 (see Dickinson 2012: 47).

Livr. 3, Pl. 16: *Strix leucotis* Temminck, 1820 (October). Now *Ptilopsis leucotis*. Temminck's text dates from 25 December 1824 (see Dickinson 2012: 47).

Livr. 3, Pl. 18, fig. 3: *Trochilus bilophus* Temminck, 1820 (October). Now *Heliactin bilophus* Temminck, 1820. **Competing names** The name *Trochilus cornutus* zu Wied, 1821, was used by Peters (1945: 128) *contra* use of *Trochilus bilophum (sic)* by Cory (1918: 288); this is from pt. 2 ('Zweiter Band'); pt. 1 is believed to have appeared before 18 June 1821 (A. Kourgli *in litt.* November 2019) and the second part is accepted as being published in 1821. Temminck's text dates from 25 December 1824 (see Dickinson 2012: 47).

Livr. 4, Pl. 20: *Strix Leschenaulti* Temminck, 1820 (November). Now *Ketupa zeylonensis leschenaulti*.¹⁰ Temminck's text dates from 25 December 1824 (see Dickinson 2012: 47).

Livr. 5, Pl. 28: *Dendrocolaptes procurvus* Temminck, 1820 (December). Temminck's text dates from 25 December 1824 (see Dickinson 2012: 47). Currently, and for nearly a century, treated as a synonym of *Campylorhamphus falcularius* (Vieillot, 1822). This situation arose when Hellmayr (1925: 339–340) noted that in the context of the new name *procurvus* Temminck provided a plate that depicted a black-billed species, and later a text that described a very similar but red-billed species. Acting as First Reviser, Hellmayr fixed

⁹ For a discussion of this see Hume (1875: 166, footnote) who was undecided as to whether male and female specimens from the Pegu hills, which were compared with Temminck's plate and which he considered 'unquestionably' a good match, were hybrids or not. Currently available photographs of wild birds demonstrate that Temminck's plate is a good likeness for Kalij Pheasant *Lophura leucomelanos* with subspecies *lathamii* as the most probable subject (R. Dekker *in litt.* June 2021, J. Corder *in litt.* July 2021). This subspecific name was provided by J. E. Gray in 1829 and the name *cuvieri* might be seen as a senior synonym. However, while most of the type specimen is almost certainly that species the tail is definitely not, i.e. the specimen is a composite. An application will soon be made to the ICZN to reverse precedence under Art. 23.9.3 of the Code (ICZN 1999) and suppress the name *Lophophorus cuvieri*.

¹⁰ Sherborn (1927: 3507) spelled this name *leschenault* based on the later text.

the name *procurvus* on the species depicted in the plate (making the specimen a holotype). He dated the name from 1820, but he placed it in the synonymy of *Campylorhamphus falcularius*, 1822, unconvinced that it deserved precedence. In a footnote he added 'The text to livr. 1 to 20 of Temminck's work is supposed to have been issued with livr. 21 in April 1822, or even later...; but if Sherborn (1898: 487) is correct in assuming that the scientific (Latin) names of the birds figured in these early parts were printed in the back of the wrappers, *Dendrocolaptes procurvus* Temminck will have to be accepted as the oldest title for *D. falcularius* Vieillot.' The similar red-billed species is *Campylorhamphus trochilirostris* described by Lichtenstein (1820). **Competing names** *Dendrocopus falcularius* (now *Campylorhamphus falcularius*) Vieillot, 1822. We believe that despite this being a name junior to the name *procurvus*, and Hellmayr's belief that *procurvus* 'would have to be accepted', the case for avoiding such a belated change and accepting prevailing usage is stronger; and we will submit an application to the Commission under Art. 23.9.3 of the Code (ICZN 1999: 28) to suppress the name *Dendrocolaptes procurvus* and thus protect use of the name *falcularius*.

Livr. 5, Pl. 29, fig. 2: *Meliphaga reticulata* Temminck, 1820 (December). Temminck's text dates from 25 December 1824 (see Dickinson 2012: 47).

Livr. 5, Pl. 30: *Muscicapa hyacinthina* Temminck, 1820 (December). Now *Cyornis hyacinthinus hyacinthinus*. Temminck's text dates from 25 December 1824 (see Dickinson 2012: 47).

Livr. 8, Pl. 44: *Falco ptilorhynchus* Temminck, 1821 (March). Now *Pernis ptilorhynchus*. **Competing names** Voisin & Voisin (2001: 175–176) suggested that this taxon was named *Buteo cristatus* by Vieillot (1823: 1225).¹¹ Temminck's text dates from 26 July 1823 (see Dickinson 2012: 47). This is based on the *Bibliographie de la France* and implies that it had been received in the preceding week or earlier, which makes Temminck's name the earliest available.

Livr. 8, Pl. 47, fig. 2: *Charadrius ruficapillus* Temminck, 1821 (March). Temminck's text dates from 26 July 1823 (see Dickinson 2012: 47).

Livr. 9, Pl. 50: *Strix africana* Temminck, 1821 (April). Now *Bubo africanus*. **Competing names** Investigation of a possible preoccupation by Shaw (1809)—see Sherborn (1923: 137) led us to the determination by Sharpe (1875: 27) that this was unidentifiable; but Sharpe then placed Temminck's name in the synonymy of *Strix maculosa* Vieillot, 1817b, which Peters (1940: 118, footnote), referring to Neumann (1914), stated was unidentifiable. Temminck's text dates from 26 July 1823 (see Dickinson 2012: 47).

Livr. 12, Pl. 68: *Strix brama* Temminck, 1821 (July). Now *Athene brama*. Temminck's text dates from 27 September 1823 (see Dickinson 2012: 47).

Livr. 12, Pl. 72, fig. 1: *Dendrocolaptes sylviellus* Temminck, 1821 (July). Now *Sittasomus griseicapillus sylviellus*. **Competing names** Lichtenstein (1822)¹² described this as *Dendrocolaptes erithacus*. Temminck's text dates from 27 September 1823 (see Dickinson 2012: 47).

Livr. 12, Pl. 72, fig. 3: *Sitta velata* Temminck, 1821 (July). Now *Sitta frontalis velata*. Temminck's text dates from 27 September 1823 (see Dickinson 2012: 47).

Livr. 13, Pl. 76: *Pitta [sic] thoracica* Temminck, 1821 (August). Now *Stachyris thoracica*. Temminck's text dates from 25 October 1823 (see Dickinson 2012: 47).

Livr. 15, Pl. 88: *Criniger barbatus* Temminck, 1821 (October). Now *Criniger barbatus barbatus*. Note that Temminck used *Criniger* in the wrapper, but introduced *Trichophorus* in the text as a new genus-group name. Temminck's text dates from 28 February 1824 (see Dickinson 2012: 47).

Livr. 15, pl. 89, fig. 1: *Bucco armillaris* Temminck, 1821 (October). Now *Psilopogon armillaris*. Temminck's text dates from 28 February 1824 (see Dickinson 2012: 47).

Livr. 16, Pl. 91: *Falco gracilis* Temminck, 1821 (November). Now *Geranospiza caerulescens gracilis*. Temminck's text dates from 27 March 1824 (see Dickinson 2012: 47).

Livr. 18, Pl. 107: *Caprimulgus nattererii* Temminck, 1822 (January). Now *Lurocalis semitorquatus nattererii*. Hartert (1892: 621) treated this as a synonym of nominate *semitorquatus*; Cory (1918: 123) as a subspecies based on size. Temminck's text dates from 22 May 1824 (see Dickinson 2012: 47).

Livr. 18, Pl. 108, fig. 1: *Nectarinia phoenicotis* Temminck, 1822 (January). Now *Chalcoparia singalensis phoenicotis*. Temminck's text dates from 22 May 1824 (see Dickinson 2012: 47).

Livr. 19, Pl. 114, fig. 1: *Emberizoides melanotis* Temminck, 1822 (February). Now *Coryphas piza melanotis*. Temminck's text dates from 26 June 1824 (see Dickinson 2012: 47).

¹¹ Published 26 July 1823 (see Evenhuis, 2003: 38). Sherborn (1925b: 1638) added '*Pernis*' to his entry for this. However, Sharpe (1874: 352) listed it as a synonym of *Baza lophotes* and pointed out that Pucheran (1850: 84) had also considered it to belong to that very distinct species. On p. 358 Sharpe discussed the 1816 name mentioning Strickland's suggestion that this might be *Baza subcristata* but did not confirm this.

¹² In a volume that suggests it was published in October but inclusion of meteorological data for the entire month proves publication must have been after 31 October.

B. Manuscript names and authors thereof given by Temminck but of which he became the author

Livr. 1, Pl. 6, fig. 1: *Sylvia conspicillata* 'Marmora' [= Temminck], 1820 (August). Now *Curruca conspicillata* *conspicillata*. **Competing names:** This name also appears in Temminck's *Manuel*, which dates from October 1820 (see Sherborn 1925b: 1487)¹³.

Livr. 1, Pl. 6, fig. 2: *Sylvia subalpina* 'Bonelli' [= Temminck], 1820 (August). Now *Curruca subalpina*. Long treated as a junior synonym of *Sylvia cantillans*, but see Svensson (2013) and Dickinson & Christidis (2014: 511). **Competing names** This name also appears in Temminck's *Manuel* in October 1820.

Livr. 3, Pl. 17: *Muscicapa caesia* 'Max.' (Prince Maximilian) [= Temminck], 1820 (October). Now *Thamnomanes caesioides*. **Competing names** Named *Lanius caesius* by Lichtenstein (1823), which according to Sclater (1890: 227) preceded Temminck's text dating from 25 December 1824 (see Dickinson 2012: 47).

Livr. 7, Pl. 39: *Strix pumila* 'Illiger' [= Temminck], 1821 (February).¹⁴ Now *Glaucidium pumilum*. **Competing names** This taxon was named *Strix pumila* by Lichtenstein, in September or later in 1823, and thus later than Temminck's delayed text, which dates from 26 July 1823 (see Dickinson 2012: 47). This name has precedence over *Glaucidium minutissimum* zu Wied, 1830, *contra* van der Hoek Ostende *et al.* (1997: 153) who mistakenly dated *minutissimum* from 1821. We consider that proposing to submerge the name *minutissimum* is a threat to stability and that the younger name should be maintained; an application to the Commission will be submitted in the next few months under Art. 23.9.3 of the Code (ICZN 1999: 28) to suppress the names *Strix pumila* Temminck, 1821, and *Strix pumila* M. H. C. Lichtenstein, 1823, and thereby protect the name *Strix minutissima* zu Wied, 1830.

Livr. 8, Pl. 45: *Falco punctatus* 'Cuvier' [= Temminck], 1821 (March). Temminck's text dates from 26 July 1823 (see Dickinson 2012: 47).

Livr. 9, Pl. 54, fig. 3: *Pipra rubro-capilla* 'Brisson'¹⁵ [= Temminck], 1821 (April). Now *Ceratopipra rubrocapilla*. The taxon had been mistakenly called *Pipra erythrocephala* by zu Wied-Neuwied (1820: 187 [184]) and later by Lichtenstein (1823: 29), but that name, derived from Linnaeus (1766: 339), applies to a related species. Temminck's text dates from 26 July 1823 (see Dickinson 2012: 47).

Livr. 10, Pl. 59, fig. 1: *Picus aurulentus* 'Illiger' [= Temminck], 1821 (April). Now *Piculus aurulentus*. **Competing names** Described by Lichtenstein (1823: 10) in or after September, but Temminck's text dating from 26 July 1823 appeared earlier.

Livr. 11, Pl. 61: *Falco hamatus* 'Illiger' [= Temminck], 1821 (May). Now *Helicolestes hamatus*. Long considered a junior synonym of *Rostrhamus sociabilis* (Vieillot, 1817f) – see Hellmayr & Conover (1949: 41, footnote). Temminck's text dates from 30 August 1823 (see Dickinson 2012: 47).

Livr. 11, Pl. 66, fig. 1: *Trochilus langsdorffi* 'Vieillot' [= Temminck], 1821 (May). Now *Discosura langsdorffi* (Temminck, 1821). **Competing names** Vieillot (1822: 574) published using the same name in the *Encyclopédie méthodique* which dates from 6 July 1821 (see Evenhuis 2003: 38).

Livr. 11, Pl. 66, fig. 2: *Trochilus chalybeus* 'Vieillot' [= Temminck], 1821 (May). Now *Lophornis chalybeus*. Temminck used Vieillot's MS name. **Competing names** Vieillot (1822: 574) named *chalybeus* in the *Encyclopédie méthodique* and Vieillot was treated as the first author by Peters (1945: 32). However, Zimmer (1950: 18) discussed precedence of Vieillot and Temminck's names, and wrote, of Temminck, 'It is known that, while the plates themselves carried no Latin names, and no text was issued until April 1822, the covers of some, and probably all, of the early parts bore the scientific names of the species included in them.' He added 'At the moment...we are obliged to accept *chalybeus*, 1822, as the name and date, and since Sherborn (*Index animalium*) has given priority of Vieillot in this instance, Vieillot may be considered as author despite the fact that Temminck rather certainly antedated him in the reference now lost.' The cover has of course now come to light. Sherborn (1925a: 1208) listed *Trochilus chalybeus* Bechstein, 1811, from p. 222 of Bechstein's *Johann Lathams allgemeine Uebersicht der Vögel* where there is a very brief description which appears to have been treated by all previous authors as a *nomen dubium*.

Livr. 12, Pl. 72, fig. 2: *Xenops rutilus* 'Lichtenstein' [= Temminck], 1821 (June). **Competing names** According to Sherborn (1930: 5701) this name appeared in the first of Lichtenstein's list of duplicates for sale, and Sherborn cites 1819, p. 37. This is a list of names and prices, with no descriptions, so this was a *nomen nudum* until used by Temminck. Using the name *rutilus*, Lichtenstein (1823: 17) published a description in a work

¹³ In the *Index animalium* Sherborn generally did not accept names associated with plates that appeared ahead of the descriptive text, but, as mentioned earlier, he acknowledged in 1922 that this policy was not now in line with general practice.

¹⁴ The wrapper refers to 'Paraguay, Brésil'; Illiger's specimens all came from Brazil. Mention of Paraguay refers to the writings of Azara whose description is now considered to have been of *Glaucidium brasilianum* rather than *pumilum* (see Pereyra 1945).

¹⁵ This name in Brisson (1760) is unavailable as the multi-volume work *Ornithologia sive synopsis methodical* has been declared non-binomial (although correctly formulated genus-group names in it are acceptable). This then, unlike other names grouped in this section, is not exactly a MS name.

dated September 1823, which should be dated no earlier than 30 September. Temminck's text—reported in the *Bibliographie de la France* on 27 September 1823 and dated from there—used the spelling *rutilans* which is listed by Sherborn (1930: 5699).

Livr. 15, Pl. 85: *Falco riocourii* 'Vieillot' [= Temminck], 1821 (October). Now *Chelictinia riocouri*. **Competing name:** *Elanoides riocourii* Vieillot, 1822, in *La galerie des oiseaux* in April (see Lebossé & Dickinson 2014: 54).

Livr. 15, Pl. 90, figs. 1–2. *Picus concretus* 'Reinwardt' = [Temminck], 1821 (October). Now *Hemicercus concretus*. Temminck's text dates from 28 February 1824 (see Dickinson 2012: 47).

Livr. 18, Pl. 103–104: *Falco uncinatus* 'Illiger' [= Temminck], 1822 (January). Now *Chondrohierax uncinatus*. Temminck's text dates from 22 May 1824 (see Dickinson 2012: 47).

Livr. 18, Pl. 106: *Columba porphyria* 'Reinwardt' [= Temminck], 1822 (January). Now *Ptilinopus porphyreus*. Temminck's text dates from 22 May 1824 (see Dickinson 2012: 47).

Livr. 19, Pl. 109: *Falco virgatus* 'Reinwardt' [= Temminck], 1822 (February). Now *Accipiter virgatus*. Temminck's text dates from 26 June 1824 (see Dickinson 2012: 47).

Livr. 20, Pl. 117: *Falco malaiensis* 'Reinwardt' [= Temminck] (Pl. 117), 1822 (March). Now *Ictinaetus malaiensis*. Temminck's text dates from 26 June 1824 (see Dickinson 2012: 47).

Livr. 20, Pl. 119 figs. 1–2: *Muscicapa hirundinacea* 'Reinwardt' [= Temminck], 1822 (March). Now *Hemipus hirundinaceus*. Temminck's text dates from 26 June 1824 (see Dickinson 2012: 47).

Livr. 20, Pl. 120, fig. 1: *Trochilus squalidus* Natterer [= Temminck], 1822 (March), Now *Phaethornis squalidus*. Temminck's text dates from 26 June 1824 (see Dickinson 2012: 47).

C. Names proposed by Temminck which were junior synonyms

Livr. 1, Pl. 3: *Falco hemidactylus* Temminck, 1820 (August). A junior synonym of *Geranospiza caerulescens caerulescens* (Vieillot, 1817c).

Livr. 3, Pl. 15: *Psittacus setarius* Temminck, 1820 (October). A junior synonym of *Prioniturus platurus* (Vieillot, 1818c).

Livr. 4, Pl. 21: *Strix sonneratii* Temminck, 1820 (November). A junior synonym of *Athene supercilariis* (Vieillot, 1817a).

Livr. 5, Pl. 29, fig. 1: *Meliphaga maculata* Temminck, 1820 (December). A junior synonym of *Lichmera flavicans* (Vieillot, 1817e).

Livr. 6, Pl. 34: *Strix occipitalis* Temminck, 1821 (January). A junior synonym of *Glauclidium perlatum* (Vieillot, 1817a).

Livr. 6, Pl. 36, fig. 1: *Tanagra specularifera* Temminck, 1821 (January). A junior synonym of *Hemithraupis flavicollis* (Vieillot, 1818b).

Livr. 7, Pl. 37: *Falco aterrimus* Temminck, 1821 (February). A junior synonym of *Daptrius ater* (Vieillot, 1816).

Livr. 7, Pl. 41, fig. 2: *Tringa albescens* Temminck, 1821 (February). A junior synonym of *Calidris ruficollis* (Pallas, 1776).

Livr. 7, Pl. 42, fig. 1: *Tanagra thoracica* Temminck, 1821 (February). A junior synonym of *Tangara desmarestii* (Vieillot, 1819a).

Livr. 7, Pl. 42, fig. 2: *Tanagra citronella* Temminck, 1821 (February). A junior synonym of *Tangara cyanoventris* (Vieillot, 1819a).

Livr. 8, Pl. 46: *Strix maugei* Temminck, 1821 (March). A junior synonym of *Ninox boobook fusca* (Vieillot, 1817a).

Livr. 8, Pl. 47, fig. 1: *Charadrius nigrifrons* 'Cuvier' [= Temminck], 1821 (March). A junior synonym of *Elseyornis melanops* (Vieillot, 1818d).

Livr. 8, Pl. 48, figs. 1–2: *Tanagra vittata* Temminck, 1821 (March). A junior synonym of *Pipraeidea melanonota* (Vieillot, 1819a).

Livr. 9, Pl. 54, figs. 1–2: *Pipra strigilata* 'Pr. de Neuwied' [= Temminck], 1821 (April). A junior synonym of *Machaeropterus regulus* Hahn, 1819.

Livr. 10, Pl. 56: *Falco pterocles* Temminck, 1821 (May). A junior synonym of *Geranoaetus albicaudatus* Vieillot, 1816c.

Livr. 11, pl. 62: *Strix macrorhynchus* Temminck, 1821 (June). A junior synonym of *Bubo virginianus* (J. F. Gmelin, 1788).

Livr. 12, Pl. 69: *Buceros sulcatus* Temminck, 1821 (July). A junior synonym of *Rhyticeros leucocephalus* (Vieillot, 1816c).

Livr. 14, Pl. 84, fig. 2: *Nectarinia inornata* Temminck, 1821 (September). A junior synonym of *Arachnothera affinis* (Horsfield, 1821). Raphael (1970) dated Horsfield's work from May 1821.

Livr. 15, Pl. 87: *Falco striolatus* Temminck, 1821 (October). A junior synonym of *Falco nitidus* Latham, 1790. This taxon was until recently called *Asturina nitida nitida* (see Stresemann & Amadon 1979: 355), but is now in genus *Buteo* (see Dickinson & Remsen 2013: 253).

Livr. 16, Pl. 92: *Falco xanthothorax* Temminck, 1821 (November). A junior synonym of *Micrastur ruficollis* (Vieillot, 1817c).

Livr. 16, Pl. 94: *Capito melanotis* Temminck, 1821 (November). A junior synonym of *Nystalus chacuru* (Vieillot, 1816b).

Livr. 16, Pl. 96, figs. 1–3: *Fringilla sphecura* Temminck, 1821 (November). A junior synonym of *Erythrura prasina* (Sparman, 1788).

Livr. 18, Pl. 108, figs. 2–3: *Nectarinia rubro cana* Temminck, 1822 (January). A junior synonym of *Dicaeum trochileum* (Sparman, 1789).

Livr. 19, Pl. 110: *Falco cuculoides* Temminck, 1822 (February). A junior synonym of *Accipiter soloensis* (Horsfield, 1821).

Livr. 19, Pl. 113: *Enicurus coronatus* Temminck, 1822 (February). A junior synonym of *Enicurus leschenaulti* (Vieillot, 1818a).

Livr. 19, Pl. 114: *Emberizoides marginalis* Temminck, 1822 (February). A junior synonym of *Emberizoides herbicola* (Vieillot, 1817d).

Livr. 20, Pl. 116: *Falco brachypterus* Temminck, 1822 (March). A junior synonym of *Micrastur semitorquatus* (Vieillot, 1817c).

Note: all names from Vieillot listed in C were introduced in the volumes of the *Nouveau dictionnaire d'Histoire naturelle* between 1816 and 1819.

D. Manuscript names given by Temminck but where he becomes the author (all are junior synonyms)

Livr. 1, Pl. 5: *Procnias ventralis* 'Illiger' [= Temminck], 1820 (August). A junior synonym of *Procnias averano carnobarba* (Cuvier, 1817); see Hellmayr (1929: 240).

Livr. 2, Pl. 8: *Falco Macei* 'Cuvier' [= Temminck], 1820 (September). A junior synonym of *Haliaeetus leucoryphus* (Pallas, 1771).

Livr. 2, Pl. 9: *Falco poecilnotus* 'Cuvier' [= Temminck], 1820 (September). A junior synonym of *Pseudastur albicollis* (Latham, 1790).

Livr. 4, Pl. 22: *Falco gularis* 'Cuvier' [= Temminck], 1820 (November). A junior synonym of *Circus buffoni* (J. F. Gmelin, 1788).

Livr. 4, Pl. 23: *Musophaga paulina* 'Vieillot' [= Temminck], 1820 (November). A junior synonym of *Tauraco erythrolophus* (Vieillot, 1819b).

Livr. 6, Pl. 32: *Falco fucosa* 'Cuvier' [= Temminck], 1821 (January). A junior synonym of *Aquila audax* (Latham, 1801).

Livr. 8, Pl. 43: *Falco torquatus* Cuvier [= Temminck], 1821 (March). A junior homonym, preoccupied by *Falco torquatus* Brünnich, 1764. Also preoccupied in genus *Accipiter* where eventually given the new name *Accipiter fasciatus hellmayri* by Stresemann (1922b).

Livr. 11, Pl. 65, fig. 2: *Malurus marginalis* 'Reinwardt' [= Temminck], 1821 (June). A junior synonym of *Megalurus palustris* Horsfield, (1821 June = May, see Raphael 1970).

Livr. 15, Pl. 89, fig. 2: *Bucco gularis* 'Reinwardt' [= Temminck], 1821 (October). A junior synonym of *Psilopogon australis australis* (Horsfield, 1821) dating from May 1821 (see Raphael 1970).

Livr. 17, Pl. 98: *Strix spadicea* 'Reinwardt' [= Temminck], 1821 (December). A junior synonym of *Glaucidium castanopterum* Horsfield, 1821 (May).

Livr. 17, Pl. 99: *Strix noctula* 'Reinwardt' [= Temminck], 1821 (December). A junior synonym of *Otus bakkamoena lempiji* Horsfield, 1821 (May).

Livr. 17, pl. 102, fig. 2: *Cuculus chalcites* 'Illiger' [= Temminck], 1821 (December). A junior synonym of *Chalcites lucidus plagosus* (Latham, 1801). See Shelley (1891: 297).

E. Names resolved many years later and then properly named

Livr. 16, Pl. 98: *Falco torquatus* (*hornotinus*) [no author cited on wrapper = Temminck], 1821 (November). Unavailable and anyway preoccupied, see Pl. 43 above. No name was provided for this until Stresemann (1922b) gave it the name *Accipiter fasciatus hellmayri*.

Why may the same species have different elevational ranges at different sites in New Guinea?

by Jared Diamond & K. David Bishop

Received 20 July 2021; revised 25 January 2022; published 11 March 2022

<http://zoobank.org/urn:lsid:zoobank.org:pub:B6A919CF-5F5B-4948-904D-C529231BEE52>

SUMMARY.—Species in mountainous areas have characteristic elevational ranges, but with some variation from site to site. Such variation has been studied extensively elsewhere in the world, but not yet for New Guinea bird species. Hence, we examined five sources of that variation for New Guinea birds: latitude, competition, slope, the Massenerhebung effect, and physical barriers. Decreases of species elevational ranges with latitude are illustrated by three sets of examples: 20 species confined to New Guinea’s mountains, but which descend to sea level at higher latitudes in Australia (joined to New Guinea at Pleistocene times of low sea level); 13 sea-level populations of some of the same New Guinea upland species on New Guinea’s Fly River bulge; and 11 populations on the Aru Islands (part of Pleistocene New Guinea and Australia). Many New Guinea species contract or expand their elevational ranges, associated with the presence or absence of competing congeners, which segregate by elevation at sites of sympatry. The flat Karimui Basin at an elevation of 1,110 m illustrates effects of slope, because the basin supports populations of many species otherwise characteristic of the flat lowlands, and lacks populations of many hill forest species characteristic of the sloping terrain found at that elevation elsewhere in New Guinea. We provide three sets of New Guinea examples of the Massenerhebung effect described for mountains elsewhere in the world: shifts of species to higher elevations on large high mountains far from the sea than on small coastal mountains or isolated mountains. Finally, we suggest that very steep high ridges boxing in a watershed on the Foja Mts. constitute dispersal barriers that have prevented 33 species expected at that watershed’s elevation from arriving or establishing themselves.

The mountains of New Guinea rise to 4,884 m. No New Guinea bird species occupies the entire span of elevations from sea level to the highest summit. Instead, each species occurs mainly within a limited elevational range, which is so characteristic of the species that it is routinely mentioned in short species accounts in field guides. For example, the standard guide by Pratt & Beehler (2015) gives 3,800–4,200 m as the range of Snow Mountain Robin *Petroica archboldi*, and 0–100 m as the range of White-bellied Pitohui *Pseudorectes incertus*. We are unaware of any record of the former species below 3,800 m, or of the latter species above 100 m.

Nevertheless, most life characteristics of animal and plant species are subject to some variation, which often proves understandable, and is also true of elevational ranges. For example, our Table 4 will demonstrate that the elevational floor of the Island Leaf Warbler *Seicercus poliocephalus* varies from 366 to 1,866 m, and its elevational ceiling from 1,195 to 2,152 m, among New Guinea mountains, and that this large variation can be explained by three physical variables. There is a considerable literature on variation in elevational ranges, initially subjected to detailed study in the Alps, and subsequently in other parts of the world (e.g., Troll 1948, Richards 1952, Howard 1968, Grubb 1971, Whitmore 1990, Foster 2010,

Bruijnzeel *et al.* 2010). However, this phenomenon has not received systematic attention in relation to New Guinea, although anecdotal reports exist.

This paper attempts an initial exploration of this phenomenon for New Guinea birds, based partly on analysis of already published information, and partly on our field experience of species elevational ranges on different New Guinea mountains, especially in the Van Rees Mts. and the Foja Mts. We shall discuss five sources of variation: latitude, competition, and terrain slope, which we discuss briefly; and the so-called Massenerhebung effect and barriers to dispersal, which we examine in more detail on the basis of our new field observations. Of course, there are surely other sources of variation that we do not discuss.

Methods

Our measurements of species elevational ranges were accumulated over the course of 27 expeditions to New Guinea and neighbouring islands since 1964 by JD, and of 86 expeditions since 1977 by KDB (e.g., Diamond 1972, Diamond & Bishop 2015, 2020, 2021a,b). Seventeen of those expeditions since 1986 have been joint efforts. JD collected bird specimens on six expeditions during 1964–74. Our subsequent records have been entirely observational, based both on sightings and (especially in forests) on vocalisations. We routinely measured elevations of all significant observations to the nearest 5 m using a Thommen altimeter (JD) or a Magellan or Garmin GPS (KDB). Elevations of fixed points along our transect were measured repeatedly on many days and at different times of day, and then averaged, to reduce the effect of variation due to atmospheric conditions. Our comparisons of species elevational ranges at different sites thus have the advantage of being based on measurements by the same observers using the same instruments. Our taxonomic nomenclature follows that of Beehler & Pratt (2016).

Latitude

South America and North America span 66 and 40 degrees of latitude, respectively. As a result, these continents offer innumerable examples of species elevational ranges decreasing with increasing latitude: species that are confined to high elevations on mountains at or near the equator shifting to lower elevations with increasing latitude, until they occur at sea level at high latitude.

New Guinea's mountains span a much smaller range of latitude: from *c.*01°S for the Tamrau Mts. of north-west New Guinea to only *c.*10.5°S for the southernmost mountains of south-east New Guinea. Our own field experience of New Guinea mountains extends only from 01.1°S in the Arfak Mts. to 08.4°S on Mt. Albert-Edward. The modest differences in species elevational ranges that we measured for those two mountains proved to be in the opposite direction to expectations based on latitude: elevational ranges are somewhat higher, rather than lower, at the higher-latitude site of Mt. Albert-Edward (*cf.* *Seicercus poliocephalus* in Table 4), probably because the effect of the small difference in latitude is overshadowed by a big difference in the Massenerhebung effect to be discussed later.

However, a much greater range of latitude is available for study when one considers Pleistocene land connections. The floor of the shallow Arafura Sea separating New Guinea from Australia today (Fig. 1 of Diamond & Bishop 2021b) emerged intermittently as dry land (the 'Arafura Shelf') during Pleistocene times of low sea level. New Guinea and Australia were then joined in a single continent extending from the equator to 44°S at the south coast of Tasmania, which was also joined to Australia in Pleistocene periods of low sea level. The 44° latitudinal span of the former single Australasian continent is greater than

TABLE 1

Species or superspecies of New Guinea mountains that breed at sea level in Australia. Lists the species or superspecies that in New Guinea are largely confined to the mountains (at least in northern New Guinea), but which in Australia have breeding populations at sea level.

		Different allospecies?	Only Cape York?
Lewin's Rail	<i>Lewinia pectoralis</i>		
Eurasian Coot	<i>Fulica atra</i>		
Pygmy Eagle	<i>Hieraaetus weiskei</i>	A	
Nankeen Kestrel	<i>Falco cenchroides</i>		
Fan-tailed Cuckoo	<i>Cacomantis flabelliformis</i>		
Black-eared Catbird	<i>Ailuroedus melanotis</i>		Y
Masked Bowerbird	<i>Sericulus [aureus]</i>	A	
Papuan Treecreeper	<i>Cormobates placens</i>	A	
Tropical Scrubwren	<i>Sericornis beccarii</i>		t
Papuan Logrunner	<i>Orthonyx novaeguineae</i>	A	
Barred Cuckooshrike	<i>Coracina lineata</i>		
Papuan Sittella	<i>Daphoenositta papuensis</i>	A	
Black-headed Whistler	<i>Pachycephala monacha</i>	A	
Trumpet Manucode	<i>Phonygammus keraudrenii</i>		t
Black-winged Monarch	<i>Monarcha frater</i>		t
Yellow-legged Flyrobin	<i>Kempiella griseoiceps</i>		t
Papuan Scrub Robin	<i>Drymodes beccarii</i>	A	t
Ashy Robin	<i>Heteromyias [albispicularis]</i>	A	Y
White-faced Robin	<i>Tregellasia leucops</i>		t
Russet-tailed Thrush	<i>Zoothera heinei</i>		

[]: New Guinea populations considered to belong to two or three different allospecies of the same superspecies.

A: New Guinea and Australian populations currently considered, by Beehler & Pratt (2016) and others, to belong to different allospecies of a superspecies. These taxonomic decisions are in a state of flux; in most cases the populations were until recently considered conspecific.

Y, t: Australian breeding populations of the superspecies confined to the Cape York Peninsula (Y), or even just to the peninsula's northern tip (t).

that of North America (40°). Hence, when one examines bird elevational ranges on New Guinea and Australia together, one finds examples of species or superspecies confined to high elevations on modern New Guinea mountains near the equator, at least in northern New Guinea, but which occur at sea level at higher latitudes in modern Australia—just as in North and South America.

Table 1 lists the 20 examples that we recognise. For example, Nankeen Kestrel *Falco cenchroides* is confined in New Guinea as a breeding species to elevations above 3,200 m on New Guinea's highest mountains, but it is widespread in the lowlands of Australia. As another example, Fan-tailed Cuckoo *Cacomantis flabelliformis* is confined in New Guinea to mountain forests at about 1,500–3,000 m, but is widespread in the lowlands of eastern and southern Australia, including Tasmania in the far south. Eight of the 20 species are confined

in Australia today to the Cape York Peninsula, and six of those eight to the peninsula's northern tip, i.e., the part of Australia closest to New Guinea.

Besides Australia, there are two other pieces of the intermittent combined continent of New Guinea / Australia where 17 species confined to mountains in the rest of New Guinea (or at least in northern New Guinea) now occur at sea level. One is southern New Guinea's Fly River bulge at $c.09^{\circ}\text{S}$ (the highest-latitude part of modern New Guinea except the south-east peninsula), where 13 species confined to mountains over most of the rest of New Guinea have sea-level populations. The other piece is the low-elevation Aru Islands at $05.5\text{--}07^{\circ}\text{S}$, the only surviving exposed fragment of the Pleistocene Arafura Shelf, where 11 species confined to mountains in the rest of New Guinea have sea-level populations. (Fig. 1 of Diamond & Bishop 2021b shows the location of the Fly River bulge and the Aru Islands.) Table 6 of Diamond & Bishop (2020) lists these Fly River and Aru Island populations. They are presumably relicts established during the cooler Pleistocene, when they and some other species now largely or entirely confined in New Guinea to the mountains shifted downslope. At that time those species maintained lowland populations variously extending from what is now lowland southern New Guinea, across the now-submerged and then-dry Arafura Shelf encompassing what are now the Aru Islands, to the lowlands of Australia. As post-Pleistocene climates warmed, and as the sea level rose and drowned the Arafura Shelf except for the Aru Islands, these species retreated in New Guinea again to the mountains, and survived in the lowlands mainly just in those two patches (plus Australia in ten cases).

Competition

Many New Guinea species belong to altitudinal sequences of two, three, four, or even five congeneric species that replace each other with elevation, often with sharp elevational transitions (Diamond 1972). Competition plays a role in maintaining the sequences. This is illustrated by the fact that, on mountains where one member of a sequence is absent, the congener whose elevational range is abutting on mountains of sympatry often expands its elevational range to occupy that of the missing congener (Diamond 1972, 1973).

For example, two closely related, ecologically similar, congeneric honeyeaters, Rufous-backed Honeyeater *Ptiloprora guisei* and Grey-streaked Honeyeater *P. perstriata*, occur sympatrically on mountains in New Guinea's Eastern Highlands and parts of south-east New Guinea. On those mountains of sympatry (e.g., Mt. Michael in the Eastern Highlands, which JD studied in 1964), the two species segregate altitudinally, *P. perstriata* occurring at approximately 2,400–3,750 m, *P. guisei* at 1,750–2,400 m. On the Huon Peninsula, where *P. perstriata* is absent, *P. guisei* occurs at least 800 m higher, to at least 3,200 m. In western New Guinea, where *P. guisei* is absent, *P. perstriata* occurs as much as 850 m lower, down to 1,550 m.

Similar examples of contractions or expansions of elevational ranges associated with presence or absence of competing species have been documented in New Guinea for species in the genera *Amblyornis*, *Megapodius*, *Melanocharis*, *Pachycephalopsis*, *Paradisaea*, *Psittacella*, *Rallidula*, *Rhipidura*, *Talegalla* and *Toxorhamphus* (e.g., Diamond 1972, 1973). These New Guinea examples have been noted anecdotally but not analysed systematically. Even more examples have been found in the Andes, where Terborgh (1971) and Terborgh & Weske (1975) did analyse them systematically. They found that at least 71% of Andean bird species expand their elevational ranges in the absence of congeners.

Terrain slope

Whilst the New Guinea lowlands include huge expanses of flat terrain, most land in New Guinea's mountains is instead sloping, often steeply. Extensive flat areas are infrequent in the mountains. One such area studied by JD in 1964–65 is the Karimui Basin, a large flat plain at an elevation of about 1,110 m connecting the bases of two extinct Pleistocene volcanoes, and rimmed by mountains pierced by a river gorge (Diamond 1972). In three respects Karimui's avifauna resembles that of the flat lowlands, rather than of the sloping terrain usually present at that elevation elsewhere in New Guinea.

One is the abundance at Karimui of lowland forest species that are uncommon or absent elsewhere in New Guinea at the same elevation, such as King Bird of Paradise *Cicinnurus regius*, Large Fig Parrot *Psittaculirostris desmarestii* and at least 23 other lowland forest species (Table 2). Almost as soon as JD started up the steep slopes of Mt. Karimui and left the flat basin floor, most (18 of the 25) of these lowland forest species disappeared (absent in JD's zone 1 of mountain surveys at 1,220–1,280 m: Diamond 1972), and all but two of the 25 species were absent in JD's zone 2 of mountain surveys at 1,341–1,448 m (Table 2, columns 2–3). JD's observations in Karimui's unusual flat terrain at 1,110 m may be compared with his observations at his collecting site of Okasa, only 95 km east of Karimui, at a comparable elevation (1,082–1,296 m), and surveyed twice by JD, only one week after his first visit to Karimui in 1964 and one week before his second visit in 1965. Unlike Karimui, Okasa is in sloping terrain typical of Karimui's elevation elsewhere in New Guinea. None of the 25 lowland forest species anomalously present at Karimui was recorded at Okasa (Table 2, column 1).

The second respect in which Karimui's avifauna is anomalous for its elevation is the converse of the first: the absence or rarity at Karimui of 16 hill forest species abundant at Karimui's elevation elsewhere in New Guinea, such as *Seicercus poliocephalus*, Grey-green Scrubwren *Sericornis arfakianus* and White-eyed Robin *Pachycephalopsis poliosoma* (Table 3). Of those 16 hill forest species, nine were unrecorded at Karimui; three were recorded just as 1–4 immature individuals; and four were recorded just as 1–4 adults. But 14 of the 16 hill forest species were encountered as soon as JD started up Mt. Karimui's steep slopes into zones 1–2 of his mountain surveys; and 13 of the 16 were recorded at Okasa (Table 3).

The third and most striking evidence for the effect of slope on elevational distributions of bird species at Karimui is the discontinuous elevational ranges of three species characteristic of sloping hill forests: Fairy Lorikeet *Charmosyna pulchella*, Black Fantail *Rhipidura atra* and *Pachycephalopsis poliosoma*. These species were common on Mt. Karimui's lower slopes just above the basin floor (1,220–1,448 m), disappeared or became rare when JD descended to the latter (1,110 m), and reappeared when JD crossed the basin's mountain ring and descended again to sloping terrain at lower elevations (610–985 m). Probably there were many other hill forest species that shared these discontinuous distributions but which JD did not observe, because he only walked quickly through the 610–985-m zone en route to and from a 600-m site, and the three species that he did observe are especially vocal and abundant.

Of New Guinea's c.190 upland bird species and superspecies, c.80 are members of pairs, trios, quartets or quintets of congeners that replace each other with elevation (Diamond 1972, Freeman & Class Freeman 2014). In seven cases the anomalous features of Karimui's avifauna just discussed result in Karimui supporting the lowland member of an elevational sequence, rather than (five cases) or in addition to (two cases) the higher-elevation member of the sequence prevalent at Karimui's elevation elsewhere in New Guinea. These cases are: Red-flanked Lorikeet *Charmosyna placentis*, Yellow-billed Kingfisher *Syma torotoro*, Pale-

TABLE 2

Lowland forest species anomalously present in the flat montane Karimui Basin. These 25 species characteristic of New Guinea lowland forest are absent or uncommon at Karimui's elevation (1,110 m) over most of New Guinea, where the terrain is normally sloping, often steeply, but they are present, mostly in abundance, at Karimui, where the terrain (exceptionally for that elevation in New Guinea) is flat.

		1. At Okasa?	2. Mt. K zone 1?	3. Mt. K zone 2?
Stephan's Emerald Dove	<i>Chalcophaps stephani</i>	—	—	—
Wompoo Fruit Dove	<i>Megaloprepia magnifica</i>	—	✓	—
Dwarf Fruit Dove	<i>Ptilinopus nainus</i>	—	—	—
Red-necked Crake	<i>Rallina tricolor</i>	—	—	—
Greater Black Coucal	<i>Centropus menbeki</i>	—	✓	—
Eastern Koel	<i>Eudynamys orientalis</i>	—	—	—
Pacific Baza	<i>Aviceda subcristata</i>	—	✓	—
Yellow-billed Kingfisher	<i>Syma torotoro</i>	—	—	—
Red-flanked Lorikeet	<i>Charmosyna placensis</i>	—	✓	✓
Large Fig Parrot	<i>Psittaculirostris desmarestii</i>	—	✓	—
Orange-breasted Fig Parrot	<i>Cyclopsitta guliemitertii</i>	—	—	—
Red-cheeked Parrot	<i>Geoffroyus geoffroyi</i>	—	—	—
White-eared Catbird	<i>Ailuroedus buccoides</i>	—	—	—
Ruby-throated Myzomela	<i>Myzomela eques</i>	—	—	—
Plain Honeyeater	<i>Pycnopygius ixoides</i>	—	—	—
Pale-billed Scrubwren	<i>Sericornis spilodera</i>	—	✓	✓
Boyer's Cuckooshrike	<i>Coracina boyeri</i>	—	—	—
Golden Cuckooshrike	<i>Campochaera sloetii</i>	—	—	—
Rusty Shrikethrush	<i>Pseudorectes ferrugineus</i>	—	—	—
Southern Variable Pitohui	<i>Pitohui uropygialis</i>	—	—	—
Sooty Thicket Fantail	<i>Rhipidura threnothorax</i>	—	—	—
King Bird of Paradise	<i>Cicinnurus regius</i>	—	—	—
Golden Monarch	<i>Carterornis chrysomela</i>	—	✓	—
Olive Flyrobin	<i>Kempiella flavovirescens</i>	—	—	—
Banded Yellow Robin	<i>Gennaedryas placens</i>	—	—	—

Column 1: present at Okasa? A site near Karimui and at similar elevation, but with sloping terrain typical of that elevation in New Guinea.

Column 2: present on Mt. Karimui's slopes rising steeply from the flat Karimui Basin, in JD's lowest survey zone (zone 1) starting only 110 m above the basin floor?

Column 3: present on Mt. Karimui's steep slopes, in JD's next-lowest survey zone (zone 2) starting only 231 m above the basin floor?

Note that, of these 25 lowland forest species anomalously present in the flat Karimui Basin, none is present at Okasa, only seven in zone 1, and just two in zone 2.

billed Scrubwren *Sericornis spilodera*, Olive Flyrobin *Kempiella flavovirescens* and White-eared Catbird *Ailuroedus buccoides* present, instead of the expected Fairy Lorikeet *Charmosyna pulchella*, Mountain Kingfisher *Syma megarhyncha*, *Sericornis arfakianus*, Yellow-legged Flyrobin *Kempiella griseiceps* and Black-eared Catbird *Ailuroedus melanotis* respectively; and

TABLE 3

Hill forest species anomalously absent or rare in the flat montane Karimui Basin. These 16 characteristic species of New Guinea hill forest are widespread and common at Karimui's elevation (1,110 m) over most of New Guinea, where the terrain is normally sloping, often steeply. But they are absent, or rare, or present only as occasional immatures ('imm.') at Karimui, where the terrain (exceptionally for that elevation in New Guinea) is flat (column 1). Columns 2–4: as columns 1–3 of Table 2. Note: of these 16 hill forest species anomalously absent in the flat Karimui Basin, most are present in the sloping terrain of Okasa at the same elevation as Karimui, and in Mt. Karimui's zones 1 and 2 above the Karimui Basin.

		1. At Karimui?	2. At Okasa?	3. Mt. K zone 1?	4. Mt. K zone 2?
Mountain Kingfisher	<i>Syma megarhyncha</i>	—	—	—	—
Fairy Lorikeet	<i>Charmosyna pulchella</i>	—	—	—	✓
Black-eared Catbird	<i>Ailuroedus melanotis</i>	—	✓	—	✓
Ornate Melidectes	<i>Melidectes torquatus</i>	rare	✓	—	✓
Grey-green Scrubwren	<i>Sericornis arfakianus</i>	—	✓	—	✓
Mottled Berryhunter	<i>Rhagologus leucostigma</i>	rare	✓	—	✓
Sclater's Whistler	<i>Pachycephala soror</i>	imm.	✓	✓	✓
Black Fantail	<i>Rhipidura atra</i>	—	✓	✓	✓
Trumpet Manucode	<i>Phonygamus keraudrenii</i>	imm.	✓	✓	✓
Lawes's Parotia	<i>Parotia lawesii</i>	—	✓	✓	✓
Superb Bird of Paradise	<i>Lophorina superba</i>	—	✓	✓	✓
Fantailed Monarch	<i>Symposiachrus axillaris</i>	imm.	✓	✓	✓
White-eyed Robin	<i>Pachycephalopsis poliosoma</i>	rare	✓	✓	✓
Yellow-legged Flyrobin	<i>Kempiella griseiceps</i>	—	✓	—	—
White-faced Robin	<i>Tregellasia leucops</i>	rare	✓	✓	✓
Island Leaf Warbler	<i>Seicercus poliocephalus</i>	—	—	—	✓

Red-cheeked Parrot *Geoffroyus geoffroyi* and Southern Variable Pitohui *Pitohui uropygialis* present in addition to the expected Blue-collared Parrot *Geoffroyus simplex* and Hooded Pitohui *Pitohui dichrous*, respectively.

A likely explanation for these effects of slope on bird distributions at Karimui is that it controls drainage and hence forest composition and structure. This interpretation could be tested by comparing bird communities at other pairs or sets of New Guinea sites similar in elevation but differing markedly in slope. If our interpretation is correct, then differences in slope are likely to be a major cause of local variation in species elevational ranges, with Karimui's large flat expanse making it an extreme example of a phenomenon widespread in milder form.

The Massenerhebung effect

There is an extensive worldwide literature on elevational differences not only in species elevational ranges, but also in habitats and climate, among different mountains within the same geographic area. Initially described for the Alps and other European mountains, these differences have been subsequently recognised for tropical mountains as well (Troll 1948, Richards 1952, Howard 1968, Grubb 1971, Whitmore 1990, Foster 2001, Bruijnzeel *et al.* 2010). The effect is cited most often by its original German name Massenerhebungseffekt (= 'mass elevation effect'), or less often recently by the English name 'Merriam effect'. The

main pattern is that comparable habitat zones and species elevational ranges tend to be at higher elevations on large high mountains far from the sea than on small coastal mountains or isolated mountains. While explanations of the effect are still incomplete, contributing factors include lower limits of mountain cloud caps near the thermally stable ocean than inland, and also differences in exposure to wind. We shall now provide three sets of examples for New Guinea birds.

Comparisons of one species on many mountains.—Table 4 lists elevational ceilings and floors that we determined for *Seicercus poliocephalus* on 13 New Guinea mountains. This warbler offers three advantages: it is widely distributed in New Guinea; it is abundant and sings frequently and distinctively, lending itself to accurate determination of its elevational range; and it has no New Guinea congener, whose presence or absence might have affected the species' elevational range and thereby confounded the interpretation.

Four of these 13 mountains are high peaks (2,560–4,770 m) of New Guinea's Central Range at a mean distance of 177 km (90–250 km) from the coast. The other nine peaks are lower peaks (mostly 1,400–2,218 m, plus one of 2,954 m) of New Guinea's outlying ranges (eight peaks) and of the former outlier Yapen Island (once part of the New Guinea mainland during Pleistocene times of low sea level, now a separate island) (see Fig. 1 of Diamond & Bishop 2021b). These nine outlying peaks lie at a mean distance of only 19 km (4–50 km) from the coast. Of the transects that we studied on these nine outliers, four were on the coastal watershed directly exposed to ocean winds; two transects were on the inland-facing watershed, wind-protected because they faced directly inland and away from the coast;

TABLE 4

Elevational range of Island Leaf Warbler *Seicercus poliocephalus* on 13 New Guinea mountains. Elevational ranges were measured either by JD & KDB, or by JD (six and seven mountains, respectively). Sources: Diamond (1972), Beehler *et al.* (2012), Diamond & Bishop (2015, 2020, 2021a), and our unpubl. observations.

Fourth column: four of these mountains belong to New Guinea's Central Range, whilst the others are among the outliers depicted in Fig. 1 of Diamond & Bishop (2021b). (NCR = North Coastal Range.) Fifth column: approximate distance of the transect from the coast. Sixth column: of the transects studied on outliers, four ('coastal') lie in the coastal watershed facing the coast, two ('inland') in the inland watershed facing the inland lowlands, and three ('interior') lie within the outlier surrounded by mountainous terrain of the outlier itself. Note that the elevational range of this warbler varies greatly among transects, as depicted in Fig. 1. This variation exemplifies the Massenerhebung effect, discussed in the text.

Mountain	Summit (m)	Elevational range (m)	Central Range?	Distance from coast (km)	Watershed
Mt. Mandala	4,700	1,683–1,991	yes	250	
Mt. Albert-Edward	3,990	1,851–2,152	yes	90	
Arfak	2,954	1,207–1,728	no	20	interior
Mt. Sisa	2,689	1,866–2,100	yes	240	
Mt. Karimui	2,560	1,311–1,860	yes	130	
Foja	2,218	951–1,409	no	50	coastal
Cyclops	2,160	1,091–1,677	no	10	inland
Wandammen	2,075	1,000–1,387	no	4	coastal
NCR (Mt. Menawa)	1,886	808–1,372	no	40	inland
Adelberts	1,675	1,250–1,655	no	30	interior
Kumawa	1,654	366–1,219	no	5	coastal
Yapen	1,430	675–1,195	no	10	interior
Fakfak	1,400	552–1,261	no	6	coastal

The Massenerhebung effect on a species' elevational range

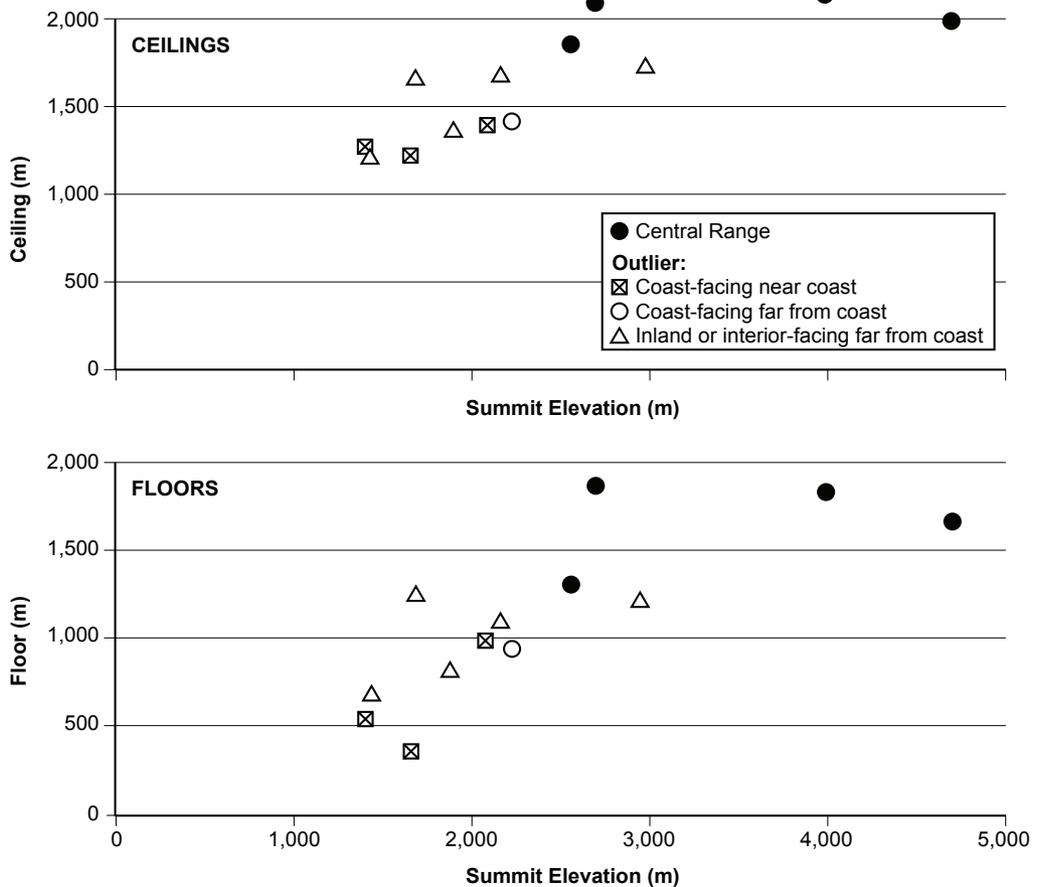


Figure 1. Example of the Massenerhebung effect: variation in the elevational ceiling and floor of the Island Leaf Warbler *Seicercus poliocephalus* on New Guinea mountains. Note that the warbler's ceiling (upper graph) and floor (lower graph) are higher on Central Range peaks than on outlier peaks; that they tend to be higher on higher peaks (summit elevation, abscissa); that they tend to be higher on inland-facing or interior-facing outlier transects than on coast-facing outlier transects; and that they tend to be higher on outlier transects further from the coast than on outlier transects nearer the coast. Data from Table 4.

and three were inside the interior of an outlier, also wind-protected because they were not directly exposed either to ocean wind or to the inland lowlands.

Table 4 and Fig. 1 show that the warbler's floor varies among mountains from 366 to 1,866 m, and its ceiling from 1,195 to 2,152 m. Both the floor and ceiling are higher on all four Central Range peaks than on any of the nine outliers (mean floor and ceiling 1,678 and 2,026 m, respectively, vs. only 878 and 1,434 m, respectively). Among the nine outliers, floors and ceilings are related to three factors: summit elevation, transect distance from the coast, and transect orientation. As for elevation, both floors and ceilings are higher on the four highest outliers (elevation $\geq 2,075$ m: floors 951–1,207 m, ceilings 1,387–2,152 m) than on four of the five lowest outliers (elevations $\leq 1,886$ m: floors 366–808 m, ceilings 1,195–1,372 m). (The exception is the Adelberts, which are only 1,675 m high, but whose transect faces the Adelberts' interior, and which lie further from the coast than most of the other outliers, and which consequently have a higher floor and ceiling than expected by

their elevation alone.) As for distance from the coast, the three outliers closest to the coast (4–6 km) have on average lower floors and ceilings (639 and 1,289 m, respectively) than the six outliers 10–50 km from the coast (floors and ceilings 997 and 1,506 m, respectively). As for orientation, the four coastal-facing transects have on average lower floors and ceilings (717 and 1,319 m, respectively) than the five inland- or interior-facing transects (floors and ceilings 1,006 and 1,525 m, respectively). With three independent variables (elevation, distance and orientation), we would need a sample size larger than the nine outliers to apportion quantitatively the relative effects of these three variables on floors and ceilings.

Thus, Table 4 and Fig. 1 illustrate for one New Guinea species the main pattern that we mentioned above for the Massenerhebung effect worldwide: that ‘...species elevational ranges tend to be at higher elevations on large high mountains far from the sea than on small coastal mountains or isolated mountains.’

Comparison of coastal- and inland-facing transects in the same mountain range.—In two cases we can illustrate the Massenerhebung effect by comparing two transects within the same outlier: a coastal-facing transect, compared to an inland- or interior-facing transect. One such involves the Kumawa Mts. (Diamond & Bishop 2015), where JD’s 1983 North Kumawa coastal transect rose directly from the coast to an elevation of 938 m at 5 km inland, while JD & KDB’s Central Kumawa inland transect descended to 1,025 m in the mountains’ interior 14 km inland and separated from the coast by many higher ridges. Three vocal, common or abundant, easily detected species were present at or above 1,025 m on the interior transect but had elevational ceilings below 938 m on the coastal one: Great Cuckoo-Dove *Reinwardtoena reinwardti*, Little Shrikethrush *Colluricincla megarhyncha* and Northern Fantail *Rhipidura rufiventris*, with ceilings at 742, 876 and 671 m, respectively.

Our other comparison involves the Foja Mts. (Beehler *et al.* 2012), where JD’s 1979 coastal transect peaked at 1,408 m and his 1981 inland-facing transect descended to 1,015 m. Three common species—*Charmosyna pulchella*, Red-breasted Pygmy Parrot *Micropsitta bruijnii* and Tropical Scrubwren *Sericornis beccarii*—had much higher elevational floors on the inland-facing transect than on the coastal one (1,442 vs. 610 m, 1,244 vs. 692 m, and 1,244 vs. 610 m, respectively). Conversely, there was no species with a well-established higher floor or ceiling on the coastal transect than on the inland-facing transect.

Each of these two comparisons of coastal vs. inland or interior transects within the same mountain range provides only limited tests of the Massenerhebung effect, because the two transects compared were at substantially different elevations. The transect locations were chosen for other reasons: accessibility, and to sample different elevations. To test specifically for the Massenerhebung effect, one would instead seek a coastal transect paired with an inland or interior transect spanning the same elevations, and one would perform repeated surveys to control for seasonal variation.

Differences in species elevational ranges between the Foja Mts. and Van Rees Mts.—Two of the outliers, Foja and Van Rees, offer a convenient comparison because they are close to each other (see Figs. 1–2 of Diamond & Bishop 2021b), and the Van Rees upland avifauna is virtually a subset of the Foja upland avifauna, but the Foja Mts. are almost twice as high as the Van Rees Mts. (2,218 vs. 1,262 m), and more than twice as far from the coast (50 vs. 20 km). Hence the Massenerhebung effect should lead to higher elevational ceilings and floors in the Foja Mts. than in the Van Rees Mts. The following paragraphs, to be summarised in Table 6, will confirm this. Ceilings and floors were measured by JD for a Foja coastal transect in 1979 and a Foja inland transect in 1981 (Diamond 1982, Beehler *et al.* 2012), and by JD & KDB for a Van Rees inland transect mostly in 1994, plus some observations at lower elevations in four earlier years (Diamond & Bishop 2021b). We shall compare in turn the elevational



Figure 2. Google Earth view of the environment of Diamond's 1979 Foja coastal transect. Visible are the narrow north-flowing stream on which Diamond's camp was sited; the western and eastern ridges flanking the valley in which the stream lies; at the bottom of the field of view, the ridges south of Diamond's camp, rising towards the Foja summits; the near-vertical east / west barrier ridge constituting the northern flank of the basin, and pierced by the stream; and, at the top, New Guinea's lowland coastal plain beyond the east / west ridge, and in which the stream flows in a braided gravel bed. A line traces the crest of the western, eastern and northern ridges, with numbers denoting elevation readings in metres. Diamond's camp in the basin, labelled 610 m, was at 02°45'S, 138°63'E.

ceilings of shared upland species, the floors of shared upland species, and the ceilings of shared lowland species between the two outliers.

Table 5 compares elevational ceilings of upland species shared between Foja and Van Rees, for those species for which the floors can be determined with confidence. (We define upland species as those largely confined to sloping elevated terrain, and absent from the flat lowlands at or near sea level: Diamond & Bishop 2015, 2020, 2021a.) Of the 37 upland species of Van Rees, we could not analyse four because they are absent in Foja; we could not analyse four others, because we had too few observations in Foja, Van Rees, or both to permit defining the ceilings with confidence; and we could not analyse nine others, because their Van Rees ceiling was 'truncated' (i.e., we observed the species right up to our Van Rees summit of 1,206 m or within 50 vertical metres of it, so that our highest observation did not necessarily represent a species ceiling above which lay further terrain in which the species was certainly absent).

That leaves 20 upland species for analysis. A potentially confounding factor, discussed earlier, is that elevational distributions tend to be higher on inland-facing slopes than on coastal slopes. All of our Van Rees observations were on the inland-facing slope. Fourteen of the 20 Foja ceilings listed in Table 5 are from JD's inland-facing Foja transect, directly comparable to the Van Rees inland-facing transect. The other six Foja ceilings are from JD's coastal Foja transect, either because the species was not encountered on the inland-facing

TABLE 5

Ceilings of upland species: Foja vs. Van Rees. For upland species present in both Foja and Van Rees, and for which elevational ceilings could be determined with confidence, this table gives the ceilings in each range. The right-hand column (Δ) is the Foja ceiling minus the Van Rees ceiling. Most ceilings are considerably higher in Foja than Van Rees, as predicted under the Massenerhebung effect. See text for discussion.

		Ceiling (in m)		
		Foja	Van Rees	Δ
Dwarf Cassowary	<i>Casuarius bennetti</i>	1,829	1,146	+683
Black-billed Cuckoo-Dove	<i>Macropygia nigrirostris</i>	1,912	1,119	+793
Pheasant Pigeon	<i>Otidiphaps nobilis</i>	1,670	1,079	+591
Claret-breasted Fruit Dove	<i>Ptilinopus viridis</i>	1,500	1,079	+421
Papuan Mountain Pigeon	<i>Gymnophaps albertsii</i>	2,040	1,067	+973
White-eared Bronze Cuckoo	<i>Chalcites meyerii</i>	1,238	1,034	+204
New Guinea Vulturine Parrot	<i>Psittichas fulgidus</i>	1,637	1,049	+588
Blue-collared Parrot	<i>Geoffroyus simplex</i>	1,921	143	+1,778
Black-eared Catbird	<i>Ailuroedus melanotis</i>	1,113	1,146	-33
Mountain Meliphaga	<i>Meliphaga orientalis</i>	1,244	1,049	+195
White-eared Meliphaga	<i>Meliphaga montana</i>	1,020	1,206	-186
Obscure Honeyeater	<i>Caligavis obscura</i>	884	1,003	-119
Stout-billed Cuckooshrike	<i>Coracina caeruleogrisea</i>	1,384	1,098	+286
Piping Bellbird	<i>Ornorettes cristatus</i>	1,113	1,127	-14
Rusty Whistler	<i>Pachycephala hyperythra</i>	1,281	1,128	+153
Drongo Fantail	<i>Chaetorhynchus papuensis</i>	1,311	1,073	+238
Trumpet Manucode	<i>Phonygamus keraudrenii</i>	1,378	366	+1,012
Green-backed Robin	<i>Pachycephalopsis hattamensis</i>	1,238	1,070	+168
Papuan Scrub Robin	<i>Drymodes beccarii</i>	1,198	1,067	+131
White-rumped Robin	<i>Peneothello bimaculata</i>	762	884	-122

one (five cases) or because the species had a lower ceiling there than on the coastal transect (one case). As we shall see in the next paragraph, the inclusion of records from the Foja coastal transect strengthens rather than confounds our conclusions.

Table 5 shows that, of the 20 species ceilings compared, 15 have considerably higher ceilings (by 131 to 1,778 m, mean 548 m) in Foja than in Van Rees; only three species have slightly higher ceilings in Van Rees (by only 119, 122 and 186 m); and for two species the ceilings are the same (within 14 or 33 m). This is as expected for the Massenerhebung effect, because Foja is considerably higher than Van Rees and lies considerably further from the coast. The difference that the Massenerhebung effect causes between Foja and Van Rees is probably even greater than Table 5 shows, because six of the 20 Foja ceilings in Table 5 are from Foja's coastal transect. Table 4, and the three examples that we gave in the preceding section to compare Foja's coastal and inland-facing transects, suggest that some of the six species would have had even higher Foja ceilings if we had been able to measure them on the Foja inland-facing transect.

We similarly compared elevational floors of upland species and elevational ceilings of lowland species shared between Foja and Van Rees, for those species for which the floors could be determined with confidence. (It is meaningless to compare floors of lowland

TABLE 6

Species ceilings and floors: Foja vs. Van Rees. For species present both in Foja and Van Rees, and whose elevational ceilings and / or floors could be ascertained, we compared the ceilings of upland species, the floors of upland species, and the ceilings of lowland species between the two ranges. For each of those three elevational limits, the table gives the number of species (no. species) for which the limit is higher in Foja by ≥ 100 m, the number for which the limit is higher in Van Rees by ≥ 100 m, and the number for which the limit is about the same (i.e., differs by less than 100 m between the two ranges). Numbers in parentheses (Δ in m) are the mean differences (in m) between the two ranges. Note that, for each limit, many more species have that limit at a higher elevation in Foja than Van Rees, and that the average difference is much greater for species with a higher limit in Foja than for species with a higher limit in Van Rees—exemplifying the Massenerhebung effect. See text for discussion.

	Foja higher		VR higher		Same	
	No. species	(Δ in m)	No. species	(Δ in m)	No. species	(Δ in m)
upland species ceilings	15	(548)	3	(142)	2	(24)
upland species floors	10	(474)	2	(182)	4	(60)
lowland species ceilings	25	(409)	12	(238)	11	(48)

species, because these are defined as species descending to sea level.) As summarised in Table 6, for all three comparisons—ceilings and floors of upland species, and ceilings of lowland species—elevational limits are higher in Foja than in Van Rees. Even more than for upland species ceilings, these comparisons under-estimate the effect for upland species floors and for lowland species ceilings, because many more of the upland floors and lowland ceilings than upland ceilings were measured on Foja's coastal slope, rather than on Foja's inland-facing slope (which offers a better comparison for Van Rees's inland-facing slope).

Thus, for many species the Massenerhebung effect is illustrated by differences between both floors and ceilings in the lower Van Rees Mts. compared to the higher and further inland Foja Mts. This agrees with the conclusions from our tabulation for *Seicercus poliocephalus* on 13 mountains in Table 4.

Barriers to dispersal?

It remains to discuss a surprising feature of the Foja avifauna that emerged from comparison with the Van Rees avifauna, and that was not recognised in JD's previous discussion of his Foja surveys (in Beehler *et al.* 2012): the unexpected absence, on Foja's low-elevation coastal transect, of 33 lowland species encountered at similar elevations in Van Rees and on numerous other New Guinea mountains (Table 7).

JD's low-elevation Foja transect, surveyed in 1979, was in the hills on the coastal slope and ran from 610 to 1,409 m. In eight days, JD observed 113 species: 62 lowland and 51 upland species. Our Van Rees transect surveyed in 1994 was on the inland-facing slope and ran from 494 to 1,206 m. In 20 days, we observed 147 species: 109 lowland species, 35 upland species and three winter visitors. The higher number of species observed on the Van Rees transect vs. the Foja transect is probably at least partly, though perhaps not entirely, due to the facts that more days of field work were devoted to the former transect, by two observers (JD & KDB) rather than by just one (JD).

But it is still surprising that the Foja coastal transect yielded no records of 33 species recorded at the same elevations (i.e., ≥ 610 m) in Van Rees. That's not because those species are absent from Foja: all 33 were recorded by Beehler *et al.* (2012) at or near Kwerba at the inland foot of the Foja Mts., 29 at elevations of 73–271 m, the other four at or slightly above 350 m (Beehler *et al.* 2012 reported very few observations above 271 m on their Kwerba

TABLE 7

Expected lowland species missing on the Foja coastal transect. List of 33 lowland species that we observed on our Van Rees transect (494–1,206 m), but that JD did not find on his 1979 Foja coastal-slope hill transect (610–1,409 m). Columns 3–4 give the species' elevational ceiling on the Kwerba transect (73–750 m) on Foja's inland slope (surveyed by Beehler *et al.* 2012), and on our Van Rees transect, respectively. None of these 33 species was observed by JD on his 1981 Foja inland-slope transect (1,015–2,040 m). The right-hand column denotes records of each species on five other mountains, surveyed by JD (three) or by JD & KDB (two) at a similar elevational range: K = Mt. Karimui in the Central Range, 610–1,113 m (Diamond 1972); A = an interior transect in the Adelbert Mts., 639–1,294 m (Diamond & Bishop 2021a); F = coastal transect in the Fakfak Mts., 600–1,208 m (Diamond & Bishop 2015); N = coastal transect in the North Kumawa Mts., 573–938 m (Diamond & Bishop 2015); and Y = coastal transect in the mountains of Yapen Island, 610–1,260 m (Diamond & Bishop 2020). Square brackets denote a different allospecies from the Van Rees and Foja allospecies of the same superspecies. Of the 33 species, one (*Heteromyias brachyurus*) lies outside the geographic range of mountains K, F, A and N, whilst nine lie outside the geographic range of Y. Thus, of the 33 lowland species not observed on the coastal Foja transect, 33 of 33, 26 of 32, 22 of 32, 20 of 32, 20 of 32, and 18 of 24 geographically 'available' species were observed in Van Rees and on K, A, F, N and Y, respectively. See text for possible reasons why these otherwise widespread species are absent on Foja's coastal transect, although present at lower elevations in Foja.

		Ceiling (m)		
		Foja inland	Van Rees	Other mountains
Victoria Crowned Pigeon	<i>Goura victoria</i>	375	799	[F] [N]
Pink-spotted Fruit Dove	<i>Ptilinopus perlatus</i>	100	921	K A F N Y
Purple-tailed Imperial Pigeon	<i>Ducula rufigaster</i>	73	1,152	K F N
Pinon's Imperial Pigeon	<i>Ducula pinon</i>	100	1,049	A F Y
Little Bronze Cuckoo	<i>Chalcites minutillus</i>	73	640	A F
White-crowned Cuckoo	<i>Caliechthrus leucolophus</i>	150	848	K A F N
Marbled Frogmouth	<i>Podargus ocellatus</i>	73	1,049	K A F N Y
Papuan Frogmouth	<i>Podargus papuensis</i>	73	1,049	K A Y
Palm Cockatoo	<i>Probosciger aterrimus</i>	271	1,049	K A F N Y
Red-flanked Lorikeet	<i>Charmosyna placentis</i>	271	854	K A F
Rainbow Lorikeet	<i>Trichoglossus haematodus</i>	271	1,049	K A F N Y
Salvadori's Fig Parrot	<i>Psittaculirostris salvadorii</i>	111	671	[K]
Eclectus Parrot	<i>Eclectus roratus</i>	271	1,104	K A F N Y
Red-cheeked Parrot	<i>Geoffroyus geoffroyi</i>	271	951	K A F N Y
Buff-faced Pygmy Parrot	<i>Micropsitta pusio</i>	73	945	A
White-eared Catbird	<i>Ailuroedus buccoides</i>	110	729	K N
Helmeted Friarbird	<i>Philemon buceroides</i>	271	902	K A N Y
Puff-backed Meliphaga	<i>Meliphaga aruensis</i>	73	1,006	K F
Mimic Meliphaga	<i>Meliphaga analoga</i>	73	732	K F N Y
Yellow-bellied Gerygone	<i>Gerygone chrysogaster</i>	111	817	K A F N Y
Black Butcherbird	<i>Cracticus quoyi</i>	73	854	K A F N
Hooded Butcherbird	<i>Cracticus cassicus</i>	73	945	K A N Y
Boyer's Cuckooshrike	<i>Coracina boyeri</i>	111	863	K A F N Y
Black-browed Triller	<i>Lalage atrovirens</i>	111	860	[K] A F
Northern Fantail	<i>Rhipidura rufiventris</i>	350	845	K A F N Y
Spangled Drongo	<i>Dicrurus bracteatus</i>	271	878	K A N Y
Twelve-wired Bird of Paradise	<i>Seleucidis melanoleucus</i>	400	610	K Y
King Bird of Paradise	<i>Cicinnurus regius</i>	111	619	
Hooded Monarch	<i>Symposiachrus manadensis</i>	271	732	
Spot-winged Monarch	<i>Symposiachrus guttula</i>	111	787	K F N
Black-chinned Robin	<i>Heteromyias brachyurus</i>	500–600	691	Y
Black-sided Robin	<i>Poecilodryas hypoleuca</i>	111	799	K A N
Black Sunbird	<i>Leptocoma aspasia</i>	271	799	K A Y

transect). Also, JD recorded 11 of the 33 species in his brief stop at Bora Bora village in the coastal lowlands 20 km north of his Foja coastal transect, in just a few hours at the village and airstrip distant from forest. All 33 are lowland species: their elevational ceilings on the Van Rees transect all fell between 610 and 1,152 m (mean 867 m); and none was found on the Foja high-elevation inland-facing transect that JD surveyed in 1981 (1,177–2,040 m, plus four hours at 1,177–1,015 m). Why, when all of these species were present in the lowlands at Foja, and when all of them ascended to at least 610 m in Van Rees, did none reach at least 610 m on the Foja lowland transect?

Brace yourself for some complicated reasoning, as we eliminate possible mundane explanations for those 33 absences!

First: could many of the 33 species have been present but overlooked on the Foja coastal transect? About four of the 33 missing species are inconspicuous (Buff-faced Pygmy Parrot *Micropsitta pusio*), uncommon (Little Bronze Cuckoo *Chalcites minutillus*) or both. But at least half are among the commonest, or noisiest, or most conspicuous species of New Guinea hill forest. It is very unlikely that Pinon's Imperial Pigeon *Ducula pinon*, Palm Cockatoo *Probosciger aterrimus*, Rainbow Lorikeet *Trichoglossus haematodus*, Eclectus Parrot *Eclectus roratus*, Helmeted Friarbird *Philemon buceroides*, Yellow-bellied Gerygone *Gerygone chrysogaster*, Black Butcherbird *Cracticus quoyi*, Hooded Butcherbird *Cracticus cassicus* and Spangled Drongo *Dicrurus bracteatus* would have escaped JD's attention for his eight days on the Foja coastal transect if they had been present.

Some of those species are targets of hunters in inhabited areas of New Guinea. Might they have been hunted out on the Foja coastal transect, but not on the Van Rees transect? Surely not: both transects lie in very sparsely populated regions; both were remote from the nearest habitation; neither showed any signs of any past human visit; and at both transects the tameness of large mammals and birds that elsewhere in New Guinea are the favoured prey of hunters testified to their lack of experience of hunting on the transect.

Might the explanation for the absence of the 33 species on the Foja coastal transect, despite their presence at the same elevations on the Van Rees transect, involve some peculiarity of the latter, rather than a peculiarity of the Foja transect? No: their presence at elevations of 494–1,152 m on the Van Rees transect is normal for New Guinea; their absence at 610–1,409 m on the Foja coastal transect is the exception requiring explanation. Table 7's right-hand column lists records of the 33 species, in approximately the same elevational range as that of the Foja coastal transect, on five other New Guinea mountains surveyed by JD (three) or by JD & KDB together (two). Each mountain lies outside the geographic range of 1–9 of the 33 species, leaving 24–32 species to analyse. On the five mountains, 18, 20, 20, 22 and 26 of the 24–32 geographically available species were recorded. Thus, the norm at those elevations in New Guinea is the presence of most of the 'available' species among the 33, rather than the absence of all of them.

Might the absence of the 33 species on the Foja coastal transect be a consequence of the Massenerhebung effect? (Now for the most complicated paragraph of reasoning!) In theory, that would be possible if Foja ceilings were on average so much lower than Van Rees ceilings that the predicted Foja ceilings for Table 7's 33 species of our Van Rees transect missing on the 1979 Foja coastal transect were all lower than 610 m, the base of the Foja transect. In reality, Foja ceilings of lowland species are on average higher, not lower, than Van Rees ceilings (Table 6): higher by 157 m. Some Foja ceilings were on the inland-facing transect of JD's 1981 survey and the three surveys of Beehler *et al.* (2012); some were on the Foja coastal transect of JD's 1979 survey. If we restrict attention to Foja ceilings on the coastal transect (i.e., the transect whose species absences we seek to explain), then for species present on both our Van Rees transect and JD's 1979 Foja coastal transect, ceilings

were virtually the same: on average, just 51 m higher on the former. (That is because of two opposite components of the Massenerhebung effect: Foja, being larger and higher and further inland than Van Rees, tends for that reason to have higher ceilings; but our Van Rees transect, because it is inland-facing, tends to have higher ceilings than the Foja 1979 coastal transect.) The main conclusion is that ceiling differences of lowland species shared by these two transects are much too small, and apparently (but not significantly) in the wrong direction, to explain absences of 33 other lowland species from the Foja transect.

Instead, as a hypothesis to explain the absence of those 33 lowland species from the Foja transect, we call attention to a peculiarity of its terrain that became apparent only via detailed examination of Google Earth satellite views of the region. The Foja coastal transect rises from what is in effect a sunken basin surrounded by high steep-sided ridges. JD selected the transect for his 1979 Foja survey because his helicopter was at that time not carrying equipment necessary to construct a landing pad in the 1,621-m Foja bog clearing that JD had discovered from the air, and which subsequently served as camp for his 1981 survey (and possibly also for the high-elevation surveys of Beehler *et al.* in 2005, 2007 and 2008). The site closest to high elevations at which the helicopter was able to land and to unload JD was the bank of a narrow mountain stream at 610 m, at 02°45'S, 138°63'E. That camp served as the base for his 1979 coastal transect, which sloped steeply upwards south from the bank.

Google Earth views (Fig. 2) show that JD's camp and the transect base lie in a basin at the south end of a stream flowing due north. The basin's west and east sides consist of steep-sided ridges rising to c.1,500 m and 1,375 m, respectively. The basin's south side (JD's coastal transect) rises steeply towards a Foja summit (c.2,175 m). Some 6.3 km north of JD's camp, the stream is almost completely blocked by a remarkable east / west barrier ridge. This ridge is narrow (<50 m wide) from north to south, has near-vertical south and north faces, and extends several km east and west to join the north / south ridges forming the basin's east and west sides. Most of the barrier ridge's crest is at 700–1,000 m, dipping to 474 m at the stream's exit.

As for the stream draining the basin, it flows north from JD's campsite through an increasingly narrow V-shaped valley, until the valley's width for the final km before the east / west barrier ridge forming the valley's north wall is less than 20 m wide. The valley floor and the stream drop from an elevation of 610 m at JD's camp to c.200 m where the stream pierces the barrier ridge via a very narrow vertical cleft 270 m high and less than 20 m wide (Fig. 3). Beyond this, the stream enters gently rolling terrain, lies in a broad braided gravel bed, within a few km reaches New Guinea's flat north coastal plain covered in lowland rainforest at an elevation of 170 m, and flows east in meanders to join the north-flowing Tor River.

What does this topography mean for the potential dispersal routes of lowland bird species from the north coastal plain at 170 m into the basin from which JD's coastal transect rises? Entering the basin from the west or east would require crossing steep ridges at about c.1,500 or 1,375 m. Entering it from the south, from lowland forests of the Mamberamo River basin, would require flying up the Foja's south slope to the watershed at c.2,000 m, and descending the north slope. Entering the basin from the north would require either: ascending the near-vertical north face of the barrier ridge, most of which rises 530–830 m from the coastal plain, decreasing to a 270-m rise at the stream cleft; flying high over the coastal plain to cross the barrier ridge in the air; or flying through the stream cleft itself, which approximates to a tunnel 1 km long and <20 m wide. JD's coastal transect did support 62 lowland species, which must have arrived by one or more of those unappealing routes. But the 33 species of Table 7 did not arrive, or else they arrived in too low numbers to

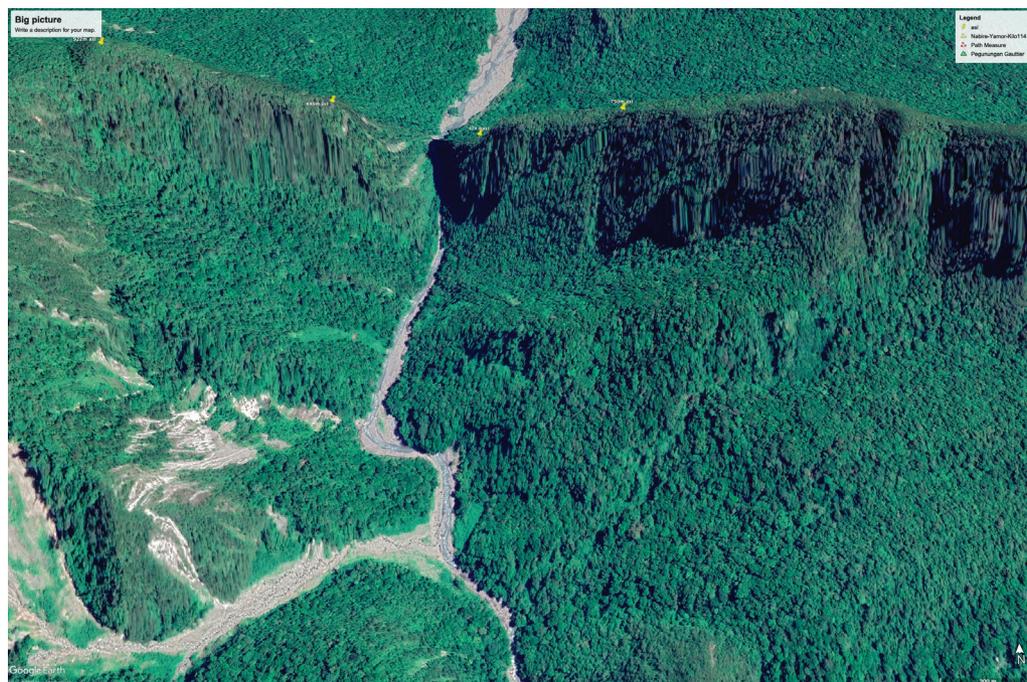


Figure 3. Google Earth close-up view, from the south, of the east / west ridge closing to the north the basin viewed in Fig. 2. The ridge has near-vertical southern and northern faces, and is pierced by the basin's stream via a cleft only c.20 m wide.

establish populations. We note that only eight of those 33 are species regularly observed to fly high above the forest canopy. Most of the rest inhabit the forest interior. We would not expect *Goura* pigeons, Yellow-bellied Gerygone, King Bird of Paradise, Spot-winged Monarch *Symposiachrus guttula* or Black-sided Robin *Poecilodryas hypoleuca* to ascend high vertical cliff faces, or to fly through a long narrow tunnel over a mountain torrent. But those 33 lowland species faced no such significant obstacles in traversing the gradually sloping foothills of the Van Rees Mts. to reach our transect thereon.

Of course, this interpretation that barriers to dispersal explain the Foja coastal transect's missing 33 species is speculative. Perhaps its plausibility can be assessed by examining possible barriers to bird dispersal elsewhere in New Guinea. Such effects of barriers could prove important, for example by causing actual species ranges to be smaller than implied by the usual maps showing continuous distributions.

We are grateful to an anonymous reviewer for pointing out that our interpretation of these upland dispersal barriers limiting and impoverishing lowland species access to a lowland basin is the converse of the much more familiar phenomenon of lowland dispersal barriers limiting upland species access to mountain tops. Competitive release—i.e., expansion of elevational range in the absence of a congener—is frequently observed for those upland species that do succeed in colonising a mountain top (*cf.* our preceding section on competition). Might those lowland species that did succeed in colonising JD's Foja coastal transect also exhibit competitive release of their elevational range?

Outlook

Obviously, our studies provide only an initial overview of variation in species elevational ranges in New Guinea. They leave much still to be done. We suggest some priorities for further studies.

Many of the transects analysed in this paper were surveyed ornithologically only once. But bird distributions may vary between seasons and years. Hence the patterns that we have described require confirmation by repeated surveys over multiple years while controlling for seasonal effects.

Are there any systematic differences between elevational ranges on the northern and southern watersheds of the Central Range?

Can one generalise about how often the presence or absence of competing species cause changes in New Guinea elevational ranges, as Terborgh (1971) and Terborgh & Weske (1975) did for Peru?

Can other effects of terrain slope on elevational ranges be recognised, besides the ones that JD noted at Karimui?

The Massenerhebung effect on elevational distributions has been studied extensively elsewhere in the world, but not in New Guinea. Our Tables 4–6 show that it is also significant for New Guinea birds. It warrants much more study in New Guinea, not only for birds but also for other animal groups and vegetational zones. The effect's explanation around the world remains debated.

Our Table 7, comparing the lowland avifauna of Diamond's 1979 Foja coastal transect with our own Van Rees transect, suggests a large effect of barriers to dispersal on species distributions. If our interpretation of that comparison is correct, such barriers are likely to be an important phenomenon elsewhere in New Guinea as well.

Acknowledgements

It is a pleasure to acknowledge our debts to the Summer Institute of Linguistics fixed-wing and helicopter pilots, without whose devoted efforts our studies in uninhabited areas of the Van Rees Mts. and Foja Mts. would have been impossible; to the Indonesian Forestry Department and Environment Department for inviting us to carry out our field work and for making it possible; to Bruce Beehler, Iain Woxvold and an anonymous reviewer for helpful suggestions on the manuscript; to Matt Zebrowski for drawing Fig. 1 and editing Figs. 2–3; and to the National Geographic Society and World Wildlife Fund for support.

References:

- Beehler, B. M. & Pratt, T. K. 2016. *Birds of New Guinea: distribution, taxonomy, and systematics*. Princeton Univ. Press.
- Beehler, B. M., Diamond, J. M., Kempes, N., Scholes, E., Milensky, C. & Laman, T. G. 2012. Avifauna of the Foja Mountains of western New Guinea. *Bull. Brit. Orn. Cl.* 132: 84–101.
- Bruijnzeel, L. A., Scatema, F. M. & Hamilton, L. S. 2010. *Tropical montane cloud forests*. Cambridge Univ. Press, Cambridge, UK.
- Diamond, J. 1972. *Avifauna of the Eastern Highlands of New Guinea*. Nuttall. Orn. Cl., Cambridge, MA.
- Diamond, J. 1973. Distributional ecology of New Guinea birds. *Science* 179: 759–769.
- Diamond, J. 1982. Rediscovery of the Yellow-fronted Gardener Bowerbird. *Science* 216: 431–434.
- Diamond, J. & Bishop, K. D. 2015. Avifauna of the Kumawa and Fakfak Mountains, Indonesian New Guinea. *Bull. Brit. Orn. Cl.* 135: 292–331.
- Diamond, J. & Bishop, K. D. 2020. Origins of the upland avifauna of Yapen Island, New Guinea region. *Bull. Brit. Orn. Cl.* 140: 423–448.
- Diamond, J. & Bishop, K. D. 2021a. Avifauna of the Adelbert Mountains, New Guinea: why is Fire-maned Bowerbird *Sericulus bakeri* the mountains' only endemic bird species? *Bull. Brit. Orn. Cl.* 141: 75–108.
- Diamond, J. & Bishop, K. D. 2021b. Avifauna of the Van Rees Mountains, New Guinea. *Bull. Brit. Orn. Cl.* 141: 446–469.
- Foster, P. 2001. The potential negative effect of global climate change on tropical montane cloud forest. *Earth Sci. Rev.* 55: 73–106.

- Freeman, B. & Class Freeman, A. M. 2014. The avifauna of Mt. Karimui, Chimbu Province, Papua New Guinea, including evidence for long-term population dynamics in undisturbed tropical forest. *Bull. Brit. Orn. Cl.* 134: 30–51.
- Grubb, P. 1971. Interpretation of the “Massenerhebung” effect on tropical mountains. *Nature* 229: 44–45.
- Howard, R. A. 1968. The ecology of an elfin forest in Puerto Rico. I. Introduction and composition studies. *J. Arnold Arboretum* 49: 381–418.
- Pratt, T. K. & Beehler, B. M. 2015. *Birds of New Guinea*. Second edn. Princeton Univ. Press.
- Richards, P. W. 1952. *The tropical rain forest: an ecological study*. Cambridge Univ. Press, Cambridge, UK.
- Terborgh, J. 1971. Distribution on environmental gradients: theory and a preliminary interpretation of distributional patterns in the avifauna of the Cordillera Vilcabamba, Peru. *Ecology* 52: 23–40.
- Terborgh, J. & Weske, J. S. 1975. The role of competition in the distribution of Andean birds. *Ecology* 56: 562–576.
- Troll, C. 1948. Der asymmetrische Aufbau der Vegetationszonen und Vegetationsstufen auf der Nord- und Südhalbkugel. *Jahresber. geobot. Inst. Rübel Zurich* 1947: 46–83.
- Whitmore, T. C. 1990. *An introduction to tropical rain forests*. Clarendon Press, Oxford.
- Addresses:* Jared Diamond, Geography Dept., Univ. of California, Los Angeles, CA 90095-1524, USA, e-mail: jdiamond@geog.ucla.edu. K. David Bishop, Semioptera Pty. Ltd., P.O. Box 1234, Armidale, NSW 2350, Australia, e-mail: kdvdbishop7@gmail.com

Fregatta lineata (Peale, 1848) is a valid extant species endemic to New Caledonia

by Vincent Bretagnolle, Robert L. Flood, Sabrina Gaba & Hadoram Shirihai

Received 14 September 2021; revised 3 January 2022; published 11 March 2022

<http://zoobank.org/urn:lsid:zoobank.org:pub:B48F3D74-2BFE-49A1-A560-C5E59CF8FD18>

SUMMARY.—We present evidence that confirms the streaked *Fregatta lineata* is a valid extant species that breeds on New Caledonia and endorse the vernacular name New Caledonian Storm Petrel. We review taxonomic deliberations over the historic five ‘Pealea’ streaked storm petrel specimens. Three belong to the recently rediscovered New Zealand Storm Petrel *F. maoriana*. We study six biometrics of the other two identical-looking specimens, one from Samoa, the other from the Marquesas Islands, a third ‘new’ specimen collected off Brisbane, and other *Fregatta* taxa. Results of Principal Component Analyses, Discriminant Analyses, and a review of phylogenetic relationships between *Fregatta* storm petrels, *F. lineata* and *F. maoriana*, lead us to conclude that the three specimens represent a single taxon, *F. lineata*. Furthermore, *F. lineata* is clearly separated from *F. maoriana*, White-bellied Storm Petrel *F. grallaria* and Black-bellied Storm Petrel *F. tropica*. We further conclude that storm petrels photographed at sea, off New Caledonia and in the Coral Sea, are *F. lineata*. We then redescribe *F. lineata* from at-sea observations, photographs taken at sea, and study of the three museum specimens. Criteria for in-hand and at-sea identification are presented. We report the first breeding record, from New Caledonia, a grounded fledgling presumably disoriented by onshore artificial lights. We explore likely breeding locations and conservation issues.

A remarkable turn of events in recent research into Procellariiformes is recognition that five museum specimens of similar-looking streaked storm petrels, collected during natural history expeditions to the Pacific Ocean during 1827–1922, represent two ‘new’ taxa, not plumage variants of known species as argued by Murphy & Snyder (1952). ‘Streaked storm petrel’ refers to black-and-white storm petrels distinctly marked with dark streaks on a white belly. Events are all the more remarkable given that the specimens represent populations of two taxa, one discovered in 2003, the other in 2008, both of which are easily located at sea.

The puzzle of one of these taxa—the New Zealand Storm Petrel *Fregatta maoriana*, accounting for three of the historic specimens, was largely resolved over a ten-year period as follows. Two if not all three of the specimens were taken in northern New Zealand in the 19th century (Bourne & Jouanin 2004, Bourne *et al.* 2004, Medway 2004). The first sightings, in 2003, were off the Coromandel Peninsula and in the Hauraki Gulf, North Island, New Zealand (Flood 2003, Saville *et al.* 2003, Stephenson *et al.* 2008a). The first live captures, in November 2005 and January 2006, in the Hauraki Gulf, confirmed the identity (Stephenson *et al.* 2008b), and the New Zealand Rare Birds Committee accepted *F. maoriana* as a valid extant species (Scofield 2007). Breeding was confirmed in 2013 on Little Barrier Island, Hauraki Gulf (Fig. 1; Rayner *et al.* 2015, Tennyson *et al.* 2016). Conservation measures are underway.

The same process of puzzle-solving for the second taxon, New Caledonian Storm Petrel (undescribed), however, has faltered. The first sighting was in 2008 off southern New Caledonia (Howell & Collins 2008), with additional observations there in subsequent years

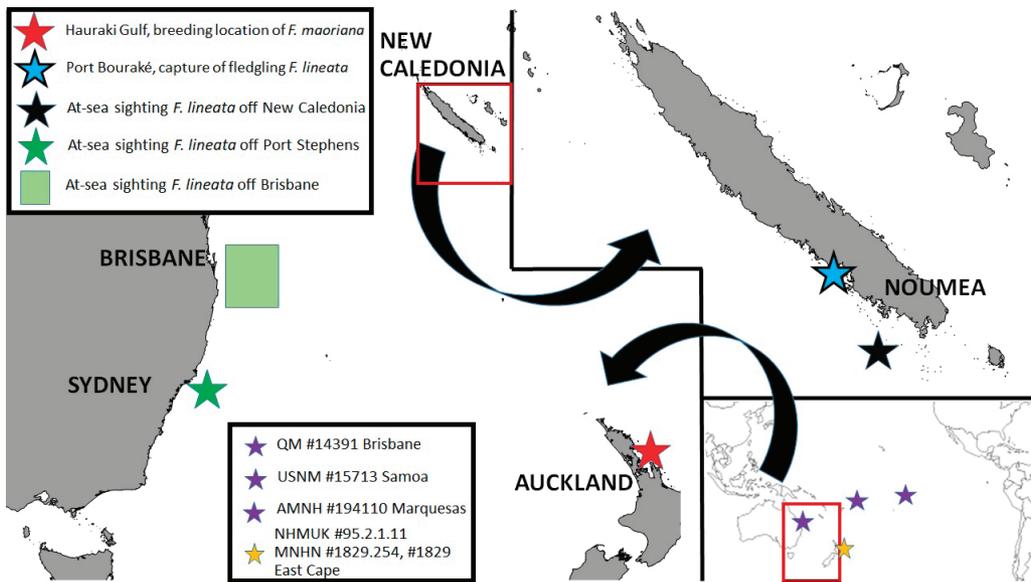


Figure 1. Map showing all locations mentioned in the text, including the breeding location of New Zealand Storm Petrel *F. maoriana*; and the locations where specimens of New Caledonian Storm Petrel *F. lineata* were collected, at-sea sightings made, and the fledgling found. There has been discussion about the origin of the specimen NHMUK 1895.2.11.1 (Galbreath 2018).

(Fig. 1; Collins 2013). The birds look similar to New Zealand Storm Petrel, but are larger and were thus presumed to be an undescribed taxon (Collins 2013). Since 2011, identical-looking streaked storm petrels have been seen regularly in the Coral Sea off eastern Australia (Fig. 1; Appendix 1 summarises all sightings known to us, 2008–21). The New Caledonian and Coral Sea storm petrels are widely assumed to be the same taxon (e.g., Howell & Zufelt 2019). However, it is not known if the two-remaining identical-looking streaked storm petrel specimens, one collected in Samoa, the other in the Marquesas, represent this taxon. Attempts to capture live birds in 2013 and 2014 were unsuccessful (C. Collins *in litt.* 2013, P. Harrison *in litt.* 2014). No findings have been published for a bird captured in the Coral Sea on 13 April 2014. The breeding location is a mystery. BirdLife Australia has deferred decisions on submissions of streaked storm petrels until the taxonomy of New Caledonian and Coral Sea storm petrels is resolved (T. Palliser *in litt.* 2021). There are no conservation measures in place.

This manuscript largely resolves the puzzle of the New Caledonian Storm Petrel. To this end, we summarise and reassess previous work on the ‘Pealea phenomenon’ (the five streaked storm petrel museum specimens, plus a newly discovered sixth specimen), discuss the taxonomy of the six specimens and *Fregatta* storm petrels in relation to biometry and genetic sequences; and conclude that the three unclassified specimens, and the New Caledonian and the Coral Sea storm petrels, are one and the same species, *Fregatta lineata* (Peale 1848). We then describe its characteristics, offer guidance for in-hand and at-sea identification, provide the first evidence of breeding, on New Caledonia, and highlight conservation priorities for this almost certainly globally threatened species.

The ‘Pealea’ storm petrels

The five streaked storm petrel specimens (Fig. 2) have been the subject of much controversy and confusion over the last 70 years (Murphy & Snyder 1952, Cibois *et*



Figure 2. The five historic and one recently discovered museum specimens of New Caledonian Storm Petrel *Fregetta lineata* and New Zealand Storm Petrel *F. maoriana*. (A) *F. lineata*, collected 1839, perhaps 23–25 November, Samoa by T. R. Peale during the US Explorer Expedition, held at National Museum of Natural History, Washington DC (USNM 15713). (B) *F. lineata*, collected 15 September 1922, presumably at sea, off Ua Pou Island, Marquesas Islands by R. H. Beck during the Whitney South Seas Expedition, held at American Museum of Natural History, New York (AMNH 194110). (C) *F. maoriana*, collected January–March 1827 by Quoy & Gaimard (1830) during first voyage of the *Astrolabe*, held at Museum national d'Histoire naturelle, Paris (MNHN C.G. 1829.254 (14393), C.G. 1829 (14372)). (D) *F. maoriana*, presented by George Carrick Steet of London in February 1895, possibly collected in the Hauraki Gulf, New Zealand (Bourne *et al.* 2004), held at the Natural History Museum, Tring (NHMUK 1895.2.11.1). (E) *F. lineata* (left) and Black-bellied Storm Petrel *F. tropica* (right), beach-cast, Stradbroke Island, Brisbane, Queensland, Australia, held at Queensland Museum, Brisbane (respectively, QM 14391 collected July 1973; and QM 31216, collected 22 May 1999) (Vincent Bretagnolle, except D: Mark Adams, © Natural History Museum, London)

al. 2015, Robertson *et al.* 2016). Their unique streaked appearance gave rise to the term 'Pealea phenomenon'. The specimens have been variously assigned to five genera, *Thalassidroma* Gould, 1844, *Fregetta* Bonaparte, 1855, *Pealea* Ridgway, 1886, *Fregettornis* Mathews, 1914, and *Pealeornis* Mathews, 1932, based on morphometrics and details of foot structure (measurements of all five specimens in Appendix 2).

Murphy & Snyder (1952) concluded that the three New Zealand specimens 'maoriana' were pale-morph Wilson's Storm Petrels *Oceanites oceanicus*, that the Samoan specimen 'lineata' was an aberrant Black-bellied Storm Petrel *Fregetta tropica*, and that the Marquesan specimen 'guttata' was an aberrant White-bellied Storm Petrel *F. grallaria*. This taxonomic treatment collapsed with the rediscovery of, and realisation that, New Zealand Storm Petrel *F. maoriana* is a valid species that accounts for the New Zealand specimens (Robertson *et al.* 2011, Robertson *et al.* 2016).

The status of the other two specimens remained an open question. However, it became apparent that they bear strong resemblance to the New Caledonian and Coral Sea storm petrels. The oldest of the two specimens was collected in 1839 at Samoa by T. R. Peale (hence 'Pealea phenomenon') during the US Explorer Expedition. It is held at the National Museum of

Natural History, Smithsonian Institution, Washington DC (USNM 15713). The specimen was described as a new species *Thalassidroma lineata* (Peale 1848, and *in* Cassin 1858). Mathews (1933) placed this taxon in *Pealea*. The original description (see Cassin 1858: 403–405) includes a drawing by Peale, also reproduced in Bourne (2008), of an underwing pattern that we will demonstrate below is diagnostic of New Caledonian Storm Petrel.

The other specimen was collected on 15 September 1922, presumably at sea, off Ua Pou Island, Marquesas Islands, by R. H. Beck during the Whitney South Seas Expedition. It is at the American Museum of Natural History, New York (AMNH 194110). The specimen was described as a new species *Fregetta guttata* (Murphy 1930) and was subsequently placed in *Fregettornis* (Mathews 1933). Both Mathews and Murphy argued that these two specimens differ notably, but only on the basis of foot structure (Murphy 1930, Mathews 1933).

There is a third, ‘new’ (recently discovered), specimen. During a visit in 2017 to Queensland Museum in Brisbane, VB found two storm petrel specimens with dark markings on a white belly (QM 31216 and QM 14391; biometrics in Appendix 2; Fig. 2). Both were labelled Black-bellied Storm Petrel *F. tropica*. They are beach-cast specimens collected on Stradbroke Island, off Brisbane. The dark belly markings qualify them as candidate *F. lineata*. However, one has dark streaks, whereas the other appears more like *F. tropica*, having dark spots, although its belly feathers are heavily abraded.

The next section presents multivariate analyses of six biometrics of *Fregetta* museum specimens. Analyses incorporate the two specimens from Brisbane and those from Samoa and the Marquesas. The aim is to investigate how the specimens and species relate to one another.

Multivariate analyses of *Fregetta* and suspected *F. lineata* specimens

We conducted a series of multivariate analyses on six biometrics: bill width, bill depth at gonys; and culmen, wing, tail and tarsus lengths. The sample ($n = 261$) comprised adults collected at colonies, held at museums worldwide, and measured by VB. Mean measurements are shown in Fig. 3. Analyses were conducted using the packages FACTORMINE and MASS from R software. Biometric characters were centred and scaled prior to analyses.

Principal Component Analyses.—Principal Component Analysis (PCA) was performed as a descriptive multivariate analysis. In the first PCA, specimens from breeding archipelagos were grouped and averaged, including *F. tropica* (11 populations), small White-bellied Storm Petrels *F. grallaria* (six populations), the large *F. [g.] titan* (from Rapa Island), and *F. maoriana* (from New Zealand). The two Brisbane specimens and the specimens ‘*lineata*’ from Samoa and ‘*guttata*’ from Ua Pou were treated individually. Results are shown in Fig. 4A. The first principal component (Dim 1; Fig. 4A) was a body size axis (especially wing length; see Fig. 5). Dim 1 clearly separates the smallest *F. maoriana* (purple) from the largest *F. [g.] titan* (blue). *F. tropica* (green) and *F. grallaria* (orange and red) were fairly evenly spread, with *F. grallaria* having an overall smaller size and notably shorter tarsi, although some individuals (mainly from the western Pacific, but also the South Atlantic) had tarsi nearly as long as *F. tropica* (Fig. 3). QM 31216 (light green) clumped with *F. tropica* (dark green), whilst QM 14391 clumped with ‘*lineata*’ and ‘*guttata*’ (black). All three were at the small end of the size range of *F. grallaria*, having slightly shorter wings, a shorter tail than other *Fregetta* (but longer than *F. maoriana*), and tarsus length intermediate between *F. tropica* and *F. grallaria* (Fig. 3). This morphometric analysis supports the separation of *F. maoriana*, highlights the distinctiveness of the ‘*lineata*, *guttata*, QM 14391’ specimens within *F. grallaria*, and aligns QM 31216 with *F. tropica*.

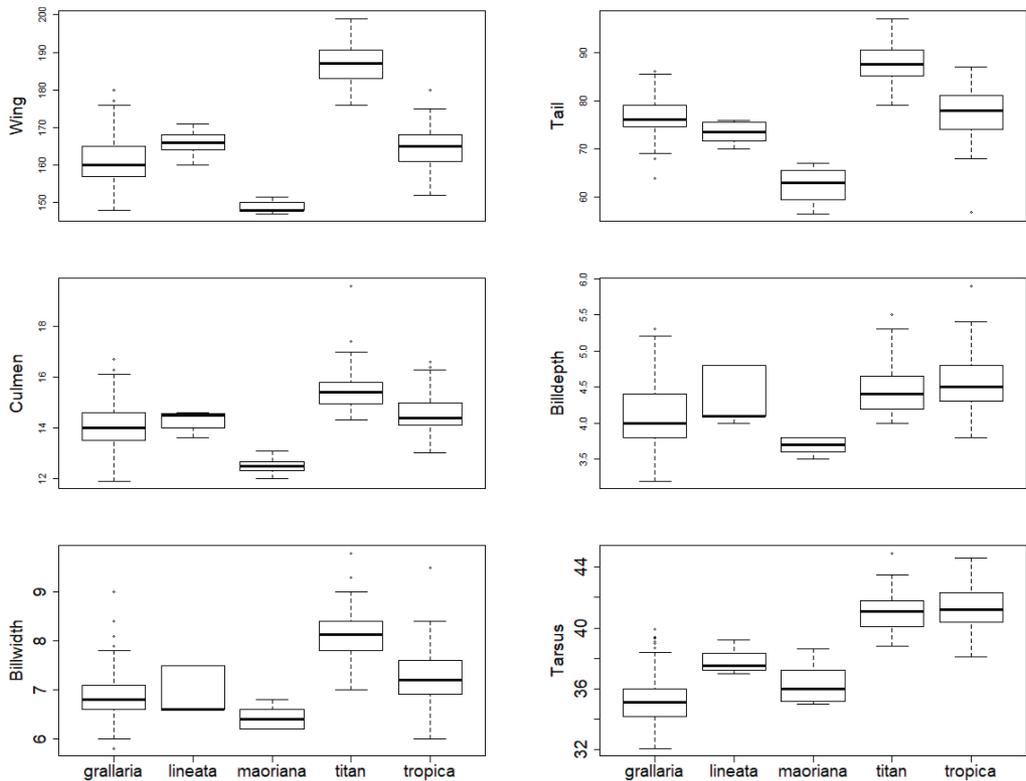


Figure 3. Means of six biometrics (bill width, bill depth at gonyes, and culmen, wing, tail and tarsus lengths) of small White-bellied Storm Petrels *Fregetta grallaria* (all taxa aggregated), New Caledonian Storm Petrel *F. lineata*, New Zealand Storm Petrel *F. maoriana*, the large Titan Storm Petrel *F. [g.] titan*, and Black-bellied Storm Petrel *F. tropica* (for methodology see main text).

These results were confirmed by two further PCAs run on individual specimens. For the *F. maoriana*, '*lineata*' and '*guttata*' specimens, we used measurements taken by various researchers, as if they were independent samples, yielding, respectively, seven and 11 'specimens' (complete list and measurements in Appendix 2). In the PCAs, individuals were grouped by breeding locality (Fig. 4B) or by taxonomy (Fig. 4C). Both PCAs indicated that '*lineata*', '*guttata*' and QM 14391 clumped between *F. grallaria* and *F. tropica*, overlapping slightly with both. Also, many *F. grallaria* specimens overlapped with *F. tropica*. Lastly, once again, *F. maoriana* and *F. [g.] titan* map as extreme opposites (Figs. 4B–C).

Discriminant Analyses.—Discriminant Analysis (DA) maximises multivariate differences between groups (taxa). It establishes classification of individuals from their biometrics based on canonical discriminant functions. DA was performed on individuals grouped by nine breeding localities (Fig. 4D), five taxa (Fig. 4E), and a reduced set of three taxa (Fig. 4F). The five taxa were '*F. lineata*' (a regrouping of '*lineata*', '*guttata*', and QM 14391'), *F. grallaria*, *F. tropica* (including QM 31216), *F. maoriana*, and *F. [g.] titan*. Error-classification rates are derived as apparent rates when using all individuals as a train dataset, or more robust estimates of error rates when using the cross-validation and leave one out procedure. The same six centred and scaled variables from PCA were used in DA.

First, a stepwise DA indicated that all six variables entered the model (with threshold significance level for dropping a variable established at 0.01), thus all six variables were retained (data not shown). Then, using Linear Discriminant Analysis (LDA), we found

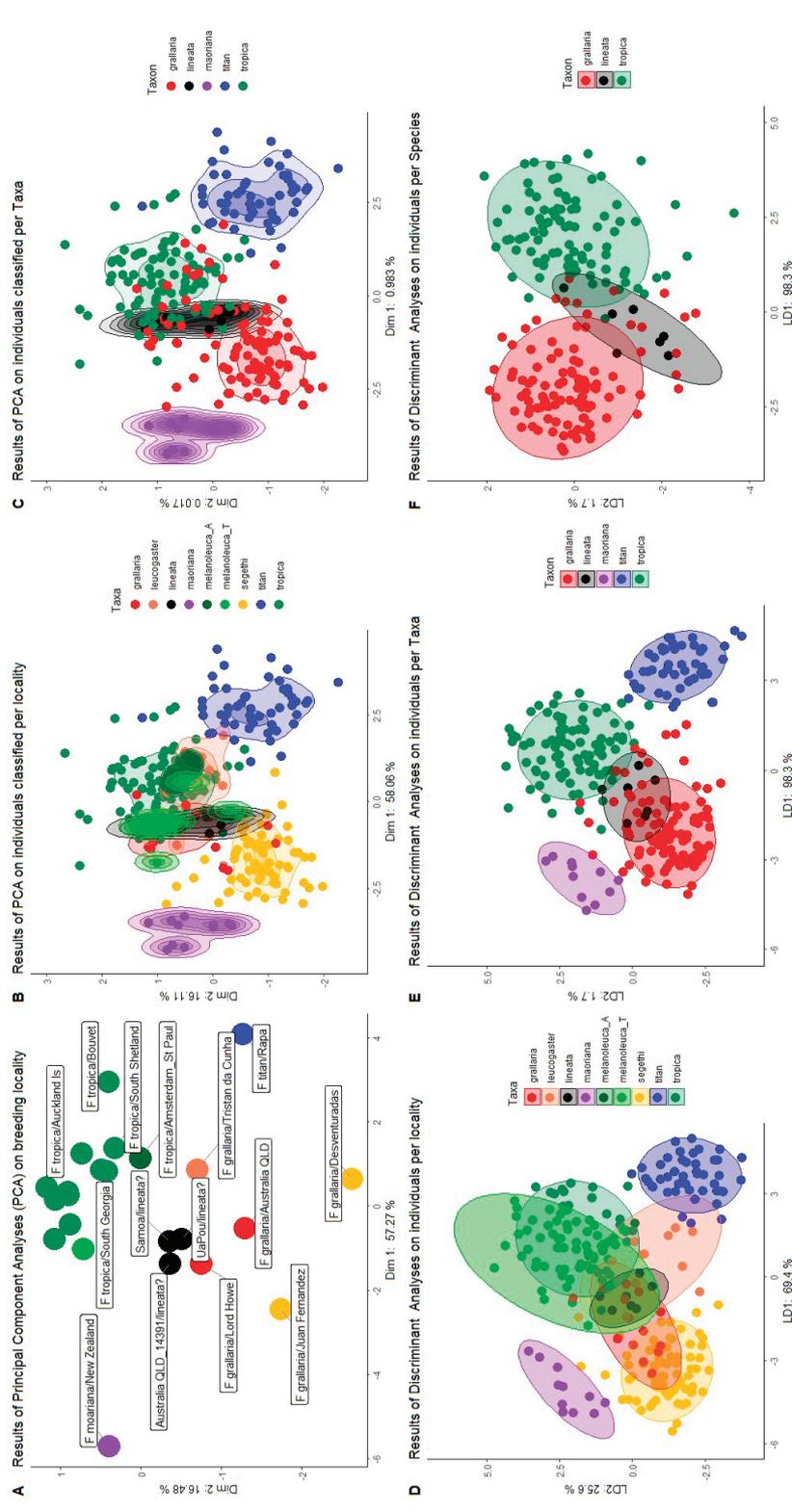


Figure 4. Top row: results of Principal Component Analyses performed on six biometrics (bill width, bill depth at gonyx, and culmen, wing, tail and tarsus lengths) taken from specimens of Black-bellied Storm Petrel *Fregatta tropica* (11 populations), small White-bellied Storm Petrels *F. grallaria* (six populations), the large Titan Storm Petrel *F. [g.] titan* (Rapa Island) and *F. maoriana* (New Zealand). The two Brisbane specimens and the specimens (*lineata*) from Samoa and (*guttata*) from Ua Pou were treated individually. (A) All taxa, plus the four museum specimens. (B) Same analysis performed on individual skins showing distinct taxa and breeding localities. (C) Same analysis for only the five recognised taxa. Bottom row: results of Discriminant Analyses performed on individual specimens from New Caledonian Storm Petrel *Fregatta lineata* (a regrouping of *lineata*, *guttata* and *QM 14391*), small White-bellied Storm Petrels *F. grallaria*, Black-bellied Storm Petrel *F. tropica* (including QM 31216), New Zealand Storm Petrel *F. maoriana*, and the large Titan Storm Petrel *F. [g.] titan*. (D) Grouped by nine breeding localities. (E) Same analysis performed on the five taxa as *a priori* groups. (F) Same analysis performed on a reduced set of taxa (*lineata*, *grallaria* and *tropica*). In all plots, each point represents a specimen, except in 4A.



apparent classification-error rate was only 10.34% ($n = 261$) when applied to all breeding localities as groups (Fig. 4D). Five of seven *F. lineata* were correctly assigned, as were all *F. maoriana* and all *F. [g.] titan*, and nearly all *F. tropica* and *F. g. segethi*. Using a cross-validation procedure for error-rate estimation led to a slight increase, as expected, of 13.0% error rate.

A second LDA was run on the five taxa as *a priori* groups (Fig. 4E). Apparent error-rate classification was lower, at 8%, but just two *F. lineata* were correctly classified. Quadratic Discriminant Analysis (QDA) was also used, as it is less conservative (permitting different variance matrices for different groups), while using a quadratic classification decision boundary. QDA significantly improved the apparent error rate (3.8%), notably with all seven *F. lineata* specimens now being correctly assigned to their group. However, using the cross-validation calibration, the error rate was 8.8%. Restricting DA to *F. lineata*, *F. grallaria* and *F. tropica* did not significantly alter the results, but placed *F. lineata* between *F. grallaria* and *F. tropica* in multivariate space (Fig. 4F), notably due to intermediate values in tarsus length (Figs. 3 and 6).

The three *F. lineata* specimens are larger than *F. maoriana* in all measurements (Fig. 3, Appendix 2), albeit with very slight overlap in bill width. Within each taxon, measurements vary to some extent between individuals, as reported by relatively high standard error values in wing and tail measurements (Appendix 2). Intra-taxon variation, however, is particularly pronounced for the three *F. lineata* specimens. Part of this variation is due to observer measurement error, and possibly also to specimen age. The within-individual range of variation (i.e., measurements made by three or four different observers) is actually higher than the within-population variation of *F. maoriana*. For example, the two specimens of *F. maoriana* held at the Muséum national d'Histoire naturelle, Paris, were measured by four different observers, and standard errors in measurements vary between 0.13 mm (culmen length in one specimen) and 2.25 mm (tail length in the other). Tarsus length also varies both within and between the three *F. lineata* specimens. Streaks on their bellies are also quite variable, as in *F. maoriana* (e.g., Flood 2003, Stephenson *et al.* 2008b), but are completely unique to *F. lineata* and *F. maoriana*. Neither taxon shows an absence of streaks, but their extent and arrangement are variable and distinctive (see below).

Phylogenetic relationships between *Fregetta* storm petrels

Recent genetic work shed light on the *Fregetta* complex, but also added uncertainties and confusion. These have confirmed that live *F. maoriana* and the three *F. maoriana* specimens are the same taxon (Robertson *et al.* 2011). They are distinct from and not close to *Oceanites* and lie within *Fregetta* (Robertson *et al.* 2011, 2016). This is supported by evidence from Mallophaga: *Philoceanus fasciatus*, a species found on both *F. tropica* and *F. grallaria*, has been collected on *F. maoriana*, and is morphologically very different from both *Philoceanus robertsi*, parasitic on *Oceanites oceanicus*, and *Philoceanus garrodiae*, parasitic on Grey-backed Storm Petrel *Garrodia nereis* (Stephenson *et al.* 2008b).

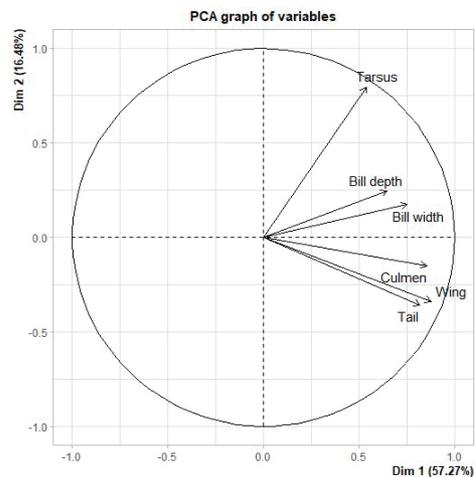


Figure 5. Principal Component Analysis showing contribution of variables to axes 1 and 2.

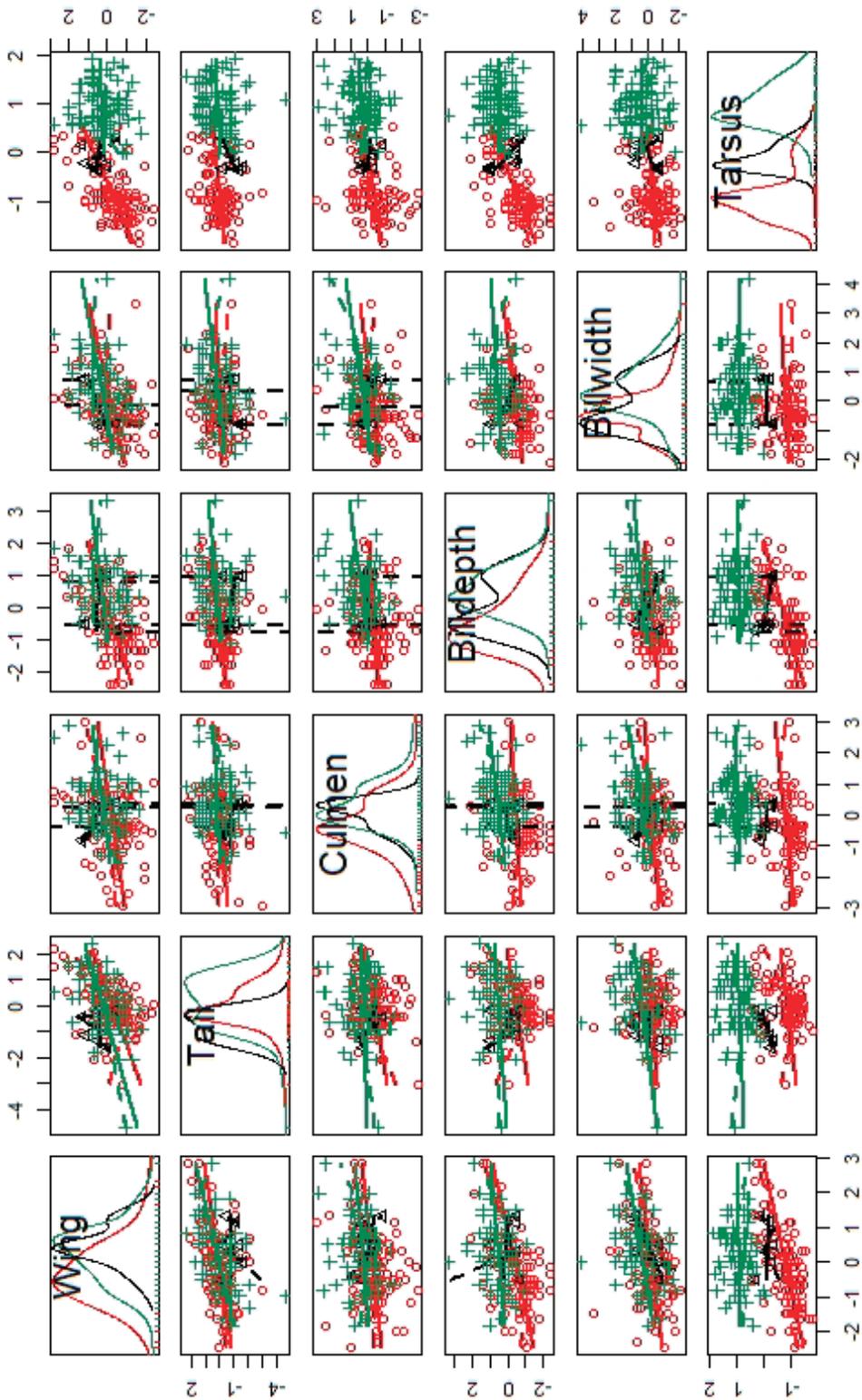


Figure 6. Comparative measurements of New Caledonian Storm Petrel *Fregata lineata* (black), White-bellied Storm Petrel *F. grallaria* (red) and Black-bellied Storm Petrel *F. tropica* (green). Data are presented as a correlation matrix for each pair of morphometric variables, with the diagonal in the matrix showing the distribution of each variable per taxon. Colour chart as in Fig. 4F.

Three studies provide *Fregetta* phylogenetic trees; based on either short (c.500 bp; Cibois *et al.* 2015), long (960 bp; Robertson *et al.* 2016), or complete *cyt-b* sequences (Robertson *et al.* 2011); as well as seventh intron of beta Fib (Robertson *et al.* 2011, 2016). This diversity of genetic material led to contrasting conclusions. *F. maoriana* was closer to *F. tropica* than *F. grallaria* in both complete *cyt-b* and nuclear intron (Robertson *et al.* 2011), closer to *F. tropica* than *F. grallaria* in short *cyt-b* (Cibois *et al.* 2015), but closer to *F. grallaria* in long *cyt-b* and closer to *F. tropica* in nuclear intron (Robertson *et al.* 2016). In addition, *F. lineata* AMNH 194110 was sequenced and results indicate that it diverges from *F. maoriana* and, based on partial *cyt-b* sequence (557 bp), is more closely related to *F. grallaria*, especially *F. [g.] titan*, than to *F. tropica* (Cibois *et al.* 2015, Robertson *et al.* 2016). A matter of note, Robertson *et al.* (2016) commented that Cibois *et al.* (2015) were wrong to include NHMUK 1953.55.101 (collected on Gough Island, South Atlantic, held at the Natural History Museum, Tring) as *F. grallaria*. However, the sequence was taken from Robertson *et al.* (2011), as recorded in GenBank, so the original error is owned by the latter.

Our findings show that USNM 15713 and AMNH 194110 are the same taxon, *F. lineata*, based on morphometrics, although no genetic data are available for the USNM specimen. Interestingly, the Brisbane specimen QM 14391 was sequenced and clumped with *F. [g.] titan* (Robertson *et al.* 2011), as did the Ua Pou specimen AMNH 194110 (Cibois *et al.* 2015), supporting the case for aggregating them. Incidentally, whilst QM 14391 is labelled *F. tropica*, Robertson *et al.* (2016) treated it as *F. grallaria*, presumably because sequences clade with *F. grallaria* rather than *F. tropica*. However, systematics of the group are complicated by the opaque taxonomy of the genus *Fregetta* itself (Howell 2010, 2012), with more than 20 different names proposed for these birds, and the complex situation in Tristan da Cunha, South Atlantic (Brooke 2004, Howell 2012, Flood & Fisher 2013). In particular, taxonomy of the *F. grallaria* and *F. tropica* complexes are not resolved (Crochet 2008, Howell 2010, 2012, Robertson *et al.* 2016). That said, there is consensus that the four *Fregetta* taxa (*F. grallaria*, *F. tropica*, *F. lineata* and *F. maoriana*) form a monophyletic clade, based on mtDNA and nuclear DNA, albeit a single gene in both cases (Robertson *et al.* 2011, Cibois *et al.* 2015, Robertson *et al.* 2016). This clade is distinct from *Oceanites* and supports the generic denomination *Fregetta*.

Taxonomic conclusions

From these univariate and multivariate analyses, we conclude that the three specimens 'lineata', 'guttata', and QM 14391 represent a single taxon, for which the oldest available name is *lineata*. This group is clearly separated from *F. maoriana* by measurements, and *F. grallaria* and *F. tropica* by dark streaks on a white belly. Phylogenetically, *F. lineata* is close to *F. [g.] titan*, as assessed by the *cyt-b* sequences of two of the three specimens. Moreover, we conclude that birds photographed off New Caledonia and in the Coral Sea are identical to the three museum specimens and are the same taxon *F. lineata*. Taxonomic conclusions for the AMNH and UNSM specimens were presented by Murphy (1924), Murphy & Snyder (1952) and Matthews (1933). We conclude that *F. lineata* is a valid species, not a morph, nor a subspecies. The next section redescribes *F. lineata* by drawing on our at-sea observations, photographs taken at sea, and study of the three museum specimens.

New Caledonian Storm Petrel *Fregetta lineata*

Holotype.—The oldest of the three *F. lineata* specimens (USNM 15713; Fig. 2) was collected on Upolu, Samoa, in 1839 by T. R. Peale and described in detail by Mathews (1933). It is the type specimen of *Thalassidroma lineata* Peale (1848, Deignan 1961). However,

the specimen has not been sequenced, unlike the other two. Probably, the specimen was collected in November 1839, perhaps during 23–25 November, when Peale visited the island. The species was said to be nesting in holes high in the mountains (Mathews 1933), ‘very high up in the mountains’ (Murphy & Snyder 1952), possibly the highest point Mt. Fito (c.1,100 m). Historic records state that a native collected the specimen for Peale, and the latter mentioned these birds were from the mountains. However, the precise circumstances are unclear and it is possible that the storm petrel breeding in the mountains was Polynesian Storm Petrel *Nesofregetta fuliginosa* (Bourne 2008), and that the specimen was collected at sea, as Peale mentioned these birds were commonly observed there. Murphy & Snyder’s (1952) conclusion that the specimen is *F. tropica*, which is not known to breed in the tropics, led Bourne (2008) to propose that it was collected by Peale in the southern seas and accidentally exchanged with the holotype of Collared Petrel *Pterodroma brevipes* (USNM 15459; also collected by Peale). As it is not *F. tropica* (see above), there is no reason to doubt the locality. USNM 15713 has not been genetically sequenced, its age is unknown, and the skin is damaged.

Measurements.—Wing length 163 mm; tail length 70 mm; culmen (bill length from feathers) 14.5 mm; bill depth (top of maxillary unguis to base of mandibular unguis) 4.8 mm; bill width at base 6.6 mm; tarsus length 37.3 mm.

Second oldest specimen.—AMNH 194110 from the Marquesas (Fig. 2) was described in detail by Murphy (1924) and is a female collected on 15 September 1922 by R. H. Beck, off Ua Pou, Marquesas. It is currently labelled *Fregetta guttata* (Mathews 1933, LeCroy 2017) and is the holotype of *F. guttata* (LeCroy 2017). Murphy (1924) initially considered the specimen to be the same taxon as *F. lineata* (Peale 1848), and noted an intermediate structure (foot, nails, rectrices, etc.) between *F. grallaria* and *F. tropica*. Mathews (1933) misinterpreted Murphy (1924), confusing *F. lineata* and *F. [g.] titan*, and concluded AMNH 194110 represented a new species, even proposing a new genus. However, *contra* Mathews (1933), Murphy & Snyder (1952) found the differences insufficient to recognise a new taxon and assigned it to *F. grallaria*, considering ‘*lineata*’ to be a synonym of ‘*grallaria*’ (see also LeCroy 2017). Measurements are given in Appendix 2.

Description.—Consult Figs. 7–9. *Foreparts* Head, neck and throat to upper breast blackish brown (old feathers brownish and new ones glossed black). Throat of worn birds may show central pale mottling. *Underparts* Lower breast, belly to upper ventral region, and flanks contrastingly white with characteristic oval-shaped blackish streaking (feather centres). Streaking somewhat variable in size and shape, but typically each streak broadens at feather tip. Streaks on flanks widest and densest, those on central belly narrowest, and form rows of oval dapples. Dark upper breast border tends to form triangular extensions into sides of white breast. *Underwing* Striking pattern with following specific characteristics. Broad blackish-brown leading edge, its border contiguous with dark upper breast. Dark leading edge of inner wing involves lesser secondary-coverts, and on outer wing the lesser and central median primary-coverts. Greater primary-coverts mostly greyish black. Median and greater primary-coverts narrowly tipped and edged white. Flight feathers essentially uniform greyish black. Resultant pattern is dark with restricted white underwing panel, which mostly involves median and greater secondary-coverts. However, some greater secondary-coverts can be dark centred, further restricting area of white panel. *Upperparts* Mantle to back and scapulars essentially blackish brown, shiny greenish / greyish on catching the light. Some mantle and scapular feathers narrowly tipped whitish. Small uppertail-coverts browner, rest white forming a well-defined wide U shape that wraps onto white underside. *Upperwing* Colour as upperparts, but upperwing-coverts a shade browner, forming an indistinct paler panel. *Tail* Blackish brown with white basal area on underside



Figure 7. New Caledonian Storm Petrel *Fregatta lineata*, off Nouméa, New Caledonia, January 2020 (Hadoram Shirihai, © Tubenoses Project)

mostly concealed by blackish-brown lateral undertail-coverts (with thin white edges) but visible on spread tail. *Bare parts* Essentially black.

In-hand identification.—*F. lineata* is distinct from *F. grallaria* in structure and measurements. Only a few *F. grallaria* are flecked / streaked on belly (Fig. 8). Murphy & Snyder (1952) stated that such markings are commonly found in *F. grallaria*. However, they are found on just eight of 68 adults collected near the Juan Fernández Islands (Chile), and seven of 35 adult *F. [g.] titan*. Similar statistics occur for *F. tropica* (AMNH). Our experience of *F. grallaria* and *F. [g.] titan* in the South Pacific, and *c.*35 *F. tropica* specimens from New Zealand, leads to the conclusion that streaking is scarce and irregular, and variable in width and density, unlike the three *F. lineata* specimens (see Flood 2003, Stephenson *et al.* 2008b). Variation in intermediate-morph *F. g. grallaria* from Lord Howe and Kermadec Islands amounts to gradual darkening on the axillaries and flanks, not streaking on the belly, and all but the darkest individuals have a pale belly (Marchant & Higgins 1990, Stephenson *et al.* 2008b).

Identification at sea and plumage variation.—*F. lineata* can reliably be identified at sea with good views and, ideally, in sharp photographs on which it is possible to evaluate details.

Separation from Fregatta storm petrels.—Usually, *F. tropica* has a thick dark central belly-stripe, sometimes narrow, scarcely broken, and a different structure and behaviour (see below). Usually, *F. grallaria* has a pure white belly, but a few have irregular thinly distributed flecks / streaks. Scarcely, individuals from all populations of *F. grallaria* have flanks streaking, narrow and close to feather shafts, never in rows of oval dapples characteristic of *F. lineata*, or straighter lines characteristic of *F. maoriana* (Fig. 8). A few extreme examples of *F. g. grallaria* from Lord Howe display broader flanks streaking, but never across the whole belly (Fig. 8). Also, unlike *F. grallaria*, *F. lineata* (and *F. maoriana*) have a narrower white ‘rump patch’ on the long uppertail-coverts and a more restricted white underwing panel. Lastly, *F. lineata* (and *F. maoriana*) lack extensive and broad white fringing on fresh upperparts as in most populations of *F. tropica* and *F. grallaria*.



Figure 8. Comparison of 'streaked' White-bellied Storm Petrel *Fregetta g. grallaria* with New Zealand Storm Petrel *F. maoriana* and New Caledonian Storm Petrel *F. lineata*. (A) White-bellied Storm Petrel, Lord Howe Island, Australia, April 2019 (David Newell, www.birdlifephotography.org.au). (B) White-bellied Storm Petrel, Lord Howe Island, February 2017 (Mark Lethlean, www.birdlifephotography.org.au). (C) White-bellied Storm Petrel, Lord Howe Island, date unknown (Jack Shick, www.lhirocenteradicationproject.org/plants-animals/birds). (D) New Zealand Storm Petrel, Hauraki Gulf, North Island, New Zealand, November 2018 (Hadoram Shirihai, © Tubenoses Project). (E) New Caledonian Storm Petrel, off Nouméa, New Caledonia, January 2020 (Hadoram Shirihai, © Tubenoses Project). (F) New Caledonian Storm Petrel, off Nouméa, New Caledonia, January 2020 (Hadoram Shirihai, © Tubenoses Project). Rarely, individuals of all populations of *F. grallaria* have limited fine streaking, for example (A) and (B), narrow and close to feather shafts, never in rows of oval dapples characteristic of *F. lineata*, for example (E) and (F), or forming straighter lines characteristic of *F. maoriana* (D). A few extreme examples of *F. g. grallaria* from Lord Howe possess broader flanks streaking, e.g. (C), but never covering the whole belly.

Separation from F. maoriana.—Consult Figs. 8–9. Similar-looking but individually variable *F. lineata* is larger, longer winged and longer legged, with different belly streaking and underwing pattern. Belly streaking of *F. lineata* is typically denser and bolder. White underwing panel of *F. lineata* typically narrower and less clean-looking (more underwing-coverts have broad dark centres). Border of dark on breast rounder in *F. lineata*, curving from sides of lower breast to central upper breast, but clearly straighter in *F. maoriana*. White 'rump patch' on long uppertail-coverts averages narrower and rounder in *F. lineata*. Both species show variation in belly streaking. For example, *F. lineata* score 4 (16.7% of birds) shows narrower less coalescing streaking, suggesting most heavily streaked *F. maoriana* score 1 (9.3% of birds). *F. lineata* score 1 (23.3% of birds) uniquely patterned, with continuous and dense rows of oval dapples, rather than the more straight-lined streaks

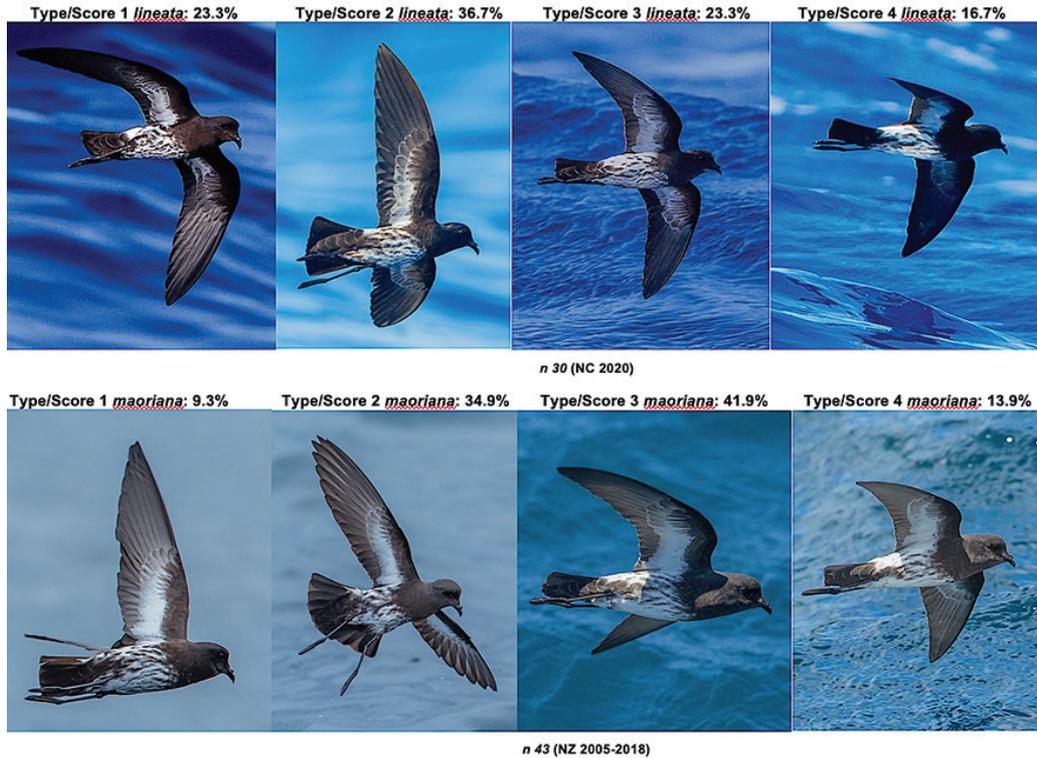


Figure 9. Comparison of underparts and underwing patterns of New Caledonian Storm Petrel *Fregatta lineata* ($n = 30$), off Nouméa, New Caledonia, January 2020 (top row) and New Zealand Storm Petrel *F. maoriana* ($n = 43$), Hauraki Gulf, North Island, New Zealand, November 2018 (bottom row). Variation is scored into four main types for each species, from the heaviest marked (score 1) to lightest marked (score 4). *Underparts streaking* Both species can show similar coverage of streaking on the white belly and a tendency for denser and / or thicker streaks on the flanks. Score 1 for *F. lineata* (23.3% of birds) is uniquely patterned, with continuous and dense rows of oval dapples, rather than straighter lines of *F. maoriana*. Score 2 for *F. lineata* (36.7%) is the most common and similar to the coverage and shape of streaking as the similarly common score 2 for *F. maoriana* (34.9%). Streaking on *F. lineata* tends to be denser and bolder giving the impression it is wider. The unstreaked belly area tends to be cleaner white in *F. maoriana*. *Border of dark breast* The border in *F. lineata* is positioned higher than in *F. maoriana*, towards the centre of the upper breast, creating a rounder and less straight border than *F. maoriana*. *Underwing pattern* In *F. lineata*, the dark leading edge to the inner wing involves lesser secondary-coverts. The longest of these have partially dark bases creating a characteristic ragged border, with strongly marked bases in 83.3%, limited dark bases in the remaining 16.7%. By contrast, the dark leading edge in *F. maoriana* invariably shows a clear-cut border on the coverts, only occasionally with a few dark spots in the longest lesser coverts, and never forming a continuous ragged border as in *F. lineata*. Usually, some greater secondary-coverts and most / all greater primary-coverts in *F. lineata* have broad dark centres. Thus, the white underwing panel of *F. lineata* is noticeably less extensive than in *F. maoriana* (Hadoram Shirihai, © Tubenoses Project)

of *F. maoriana* (for explanation of scoring see Fig. 9). Borderline cases of belly streaking separated when underwing pattern diagnostic. Underwing of *F. lineata* diagnostic when shows partially dark row of longest lesser secondary-coverts, creating characteristic ragged border to dark leading edge, and has dark centres to greater secondary-coverts. Conversely, a clear-cut border and all-white greater secondary-coverts are diagnostic of *F. maoriana* (e.g., as evidenced by the first proven record of *F. maoriana* away from New Zealand, off Fiji; Flood & Wilson 2017). Also consider jizz and behaviour as follows.

Jizz and behaviour.—Once learnt, *F. lineata* is readily identifiable by jizz, flight and feeding behaviour. Compared to other *Fregatta* storm petrels, including *F. maoriana*, note the slimmer build, with proportionately longer and narrower wings, elongated rear body, and

long squarer-ended tail. *F. lineata* has a less square, more angular forehead profile, longer neck, and quite long and thick bill that curves downward. It also has long legs, notably the tibia, which can approach the very long legs of White-faced Storm Petrel *Pelagodroma marina*, best appreciated when foot-pattering (Fig. 7). Feet relatively 'huge', accentuating impression of 'walking on water'. Unlike other *Fregetta* that freely 'ski' using one foot, this species only occasionally performs short 'skis'. Rather, it employs both feet simultaneously, occasionally followed by a short 'ski'. *F. maoriana* 'skis' on one foot in travelling flight, but not habitually like *F. tropica* and *F. grallaria*. Travelling flight striking, comprising glides and flaps on stiff wings, close to the sea surface. Collects prey from sea surface like other *Fregetta*. A bird once dived c.30 cm to collect small pieces of fish. On several occasions, foraging birds challenged Tahiti Petrel *Pseudobulweria rostrata* and Gould's Petrel *Pterodroma leucoptera*, quickly snatching fish pieces, then escaping. *F. lineata* may associate with *P. leucoptera* as they often arrive simultaneously at chum, and *F. lineata* is always present at large feeding aggregations of *P. leucoptera*. Also, *F. lineata* constantly follows feeding Copper Sharks *Carcharhinus brachyurus*.

Breeding New Caledonian Storm Petrel *Fregetta lineata*

First confirmed breeding in New Caledonia.—On 26 September 2014, a juvenile *F. lineata* was caught by inhabitants of New Caledonia. Information is sparse, but it was found on the shore of mainland New Caledonia, in an inhabited area (Fig. 1), and the juvenile probably was disoriented by street lights, as happens elsewhere with petrels, shearwaters and storm petrels (Rodríguez *et al.* 2017). Photographs were taken that day at Port Bouraké, in front of Îlot Leprédour (Fig. 10). In 2009, this islet became a nature reserve of the Province Sud. Eradication of European Rabbits *Oryctolagus cuniculus* from the islet is underway. The photographs were first sent to L. Renaudet (of the Société Calédonienne d'Ornithologie), who forwarded them to VB for identification. The bird had down on its head and nape, indicating a recent fledgling and confirming breeding on New Caledonia. No feather or blood samples were taken, and the bird was released. This is the only definite record of *F. lineata* on land and the only one indicative of breeding.

What is the breeding season in New Caledonia?—A fledgling in September points to winter breeding in the Southern Hemisphere. A six-month season is expected given the size of *F. lineata*. Thus, based on the fledgling, March–April is the likely egg-laying period. This corresponds with the majority of sightings in March and April off New Caledonia (Appendix 1). Further, numerous sightings as early as January off New Caledonia in 2020 suggest that egg laying may occur over an extended period, possibly January–April. In January 2020, off New Caledonia, birds were in rather fresh plumage, but tail and breast feathers were worn. The lack of primary moult and feather condition indicate that at least some were engaged in pre-breeding or breeding activities. (Primary moult of successful breeding storm petrels generally commences post-breeding.) Sightings off Australia perhaps correspond mainly to non-breeders. Indeed, birds there in March often had rather worn plumage and in April 2014 active wing moult was noted, which would not be expected in breeding adults. That said, some did not show obvious wear or moult.

Where exactly does it breed?—All islets in the southern lagoon of New Caledonia have been visited and carefully searched, with several nights spent on most of them (Benoit & Bretagnolle 2002). No storm petrel was ever seen, no *Fregetta* whistling call was heard and, as far as we know, none of the many ornithologists who subsequently visited the islets has reported storm petrels. The only known storm petrel colony in New Caledonia was located in December 1999 in the interior of an islet off northern New Caledonia (VB pers. obs.). Seven to nine burrows with entrances of c.5–7 cm width were located in sand. No particular



Figure 10. New Caledonian Storm Petrel *Fregetta lineata*, Port Bouraké, New Caledonia, 26 September 2014; the first documented fledgling; note traces of down on head, stripes on belly diagnostic of *F. lineata*, narrow white fringes on dorsal feathers and upperwing (the latter most typical of *F. grallaria*) (photographer unknown, images supplied by L. Renaudet)

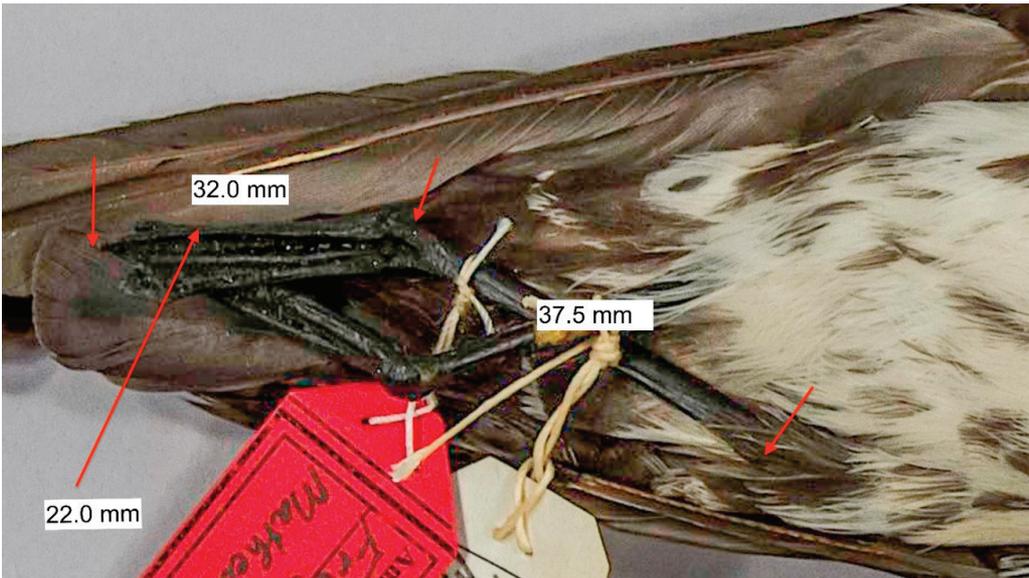


Figure 11. New Caledonian Storm Petrel *Fregetta lineata* held at the American Museum of Natural History, New York (AMNH 194110); the annotations demonstrate that the middle toe and claw measure 32 mm, and the published measurement of 22 mm is incorrect (Hadoram Shirihai)

smell was detected and nothing was observed in the burrows. They were not disturbed as burrows in sand are easily and irreparably damaged. It was not possible to spend the night on the islet, but during several nights on neighbouring islets no storm petrel was seen or heard. Polynesian Storm Petrel *Nesofregatta fuliginosa*, a long-suspected breeder in New Caledonia, was believed to be the burrow owner. In May 2000, M. Pandolfi spent a night at the colony, heard whistling calls, but did not see or catch any storm petrels. Winter breeding supported the assumption that *N. fuliginosa* was involved. However, the following summer rats *Rattus rattus* were found on the islet. Although successfully eradicated in 2008, no one has located storm petrels on subsequent visits and no burrow has been found (J. Baudat & P. Villard pers. comm. 2008–18). The species of storm petrel involved remains unknown.

F. lineata may breed either inland or on islets in Bouloupari Lagoon (not visited). These islets are atypical and quite unlike southern lagoon islets. Some are rocky and most are surrounded by mangroves. The most suitable location would be Leprédour Islet where introduced mammals were recently eradicated. Any storm petrel population on the islet would likely have recovered somewhat, leading to at-sea sightings, as suggested for *F. maoriana* which breeds on Little Barrier Island where cats were recently eradicated. Alternatively, breeding may occur on mainland New Caledonia; a likely location is the Tontouta River valley where *Pterodroma leucoptera* breeds. High forested peaks along the coast, such as Dent de Saint Vincent, are also suitable search locations.

Apart from New Caledonia, the Marquesas Islands, where AMNH 194110 was collected, could hold a breeding population. The presence of subfossil bones attributed to *Fregatta* on Ua Huka and Tahuata (Steadman 2006) might evidence the past presence of *F. lineata*. In addition, on 30 September 2013, one or two streaked storm petrels were seen south-west of Fatu Hiva, which provides hope that the streaked storm petrel survives in the Marquesas (Flood & Wilson 2017). However, in September–October 2021, an 18-day seabird survey circumnavigating the islands recorded numerous storm petrels, but no streaked birds (Flood *et al.* 2022). Perhaps seas around the Marquesas form part of the non-breeding range, given that the AMNH specimen and the recent sightings were in September, at the end of the likely breeding season in New Caledonia discussed above. Also, *F. lineata* could breed and survive on Samoa, where USNM 15713 was collected (especially if the bird was collected on land, see above). Mt. Fito would be a likely breeding locality, although again, the seas around Samoa could form part of the non-breeding range, as the specimen was collected in November.

Conservation

It is now vitally important to find breeding burrows where immediate protective measures will be required. Based on the numbers seen at sea, both off Australia and New Caledonia, the population is perhaps in the order of 100–1,000 pairs and almost certainly globally threatened. Compared to breeding on islets, nesting in the mountains would be far more difficult to confirm and conservation management far more difficult to implement. Thus, our primary recommendation is to search for evidence of breeding on islets, in April or May, using spotlighting which is known to attract storm petrels. Nocturnal searches are preferable as a first step, which is quite manageable given the small number of islets. If successful, this should be followed by catching and fitting birds with radio tags. If unsuccessful, searches on the main island should be undertaken. It is worth recalling that *F. maoriana* survived undetected on Little Barrier Island for more than 100 years, breeding in large forests and on cliffs, despite the presence of cats and rats (Rayner *et al.* 2015).

Acknowledgements

Thanks to Ludovic Renaudet for sending photographs of the fledgling *F. lineata*, Mireille Pandolfi and Pascal Villard for their help in searching for storm petrels on the northern islets, and Julien Baudat for sharing his knowledge of seabirds. VB thanks the many museum curators, too numerous to name individually, who permitted and supported his visits for storm petrel studies. RLF thanks Mark Adams of NHMUK for supplying at short notice a photograph of NHMUK 1895.2.1.11. HS particularly thanks Gabriel Levionnois for assisting three days of pelagic work off New Caledonia in January 2020, the masterful skippering of his boat making possible high-quality photographs, and his great enthusiasm to learn about seabird conservation on his island home. Also, much appreciation goes to François Levionnois and Odile Thomas for their warm hospitality during HS's long stay in New Caledonia, January–August 2020. HS also expresses his thanks to the Jorvall Foundation for many years of support of avian taxonomic research. Thanks to an anonymous reviewer, and to Chris Collins and Paul Walbridge for helpful advice. Guy Kirwan provided help in editing the text, and we thank him for supplying additional references that were initially missed.

References:

- Benoit, M. P. & Bretagnolle, V. 2002. Seabirds of the southern lagoon of New Caledonia: distribution, abundance and threats. *Waterbirds* 25: 202–213.
- Bourne, W. R. P. 2008. Petrels collected by Titian Ramsay Peale in the Pacific Ocean during the United States Exploring Expedition of 1838–1842. *Arch. Nat. Hist.* 35: 143–149.
- Bourne, W. R. P. & Jouanin, C. 2004. The origin of specimens of New Zealand storm petrel (*Pealeornis maoriana* Mathews, 1932). *Notornis* 51: 57–58.
- Bourne, W. R. P., Jouanin, C. & Catto, J. V. F. 2004. Letter. The original specimens of the New Zealand storm petrel. *Notornis* 51: 191.
- Brooke, M. de L. 2004. *Albatrosses and petrels across the world*. Oxford Univ. Press.
- Cassin, J. 1858. *United States Exploring Expedition. During the years 1838, 1839, 1840, 1841, 1842*, vol. 8. J. B. Lippincott & Co., Philadelphia.
- Cibois, A., Thibault, J.-C., LeCroy, M. & Bretagnolle, V. 2015. Molecular analysis of a storm petrel specimen from the Marquesas Islands, with comments on specimens of *Fregatta lineata* and *F. guttata*. *Bull. Brit. Orn. Cl.* 135: 240–246.
- Collins, C. 2013. New Caledonian Storm-petrel. www.birdsandwildlife.com/new-caledonian-storm-petrel (accessed 18 December 2021).
- Crochet, P.-A. 2008. Western Palearctic list update: deletion of White-bellied Storm Petrel. *Dutch Birding* 30: 18.
- Deignan, H. G. 1961. Type specimens of birds in the United States National Museum. *Bull. US Natl. Mus.* 1–718.
- Flood, R. 2003. The New Zealand storm petrel is not extinct. *Birding World* 16: 479–483.
- Flood, R. & Fisher, A. 2013. *North Atlantic seabirds: storm-petrels & Bulwer's Petrel*. Pelagic Birds & Birding Multimedia ID Guides, Scilly.
- Flood, R. L. & Wilson, A. C. 2017. A New Zealand Storm Petrel *Fregatta maoriana* off Gau Island, Fiji, in May 2017. *Bull. Brit. Orn. Cl.* 137: 278–286.
- Flood, R. L., Tanoi, S. & Zufelt, K. 2022. Pelagic observations during a circumnavigation of the Marquesas Islands, French Polynesia, September–October 2021. Pacific Seabird Group Tech. Publ. No. 4. <https://pacificseabirdgroup.org/psg-publications/technical-publications/>.
- Galbreath, R. 2018. The locality and date of collection of the holotype of New Zealand storm petrel, *Pealeornis maoriana* Mathews, 1932. *Notornis* 65: 113–116.
- Howell, S. N. G. 2010. Identification and taxonomy of White-bellied Storm Petrels, with comments on WP report in August 1986. *Dutch Birding* 32: 36–42.
- Howell, S. N. G. 2012. *Petrels, albatrosses, and storm-petrels of North America: a photographic guide*. Princeton Univ. Press.
- Howell, S. N. G. & Collins, C. 2008. A possible New Zealand Storm-petrel off New Caledonia, southwest Pacific. *Birding World* 21: 207–209.
- Howell, S. N. G. & Zufelt, K. 2019. *Oceanic birds of the world: a photographic guide*. Princeton Univ. Press.
- Lecroy, M. 2017. Addenda and corrigenda to type specimens of birds in the American Museum of Natural History, Part 1. Supplement to *Bull. Amer. Mus. Nat. Hist.* 150(3): 207–346 (1973).
- Marchant, S. & Higgins, P. J. (eds.) 1990. *Handbook of Australian, New Zealand and Antarctic birds*, vol. 1. Oxford Univ. Press, Melbourne.
- Mathews, G. M. 1933. On *Fregatta* Bonaparte and allied genera. *Novit. Zool.* 39: 34–52.
- Medway, D. G. 2004. The place of collection of the original specimens of *Pealeornis maoriana* Mathews, 1932. *Notornis* 51: 58–59.
- Murphy, R. C. 1924. Birds collected during the Whitney South Sea Expedition. II. *Amer. Mus. Novit.* 124: 1–13.
- Murphy, R. C. 1930. Birds collected during the Whitney South sea expedition. XI. *Amer. Mus. Novit.* 419: 1–15.
- Murphy, R. C. & Snyder, J. P. 1952. The 'Pealea' phenomenon and other notes on storm petrels. *Amer. Mus. Novit.* 7: 1–16.

- Peale, T. R. 1848. *United States Exploring Expedition. During the years 1838, 1839, 1840, 1841, 1842*, vol. 8. C. Sherman, Philadelphia.
- Quoy, J. R. C. & Gaimard, P. 1830. Zoologie, vol. 1 in Dumont d'Urville, J. S. C. *Voyage de découvertes de l'Astrolabe. Exécuté par ordre du Roi, pendant les années 1826-1827-1828-1829, sous le commandement de M. J. Dumont d'Urville*. J. Tastu, Paris.
- Rayner, M. J., Gaskin, C. P., Stephenson, B. M., Fitzgerald, N. B., Landers, T. J., Robertson, B. C., Scofield, R. P., Ismar, S. M. H. & Imber, M. J. 2014. Brood patch and sex-ratio observations indicate breeding provenance and timing in New Zealand storm-petrel *Fregatta maoriana*. *Marine Orn.* 41: 107–111.
- Rayner, M. J., Gaskin, C. P., Fitzgerald, N. B., Baird, K. A., Berg, M. M., Boyle, D., Joyce, L., Landers, T. J., Loh, G. G., Maturin, S., Perrimen, L., Scofield, R. P., Simm, J., Southey, I., Taylor, G. A., Tennyson, A. J. D., Robertson, B. C., Young, M., Walle, R. & Ismar, S. M. H. 2015. Using miniaturized radiotelemetry to discover the breeding grounds of the endangered New Zealand Storm Petrel *Fregatta maoriana*. *Ibis* 157: 754–766.
- Robertson, B. C., Stephenson, B. M. & Goldstien, S. J. 2011. When rediscovery is not enough: taxonomic uncertainty hinders conservation of a critically endangered bird. *Mol. Phyl. & Evol.* 61: 949–952.
- Robertson, B. C., Stephenson, B. M., Ronconi, R. A., Goldstien, S. J., Shepherd, L., Tennyson, A., Carlile, N. & Ryan, P. G. 2016. Phylogenetic affinities of the *Fregatta* storm-petrels are not black and white. *Mol. Phyl. & Evol.* 97: 170–176.
- Rodriguez, A., Holmes, N. D., Ryan, P. G., Wilson, K. J., Faulquier, L., Murillo, Y., Raine, A. F., Penniman, J. F., Neves, V., Rodriguez, B., Negro, J. J., Chiaradia, A., Dann, P., Anderson, T., Metzger, B., Shirai, M., Deppe, L., Wheeler, J., Hodum, P., Gouveia, C., Carmo, V., Carreira, G. P., Delgado-Albuquerque, L., Guerra-Correa, C., Couzi, F. X., Travers, M. & Le Corre, M. 2017. Seabird mortality induced by land-based artificial lights. *Conserv. Biol.* 31: 986–1001.
- Saville, S., Stephenson, B. & Southey, I. 2003. A possible sighting of an 'extinct bird' – the New Zealand Storm-petrel. *Birding World* 16: 173–175.
- Scofield, P. (on behalf of the OSNZ Rare Birds Committee). 2007. Ruling on four records of *Pealeornis maoriana*. *Southern Bird* 30: 14.
- Steadman, D. W. 2006. *Extinction and biogeography of tropical Pacific birds*. Univ. of Chicago Press.
- Stephenson, B. M., Flood, R. L., Thomas, B. & Saville, S. 2008a. Rediscovery of the New Zealand Storm-petrel (*Pealeornis maoriana* Mathews 1932): two sightings that revised our knowledge of storm petrels. *Notornis* 55: 77–83.
- Stephenson, B. M., Gaskin, C. P., Griffiths, R., Jamieson, H., Baird, K. A., Palma, R. L. & Imber, M. J. 2008b. The New Zealand storm-petrel (*Pealeornis maoriana* Mathews, 1932): first live capture and species assessment of an enigmatic seabird. *Notornis* 55: 191–206.
- Tennyson, A. J. D., Rayner, M. J., Taylor, G. A., Ismar, S. M. H., Fitzgerald, N. B., Friesen, M. & Gaskin, C. P. 2016. Breeding biology of the New Zealand storm petrel. *Notornis* 63: 187–188.

Addresses: Vincent Bretagnolle, CEBC-CNRS, UMR 7372, CNRS & La Rochelle Université, Beauvoir sur Niort, 79360, France, e-mail: vincent.bretagnolle@cebc.cnrs.fr. Robert L. Flood, FitzPatrick Institute of African Ornithology, DST-NRF Centre of Excellence, Univ. of Cape Town, Rondebosch 7701, South Africa, e-mail: live2seabird@gmail.com. Sabrina Gaba, INRAE, USC 1339 Agripop, Centre d'Etudes Biologiques de Chizé, 79360 Villiers-en-Bois, France, e-mail: sabrina.gaba@inrae.fr. Hadoram Shirihai, Naturhistorisches Museum der Burgergemeinde Bern, Bernastrasse 15, 3005, Bern, Switzerland, e-mail: albatross_shirihai@hotmail.com

Appendix 1: at-sea observations of New Caledonian Storm Petrel off New Caledonia and in Coral Sea

The recent history of the New Caledonian Storm Petrel *Fregatta lineata* begins with observation of a streaked storm petrel by C. Collins, RLF, S. N. G. Howell *et al.* during the 2008 Western Pacific Odyssey (WPO, Heritage Expeditions). The location was c.25 nm south-west of New Caledonia at c.22°40'S, 166°23'E (Howell & Collins 2008). None was seen during the 2009 WPO, nor the previous one in 2007, but singles were found in the same area during the 2010, 2011 and 2012 voyages (Table 1). Since then, many have been observed and photographed in the same region (Table 1). On 31 January 2020, 25 nm south of Nouméa, New Caledonia, in deep waters just outside the lagoon at c.22°50.22'S, 166°26.17'E (Fig. 1), 24 were attracted to chum, to date the largest single-day count.

Further to this, in 2011 D. Mantle and P. Walbridge came across identical-looking storm petrels in the Coral Sea, off Queensland, Australia (<http://www.sossa-international.org/>). Subsequently, many have been logged over seamounds in the Coral Sea, c.300 km east of Queensland, more rarely further south, off the adjacent state of New South Wales (Table 1). Some birds of those off New South Wales may have been New Zealand Storm Petrels. On 13 April 2014, one was caught and released. 'Coral Sea Storm Petrel' is the proposed alternative vernacular name.

Birds have been recorded in January–April off New Caledonia, although we know of no pelagic trip there May–November. We know of records in December–June and October off Queensland, with max. numbers in April, but none during pelagic trips in July–December (<http://www.sossa-international.org/>).

TABLE 1

At-sea records of New Caledonian Storm Petrel *Fregatta lineata* 2008–21. Some birds off New South Wales may have been New Zealand Storm Petrels *F. maoriana*. Includes all records noted in publications and online. Some sightings may not have been located or reported. Distances approximate. Nouméa is capital of New Caledonia. NSW = New South Wales; QLD = Queensland, Australia. ‘SOSSA 2012’ = a report in 2012 by Southern Ocean Seabirds Study Association. Ditto subsequent years. Source for Rob Hynson www.pbbase.com/rob_hynson/image/123145261; for Alan Stuart www.thinkingaboutbirds.com/that-storm-petrel.php; for Heritage Expeditions, page recently removed from www.heritage-expeditions.com/.

Year	Location	Date	No.	Notes	Source
2008	25 nm S of Nouméa, 22°40'S, 166°23'E	7 Apr	1		Howell & Collins (2008)
2010	25 nm S of Nouméa	?	1		Collins (2013)
2010	Off Ulladulla, NSW	29 Mar	1	Moulting	Rob Hynson
2011	25 nm S of Nouméa	?	1		Collins (2013)
2011	32 nm ENE of Southport, QLD	18 Jun	1	Morning	SOSSA 2011
2012	Off SE New Caledonia	Apr	1		Collins (2013)
2012	35 nm NE of Brisbane, QLD, 27°S, 154°E, to 27°S, 155°E	14 Apr	6	Morning (4), late afternoon (2)	SOSSA 2012
2012	85 nm E of Brisbane, QLD, 28°S, 155°E	15 Apr	4	Morning and early afternoon	SOSSA 2012
2013	30 nm ENE of Southport, QLD, 27°S, 153°E to 27°S, 154°E	19 Jan	2	Morning	SOSSA 2013
2013	Off S New Caledonia	20 Mar	10		Collins (2013)
2013	Off S New Caledonia	21 Mar	1		Collins (2013)
2013	Off S New Caledonia	Apr for 6 days	21		P. Harrison (<i>in litt.</i> 2014)
2014	85 nm ENE of Brisbane, QLD, 27°S, 155°E	12 Apr	4	1 at 17.00 h	SOSSA 2014
2014	85 nm ESE of Brisbane, QLD, 28°S, 155°E	13 Apr	21	1 captured in moult; morning	SOSSA 2014
2014	28 nm ENE of Southport, QLD, 27°S, 153°E	19 Apr	1	At 11.35 h	SOSSA 2014
2015	Off Port Stephens, NSW	Jun	1		Alan Stuart
2018	Off Brisbane, QLD	21 Apr			SOSSA 2018
2018	Off Brisbane, QLD	30 Jun			SOSSA 2018
2019	12 nm W Nouméa	22 Mar	>1		Heritage Expeditions
2019	Off QLD	19 Oct	>1		ebird.org/species/necstp1
2020	25 nm S of Nouméa	21 Jan	10	Some worn, none moulting	This study
2020	25 nm S of Nouméa	31 Jan	24	Some worn, none moulting	This study
2020	25 nm S of Nouméa	20 Feb	6	Some worn, none moulting	This study
2020	South Britannia Seamount, NSW	28 Mar	1		ebird.org/species/necstp1
2021	Off Port Stephens, NSW, 32°48'S, 152°39'E	17 Jan	1	11.30–12.30 h	SOSSA 2021
2021	Off Southport, QLD	14 Feb	1		ebird.org/species/necstp1
2021	Off QLD	13 Mar	>1		ebird.org/species/necstp1
2021	South Britannia Seamount, NSW	14 Mar	>1		ebird.org/species/necstp1
2021	Off Port Stephens, NSW	28 Mar	1		Eremaea BirdLines 2021
2021	Off Kempsey, NSW	3 Apr	1	Worn primaries	ebird.org/species/necstp1
2021	Off Southport, QLD	18 Dec	1	First Dec record	P. Walbridge (<i>in litt.</i>)

Appendix 2

Biometrics (mm) of all known museum specimens of New Caledonian Storm Petrel *Fregatta lineata* and New Zealand Storm Petrel *F. maoriana*. AMNH = American Museum of Natural History, New York. NHMUK = Natural History Museum, Tring. QM = Queensland Museum, Brisbane. USNM = National Museum of Natural History, Smithsonian Institution, Washington DC. Taxon is *Fregatta*. I = island. N = number (I, unless otherwise stated). NZ = New Zealand. S = sex (male / female) VB = Vincent Bretagnolle. Notes: ¹The value 22.0 mm in Murphy & Snyder (1952) is dubious. On reassessment, it should read 32.0 mm (see Fig. 11); ²The value 34.5 mm (Mathews 1933) is dubious and likely erroneous.

Specimen reg. no.	Museum / Reference	Taxon	S	N	Location	Observer / source	Date collected	Wing	Tail	Culmen	Bill depth	Bill width	Tarsus	Middle toe and claw
194110	AMNH	<i>lineata</i>	F		Ua Pou, Marquesas	VB	15/9/1922	171	75	13.6	4.1	7.5	38.7	
						Shirihai (2015)		170	72	14.5			37.5	32.0
						Murphy & Snyder (1952)		165	73.5	14.0			38	22.0 ¹
15713	USNM	<i>lineata</i>	M		Upolu, Samoa	VB	?/11/1839	163	70	14.5	4.8	6.6	37.3	
						Mathews (1933)		166	76	14.0			34.5 ²	31.0
						Murphy & Snyder (1952)		166	71.2	14.6			37.0	28.6
14391	QM	<i>lineata</i>	-		Stradbroke I	VB	?/7/1973	160	76	14.6	4.0	6.6	39.2	
31216	QM	<i>tropica</i>	M		Stradbroke I	VB	22/5/1999	157	75	14.5	4.4	6.9	41.4	
	Mean ± SE			3				162.8 (3.01)	74.0 (1.35)	14.3 (0.23)	4.3 (0.18)	6.7 (0.40)	39.2 (0.85)	
1895.2.1.11	NHMUK	<i>maoriana</i>	-		North I, NZ	VB	4/3/1868	150	67	12.1	3.5	6.8	35.9	
						Murphy & Snyder (1952)		151.5	64.2	12.5			35.0	27.2
						Bourne (2004)		148	67	12.5			35.0	
C.G. 1829.254 (14393)	MNHN	<i>maoriana</i>	M		North I, NZ	VB	4/2/1827	150	58	13.1	3.8	6.2	38.6	
						Murphy & Snyder (1952)		147	56.6	12.7			35.3	27.6
						Jouanin (2004)		148	65	12.5			37.0	28.0
						(Bourne 2004)		148	66	12.0			37.0	27.5
C.G. 1829 (14372)	MNHN	<i>maoriana</i>	-		North I, NZ	VB	4/2/1827	150	62	12.6	3.7	6.4	38.4	
						Murphy & Snyder (1952)		148	58	12.5			35.1	27.2
						Jouanin (2004)		150	63	13.0			37.5	28.0
						Bourne (2004)		148	61	12.0			36.0	27.0
	Mean ± SE			3				150 (0)	62.3 (2.25)	12.6 (0.25)	3.7 (0.08)	6.5 (0.15)	37.6 (0.75)	
Live birds	Rayner et al. (2014)	<i>maoriana</i>	M	20	Hauraki Gulf, NZ		2005–12	151.8 ± 3.6	64.8 ± 3.6	12.7 ± 0.63			35.0 ± 1.5	
			F	7	Hauraki Gulf, NZ		2005–12	153.6 ± 3.7	64.1 ± 2.8	12.6 ± 0.60			35.3 ± 0.8	
	Stephenson et al. (2008)	<i>maoriana</i>		4	Hauraki Gulf, NZ		2005–06	148.7 ± 3.7	66.0 ± 1.5	13.4 ± 0.3			35.9 ± 0.9	29.5 ± 1.2



The tangled nomenclatural history of *Haplopetelia forbesi* Salvadori, 1904: were Forbes and Robinson right all along?

By John-James Wilson, Clemency T. Fisher, Tereza Senfeld,
Thomas J. Shannon & J. Martin Collinson

Received 19 September 2021; revised 7 January 2022; published 11 March 2022

<http://zoobank.org/urn:lsid:zoobank.org:pub:DE0BB39D-7893-4B36-B85A-CCEBF8F05F7A>

SUMMARY.—The specimen in Liverpool known as Forbes' Lemon Dove, collected pre-1844 purportedly in Cayenne (French Guiana), was catalogued by Forbes & Robinson in 1900 as *Haplopetelia principalis*, despite this species having been described from the island of Príncipe in the Gulf of Guinea. As a result of the discrepancy in localities, the Liverpool specimen was subsequently described as a new species (*Haplopetelia forbesi*) by Salvadori and suggested to be from West Africa. Over the course of the next century, the new taxon was subject to a variety of taxonomic treatments. To investigate the status and provenance of Forbes' Lemon Dove, we obtained a 472 bp *cyt-b* sequence from the specimen. This possessed 100% similarity with a Lemon Dove *Columba* (*Aplopelia*) *larvata* sequence from Príncipe and 99.79% similarity with a sequence of the same species from São Tomé. This suggests that Forbes & Robinson were correct that the specimen represents *A. larvata principalis* and was thus probably collected on Príncipe. However, more sequencing from across the Lemon Dove's range is required to resolve the taxonomy of this complex group and place Forbes' Lemon Dove more definitively.

The islands of the Gulf of Guinea are rich in endemic bird species and are covered by several Key Biodiversity Areas and Important Bird and Biodiversity Areas. De Lima & Melo (2021) recently compiled an updated checklist of birds known from these islands but predicted it would rapidly become outdated due to ongoing taxonomic changes, especially as a result of molecular work. More specifically, the taxonomy of Lemon Doves *Columba* (*Aplopelia*) on the islands, and their mainland allies, has been in constant flux. A case in point is *Haplopetelia forbesi* Salvadori, 1904, the type specimen of which has been subject to a variety of taxonomic treatments since the mid 1800s (Table 1).

The holotype of what is now known as Forbes' Lemon Dove was purchased by the 13th Earl of Derby from the London dealers, Leadbeater, in September 1844. The specimen was unsexed, thought to be fully adult, and suspected of having been in captivity as its right wing was clipped and its tail feathers, except the central two, appeared worn at the tips. It bore the label 'interior of Cayenne' (French Guiana) but apparently no other information.

In the 13th Earl of Derby's museum stock books, a multi-volume register of specimens, compiled by his curators Louis Fraser and Thomas Moore in the late 1840s (Largen 1987) and now held at National Museums Liverpool, specimen NML-VZ D3567b was grouped (with a question mark) as a female (series no. '3567') with a specimen of Caribbean Dove *Leptotila jamaicensis*. A single specimen of Caribbean Dove (NML-VZ D3567a) had been in the Earl's menagerie before it was accessioned into the museum at Knowsley Hall on its death in August 1811. *Leptotila jamaicensis* is a very different species from Forbes' Lemon Dove (Fig. 1) but given their proximity in G. R. Gray's (1844–49) *Genera of birds*, and the locality on the label, this tentative grouping was understandable. These pigeons were subsequently bequeathed to the people of Liverpool upon the 13th Earl of Derby's death in

TABLE 1
Scientific names used for Forbes' Lemon Dove *Haplopelia forbesi* Salvadori.

Source	Scientific name	Specimen examined	Action
Fraser & Moore (1844-51 in an unpublished stock book held by National Museums Liverpool)	<i>Leptotila jamaicensis</i>	Yes	incorrect determination
Forbes & Robinson (1900)	<i>Haplopelia principalis</i>	Yes	determination
Salvadori (1904)	<i>Haplopelia forbesi</i>	Yes	described as new species
Bannerman (1916)	<i>Haplopelia forbesi</i>	Yes	
Bannerman (1931)	<i>Aplopelia simplex forbesi</i>	Yes	<i>forbesi</i> treated as subspecies of <i>simplex</i>
Peters (1937)	<i>Aplopelia simplex plumbescens</i>		<i>forbesi</i> synonymised with <i>plumbescens</i>
Bannerman (1953)	<i>Aplopelia simplex plumbescens</i>		
Serle (1959)	<i>Aplopelia larvata</i>		<i>simplex</i> synonymised with <i>larvata</i> and subspecies considered indeterminate
Goodwin (1967)	<i>Aplopelia larvata plumbescens</i>		<i>simplex</i> synonymised with <i>larvata</i>
Goodwin (<i>in litt.</i> 1975 to W. Wagstaffe; cf. Wagstaffe 1978)	<i>Aplopelia larvata</i>	Yes	subspecies considered indeterminate
Wagstaffe (1978)	<i>Aplopelia larvata</i>	Yes	
Baptista <i>et al.</i> (1997)	<i>Columba larvata</i>		<i>Aplopelia</i> synonymised with <i>Columba</i>



Figure 1. Forbes' Lemon Dove *Haplopelia forbesi* (NML-VZ D3567b) (top) and Caribbean Dove *Leptotila jamaicensis* (NML-VZ D3567a) (bottom) bequeathed by the 13th Earl of Derby to the people of Liverpool and now in the Vertebrate Zoology collection at World Museum, National Museums Liverpool (© National Museums Liverpool [World Museum Liverpool] / John-James Wilson)



Figure 2. Specimens of Lemon Doves *Columba (Aplopelia) larvata* in the Vertebrate Zoology collection at World Museum, National Museums Liverpool. From left to right (subspecies according to labels): *bronzina* (NML-VZ T13165), *forbesi* (NML-VZ D3567b), *larvata* (NML-VZ D4217), *johnstoni* (NML-VZ T18511), *larvata* (NML-VZ T16271), *larvata* (NML-VZ T8168) (© National Museums Liverpool [World Museum Liverpool] / John-James Wilson)

1851, along with most of his substantial natural history collection (World Museum 2021), founding what became the Derby Museum, Liverpool Museums (Morgan 1978) and now World Museum, National Museums Liverpool.

Henry Ogg Forbes, Director of the Liverpool Museums and his assistant, Herbert Christopher Robinson, published a catalogue of the pigeons in the Liverpool Museums in 1900. Identification of NML-VZ D3567b proved especially difficult. Firstly, Forbes & Robinson (1900) must have concluded that it was congeneric but not conspecific with other specimens grouped under *Haplopelia* as defined by Salvadori (1893). These included the taxa *larvata* (type locality, modern-day South Africa), *simplex* (São Tomé), *bronzina* (Ethiopia) and *johnstoni* (Malawi) (Fig. 2). Forbes & Robinson (1900) also noted the specimen's close agreement with *Columba erythrorax* [sic] Temminck, 1811, said to be from Suriname, but with a key difference: 'under tail coverts are hoary grey, not cinnamon as in that species'. *C. erythrorax* had already been synonymised under *H. larvata* from South Africa by Gray (1844–49) and Salvadori (1893). 'With assistance of the British Museum', Forbes & Robinson (1900) ultimately catalogued NML-VZ D3567b as *Haplopelia principalis* (Hartlaub 1866), noting that it differed from *H. simplex* by 'its more rufous breast' and from all other species of *Haplopelia* by 'its white under tail-coverts' (Forbes & Robinson 1900).

Peristera principalis Hartlaub, 1866, was described (in Dohne 1866) from a bird collected on Príncipe in 1865 (Jones & Tye 2006). Hartlaub noted that it was nearly allied to his own nomen, *simplex* Hartlaub, 1849, described from the nearby island of São Tomé. According to Salvadori (1893, 1904), there were no specimens of *principalis* at the then British Museum (Natural History) (BMNH), however, apparently unbeknownst to Salvadori (1904) a



Figure 3. The second specimen identified as *Haplopelia forbesi* Salvadori, now at the Natural History Museum at Tring (NHMUK 1896.10.22.1) (© Trustees of the Natural History Museum, London / A. Bond)

principalis (NHMUK 1896.10.22.1) was accessioned there in 1896. This specimen (Fig. 3) said to be from 'W. Africa' and 'Presented [to BMNH] by the Committee of the Manchester Museum, The Owens College, Manchester', bears a strong similarity to Forbes' Lemon Dove. According to the register in Manchester, the specimen was given to Manchester Museum by 'A. Yarquar' in 1893. There is no indication of who determined the specimen to be *principalis* or when.

The wildly incongruous localities of both Príncipe and Cayenne for *H. principalis* had drawn the attention of Salvadori (1903, 1904) who described Forbes' Lemon Dove as a new species, *Haplopelia forbesi* Salvadori, 1904, and stated that the type (NML-VZ D3567b) must have originated from West Africa, not South America. A year earlier *Haplopelia poensis* Alexander, 1903, had been described from Bioko, while earlier in the same year *Haplopelia plumbescens* Sharpe, 1904, was described from Efoulen, Cameroon as 'a species very similar to *H. principalis*' (Sharpe 1904).

Bannerman (1916) revised *Haplopelia* in 1916, making a distinction between a *larvata* 'section' and a *simplex* 'section'; *larvata* being found in South and East Africa, and *simplex* centred on the islands and adjacent mainland of the Gulf of Guinea. Taxa listed under *simplex* were: *s. simplex* restricted to São Tomé; *s. inornata* from Cameroon; *s. poensis* from Bioko; *s. hypoleuca* from Annobón; *s. plumbescens* from southern Cameroon; and *s. jacksoni* from Uganda. Taxon *forbesi* (represented by NML-VZ D3567b and NHMUK 1896.10.22.1) from West Africa, was retained as a species and *principalis*, confined to Príncipe, and being pinkish instead of grey, was kept as a separate 'well differentiated race', i.e. not considered conspecific with *H. simplex* but part of the 'section'.

Fifteen years later, Bannerman (1931) still treated *principalis* as a species but was ready to include *forbesi* as a subspecies under *simplex* and, although hesitant to 'ally *forbesi* with *simplex plumbescens* due to the rusty-red tint to the plumage', mentioned the latter as a potential synonym. Peters (1937) tentatively did synonymise *forbesi*, whilst retaining all of Bannerman's other subspecies, but placed *principalis* (still treated as a species by Bannerman 1931) under *simplex*.

Until the 1950s, Bannerman's two 'sections', *simplex* and *larvata*, were generally followed, with the *simplex* group having greyish males and much paler brown females. However, a population with apparently overlapping characteristics was found by White (1948) in modern-day Zambia. From females, White (1948) had thought birds in this region



Figure 4. Sub-tree (of a larger tree produced by Neighbor Joining) showing the four Lemon Dove *Columba (Aplopelia) larvata* cytochrome sequences in NCBI GenBank aligned by BLAST with the sequence from Forbes' Lemon Dove *Haplopelia forbesi* (NML-VZ D3567b). Sequences are annotated with the collection locality followed by the GenBank accession no.

were akin to *larvata* (Amadon 1953), however on obtaining a male described it as *Aplopelia simplex samaliyae* (see White 1948), but subsequently (in a letter to J. Chapin seen by Amadon 1953) he concluded that this demonstrated that *larvata* and *simplex* were conspecific. Amadon (1953) recognised only two taxa in the Gulf of Guinea: *A. larvata simplex* (São Tomé) and *A. l. principalis* (Príncipe). Meanwhile Bannerman (1953) retained four 'races' of *simplex*, plus *principalis* as a species, in the *Birds of West and Equatorial Africa*, but made no mention of *forbesi*, presumably following Peters (1937) in lumping it with *plumbescens*. On the basis of overlapping plumage characters among specimens at BMNH, Serle (1959) made a strong case for synonymising *inornata*, *plumbescens* and *poensis* with *simplex* as the only subspecies under *larvata* (following Amadon 1953), but thought they were usefully retained as designators of geographic origin. Due to lack of precise locality information, *forbesi* was not included in his assessment, while the validity of *principalis* was not questioned.

By the 1960s the conspecificity of *larvata* and *simplex* was well accepted, and Goodwin (1967) treated all of the taxa in Bannerman's (1916) *simplex* 'section' under *larvata*, without mentioning *forbesi*. According to Wagstaffe (1978), Derek Goodwin examined NML-VZ D3567b in 1975 and had no doubt the specimen was an immature female of *larvata sensu lato*, but with subspecies indeterminate. To our knowledge, the type specimen of Forbes' Lemon Dove has not been taxonomically reassessed since then. Jones & Tye (2006) and de Lima and Melo (2021) listed *C. l. principalis* on Príncipe and *C. l. simplex* on São Tomé.

Recently, DNA analysis has been applied to the question of Lemon Dove taxonomy. Pereira (2013) sequenced three mitochondrial (*NADH dehydrogenase subunit 2*, *cyt-b*, *cyt-oxidase I*) and one nuclear gene (*β-fibrinogen intron 7*) from two individuals of Lemon Dove (*Aplopelia larvata sensu lato*) from São Tomé, two from Príncipe, and a museum specimen from Malawi. The sequences are unpublished, but the figured (Bayesian Inference) mitochondrial tree reveals each island population as monophyletic but highly similar to each other, and 4.3% distant (uncorrected 'p') from the mainland sequence.

The only sequences currently available on NCBI GenBank for Lemon Doves were generated as part of a global survey examining patterns of diversity in island bird communities by Valente *et al.* (2020). *Cyt-b* sequences were obtained from samples taken from three Lemon Doves on São Tomé (MH307437–439) and one on Príncipe (MH307436). The published tree showed the single sequence from Príncipe nested within those from São Tomé (note, sequence MH307437 from São Tomé is incorrectly labelled *principalis* on the published tree; see supplemental material in Valente *et al.* 2020).

To investigate the status and provenance of Forbes' Lemon Dove further, we obtained a 472 bp *cyto-b* sequence from NML-VZ D3567b. We designed four new pairs of primers specifically for *Haplopelia* (HapF1-3; HapR1-3; registered in the BOLD Primer Database

www.boldsystems.org), each amplifying c.150 bp then concatenated the resulting sequences. Our molecular methods otherwise followed those of Senfeld *et al.* (2019). The sequence is published in NCBI GenBank (Sayers *et al.* 2021) under accession no. MZ438312. The Forbes' Lemon Dove sequence was 'blasted' against GenBank and showed 100% similarity with MH307436, from a Lemon Dove at Oquê Daniel, Príncipe. The next most similar sequence, MH307438, from a Lemon Dove at Contador Dam, São Tomé, showed 99.79% similarity (1 bp difference) to the sequence of *forbesi*.

As in the published tree of Valente *et al.* (2020), the *cyt-b* Neighbor Joining tree generated using the BLAST web app of the 100 sequences producing significant alignments (Zhang *et al.* 2000) showed the sequence from Príncipe (*principalis*) nested among sequences from São Tomé (*simplex*) (Fig. 4). The distance between the outlying *simplex* sequence (MH307437) and the cluster of the other four samples is relatively large (>2%) and of a magnitude generally seen between species, whilst the distance between *principalis* + *forbesi*, and the two other clustered *simplex* samples is relatively short (>1.5%) and more indicative of intraspecific variation at the mitochondrial locus (e.g. Johnsen *et al.* 2010). Although the 100% similarity of *forbesi* to the *principalis* sample tends to confirm its correct placement with the Príncipe population, the nesting of the morphologically distinct *principalis* within *simplex* is biogeographically counter-intuitive. More sequencing from across the range of *larvata* and *simplex* is ultimately required to resolve the taxonomy of this complex group.

Our result is, however, consistent with Forbes & Robinson's (1900) original determination that NML-VZ D3567b is a specimen of *principalis*. If so, given that *principalis* is restricted to Príncipe, it too would almost certainly have been collected there. Forbes' Lemon Dove matches females of *principalis* fairly well in size and colour, and some specimens of *principalis* have white/hoary grey undertail-coverts like those of NML-VZ D3567b (Bannerman 1931, Wagstaffe 1978). Based on the collection date we speculate very tentatively that NML-VZ D3567b was collected during the British Government Expedition to the River Niger 1841–42, which used the Gulf of Guinea islands as a base (Tye & Jones 2006). The provenances of many birds collected during this expedition were incorrectly recorded (Tye & Jones 2006) although how the specimen found its way to Leadbeater labelled 'Cayenne' is a mystery. De Lima and Melo's (2021) prediction of further taxonomic changes to the checklist of birds from the islands of the Gulf of Guinea seems well founded.

Acknowledgements

Alex Bond (NHMUK) and Rachel Petts (Manchester Museum) provided information about the only other specimen known to have been identified as *Haplopetia forbesi*. We are grateful to Martim Melo and Luis Lima Valente for access to Hugo José Eira Pereira's M.Sc. thesis and information about recent Lemon Dove samples collected in the Gulf of Guinea. We are indebted to Peter Jones for invaluable comments on the manuscript. Robert Prýs-Jones, Alan Tye and an anonymous reviewer provided very helpful suggestions on the submitted draft.

References:

- Amadon, D. 1953. Avian systematics and evolution in the Gulf of Guinea. *Bull. Amer. Mus. Nat. Hist.* 100: 393–492.
- Bannerman, D. A. 1916. A revision of the genus *Haplopetia*. *Ibis* (10)4: 1–16.
- Bannerman, D. A. 1931. *The birds of tropical West Africa with special reference to those of the Gambia, Sierra Leone, the Gold Coast and Nigeria*, vol. 2. Crown Agents for the Colonies, London.
- Bannerman, D. A. 1953. *The birds of West and Equatorial Africa*, vol. 2. Oliver & Boyd, Edinburgh.
- Baptista, L. F., Trail, P. W. & Horblit, H. M. 1997. Family Columbidae (pigeons and doves). Pp. 60–243 in del Hoyo, J., Elliott, A. & Sargatal, J. (eds.) *Handbook of birds of the world*, vol. 4. Lynx Edicions, Barcelona.
- Dohne, H. 1866. Synopsis of the birds of Ilha do Principe, with some remarks on their habits and descriptions of new species. *Proc. Zool. Soc. Lond.* 1866: 324–332.
- Forbes, H. O. & Robinson, H. C. 1900. Catalogue of the charadriomorphic birds (Charadriiformes): auks (Alcidae), gulls (Laridae), and skuas (Stercorariidae) – Lari; lark-plovers (Thinocoridae), stone-curlews (Edicnemidae), jacanas (Jacanidae), sheathbills (Chionidae), crab-plovers (Dromadidae), coursers

- (Cursoriidae), plovers and snipes (Charadriidae) – Limicolae; pigeons (Columbae), and sandgrouse (Pterocles), in the Derby Museum (concluded). *Bull. Liverpool Mus.* 2: 117–150.
- Goodwin, D. 1967. *Pigeons and doves of the world*. First edn. Brit. Mus. (Nat. Hist.), London.
- Gray, G. R. 1844–49. *The genera of birds*, vol. 2. Longman, Brown, Green & Longmans, London.
- Johnsen, A., Rindal, E., Ericson, P. G. P., Zuccon, D., Kerr, K. C. R., Stoeckle, M. Y. & Lifjeld, J. T. 2010. DNA barcoding of Scandinavian birds reveals divergent lineages in trans-Atlantic species. *J. Orn.* 151: 565–578.
- Jones, P. & Tye, A. 2006. *The birds of São Tomé & Príncipe with Annobón: islands of the Gulf of Guinea*. BOU Checklist no. 22. British Ornithologists Union & British Ornithologists' Club, Oxford.
- Largen, M. J. 1987. Bird specimens purchased by Lord Stanley at the sale of the Leverian Museum in 1806, including those still extant in the collections of the Liverpool Museum. *Archiv. Nat. Hist.* 14: 265–288.
- de Lima, R. F. & Melo, M. 2021. A revised bird checklist for the oceanic islands of the Gulf of Guinea (Príncipe, São Tomé and Annobón). *Bull. Brit. Orn. Cl.* 141: 179–198.
- Morgan, P. J. 1978. Historical introduction to the bird collections of the Merseyside Country Museums. Pp. 1–3 in Wagstaffe, R. (ed.) *Type specimens of birds in the Merseyside County Museums (formerly City of Liverpool Museums)*. Merseyside County Museums, Liverpool.
- Peters, J. L. 1937. *Check-list of birds of the world*, vol. 3. Harvard Univ. Press, Cambridge, MA.
- Pereira, H. J. E. 2013. Conservation genetics of the endemic pigeons of São Tomé and Príncipe. M.Sc. thesis. Faculdade de Ciências da Universidade do Porto.
- Salvadori, T. 1893. *Catalogue of the birds in the British Museum*, vol. 21. Trustees of the Brit. Mus. (Nat. Hist.), London.
- Salvadori, T. 1903. Uccelli dell'isola del Principe. *Mem. Accad. Sci. Torino* (2)53: 2–16.
- Salvadori, T. 1904. Description of a new species of dove of the genus *Haplopelia*. *Ibis* (8)4: 367–369.
- Sayers, E. W., Beck, J., Bolton, E. E., Bourexis, D., Brister, J. R., Canese, K., Comeau, D. C., Funk, K., Kim, S., Klimke, W., Marchler-Bauer, A., Landrum, M., Lathrop, S., Lu, Z., Madden, T. L., O'Leary, N., Phan, L., Rangwala, S. H., Schneider, V. A., Skripchenko, Y., Wang, J., Ye, J., Trawick, B. W., Pruitt, K. D. & Sherry, S. T. 2021. Database resources of the National Center for Biotechnology Information. *Nucleic Acids Res.* 49(D1): 10–17.
- Serle, W. 1959. The West African races of the Lemon-Dove *Aplopelia larvata* (Temm. and Knip). *Bull. Brit. Orn. Cl.* 79: 38–41.
- Senfeld, T., Shannon, T. J., van Grouw, H., Pajimans, D. M., Tavares, E. S., Baker, A. J., Lees, A. C. & Collinson, J. M. 2019. Taxonomic status of the extinct Canary Islands Oystercatcher *Haematopus meadewaldoi*. *Ibis* 162: 1068–1074.
- Sharpe, R. B. 1904. On further collections of birds from the Efulen district of Cameroon, West Africa. *Ibis* (8)4: 38–106.
- Valente, L., Phillimore, A. B., Melo, M., Warren, B. H., Clegg, S. M., Havenstein, K., Tiedemann, R., Illera, J. C., Thébaud, C., Aschenbach, T. & Etienne, R. S. 2020. A simple dynamic model explains the diversity of island birds worldwide. *Nature* 579: 92–96.
- Wagstaffe, R. 1978. *Type specimens of birds in the Merseyside County Museums (formerly City of Liverpool Museums)*. Merseyside County Museums, Liverpool.
- White, C. M. N. 1948. A new race of Lemon Dove from Northern Rhodesia. *Bull. Brit. Orn. Cl.* 69: 20–21.
- World Museum, National Museums Liverpool (2021) Vertebrate Zoology collection. <https://www.gbif.org/grscicoll/collection/225db9c9-16a8-47d4-a1a2-6940bb4a2da5> (accessed via GBIF.org 19 September 2021).
- Zhang, Z., Schwartz, S., Wagner, L. & Miller, W. 2000. A greedy algorithm for aligning DNA sequences. *J. Computational Biol.* 7: 203–214.
- Addresses:* John-James Wilson, Vertebrate Zoology at World Museum, National Museums Liverpool, William Brown Street, Liverpool L3 8EN, UK, e-mail: john.wilson@liverpoolmuseums.org.uk. Clemency T. Fisher, Vertebrate Zoology at World Museum, National Museums Liverpool, William Brown Street, Liverpool L3 8EN, UK, and Bird Group, Dept. of Life Sciences, Natural History Museum, Tring, Herts. HP23 6AP, UK, e-mail: clem.fisher@liverpoolmuseums.org.uk. Tereza Senfeld, School of Medicine, Medical Sciences and Nutrition, University of Aberdeen, Institute of Medical Sciences, Foresterhill, Aberdeen AB25 2ZD, UK, e-mail: t.senfeldova.17@aberdeen.ac.uk. Thomas J. Shannon, School of Medicine, Medical Sciences and Nutrition, University of Aberdeen, Institute of Medical Sciences, Foresterhill, Aberdeen AB25 2ZD, UK, e-mail: r01ts17@abdn.ac.uk. J. Martin Collinson, School of Medicine, Medical Sciences and Nutrition, University of Aberdeen, Institute of Medical Sciences, Foresterhill, Aberdeen AB25 2ZD, UK, e-mail: m.collinson@abdn.ac.uk

Novel ecological information for Silvery Pigeon *Columba argentina*, with first description of the chick

By Muhammad Iqbal, Tom Amey, Irda Kusuma, Satri Sara Alim & Akmal Husni

Received 9 October 2021; revised 30 December 2021; published 11 March 2022

<http://zoobank.org/urn:lsid:zoobank.org:pub:1422C237-8C82-4E84-A173-68071953E32F>

SUMMARY. — Silvery Pigeon *Columba argentina* is a Critically Endangered species whose known population is apparently tiny and confined to islands off western Sumatra. In July 2021, during a bird survey of Simeulue and surrounding islands (Aceh province, Sumatra) we found a chick of this species collected by local people, an adult kept as a cagebird, and made several observations in the wild. We describe the species' chick, report other anecdotal information concerning nesting, and supply dietary information for this little-known pigeon.

Silvery Pigeon *Columba argentina* is a Critically Endangered small-island specialist now found only on a few islands in the Barusan chain off western Sumatra (BirdLife International 2021, Eaton *et al.* 2021). Its historical range is thought to have been also restricted but to a broader area of the Sundaic region, on small islands between Borneo, Sumatra and the Malay Peninsula, along with islands off west Sumatra (Simeulue to Pagai), and possibly at a few coastal mainland locations (Collar *et al.* 2001, Wilson 2004, Mann 2008, Yong 2009, Iqbal 2010, BirdLife International 2021).

Until it was finally documented photographically in 2008, Silvery Pigeon was thought to be extinct in the wild (Lee *et al.* 2009) but has since been recorded on the west Sumatran islands of Banyak, Simeulue, Nias, Babi and Siberut (Eaton & Rossouw 2011, Lee *et al.* 2009, Verbelen 2010, Eaton 2011, Eaton *et al.* 2021). During a taxonomic and conservation re-appraisal of the avifauna of Nias, Rheindt *et al.* (2020) recorded groups of up to 50 birds, which—along with the sightings discussed herein—is likely to represent one of the largest extant populations of Silvery Pigeon.

Columba argentina is similar to Pied Imperial Pigeon *Ducula bicolor* in size and plumage pattern (MacKinnon & Phillipps 1993, Iqbal 2005, Yong 2009). It has been recorded in large mixed colonies with Pied Imperial Pigeon, and the two species have also been observed feeding together; although detailed studies are lacking, this suggests they consume the same fruits (Gibbs *et al.* 2001). Great care therefore must be taken when identifying the species. Silvery Pigeon is safely identified from Pied Imperial Pigeon by its reddish orbital skin, bluish-horn bill with a black tip (not dark brown with a pale yellowish tip), bluish-grey (not pink to flesh-grey) legs, often a greyish overall hue to the white parts (rather than yellowish white), and a rounder head. In flight, Pied Imperial shows black bases (as well as tips) to the underside of the primaries (which can be difficult to see) and appears heavier and longer necked with broader wings (MacKinnon & Phillipps 1993, Gibbs *et al.* 2001, Eaton *et al.* 2021).

The ecology of Silvery Pigeon is poorly known, with no information on breeding season or diet (Baptista *et al.* 1997, Gibbs *et al.* 2001, BirdLife International 2021). Here, we present the first documented record of a chick and additional information on feeding.

First description of a Silvery Pigeon chick

Whilst undertaking a bird survey on Simeulue and surrounding islands, on 3 July 2021 we were informed by local people at Lamerem village, Alafan subdistrict, Simeulue Island, Aceh province, Indonesia, about two young columbids collected in the wild. They were taken on Tepi (02°53'N, 95°45'E), a small island of c.70 ha that lies just c.550 m off Simeulue and close to Lamerem. One was a young *Treron* sp., presumably a Pink-necked Green Pigeon *T. vernans*, as this is the commonest *Treron* in the coastal zone around Lamerem village and on Tepi.

The other chick, however, drew our attention; it had a blackish pink-skinned body with yellow down, dark eyes and bill, darkish legs and reddish feet (Fig. 1). The bird was presumed to have hatched fairly recently. It was 84 mm long and weighed 40 g. Unlike other altricial birds, the chick was silent and did not open its bill to beg for food. The owner forced open the gape to feed it mashed chicken or bird pellets, namely 'lima sebelas' or '511', a mix that is often used to feed wild-caught birds, especially White-rumped Shama *Copsychus malabaricus* and Oriental Magpie-Robin *C. saularis*.

Local people knew that the adult of this chick is a black-and-white pigeon with a red-eye ring, and distinguish the two species of 'pied' pigeon by eye colour, size, calls and overall colour. Convincingly, the owner of the chick showed us a captive Silvery Pigeon kept by his neighbour (Fig. 2). He explained that there are differences between the breeding behaviour of Silvery and Pied Imperial Pigeons: whereas the latter nests in colonies on smaller islands that are rarely visited by humans, Silvery Pigeon breeds singly or in smaller groups on islands closer to the mainland such as Tepi.

We were informed that the adult in Fig. 2 was also collected as a chick on Tepi, with both birds taken from nests in Coconut Palms *Cocos nucifera*. Gibbs *et al.* (2001) reported that



Figure 1. Silvery Pigeon *Columba argentina* chick, collected on Tepi Island, Aceh province, Sumatra, 3 July 2021 (Muhammad Iqbal)



Figure 2. Adult Silvery Pigeon *Columba argentina*, collected on Tepi Island as a chick c.2 years earlier by a villager at Lamerem, Simeulue Island, Aceh province, 3 July 2021 (Muhammad Iqbal)

another tropical forest *Columba* (Metallic Pigeon *C. vitiensis*) incubates for 17–19 days, with the young fledging at 21 days. As the Silvery Pigeon chick was thought to be c.3–5 days old, based on the data for Metallic Pigeon we suspect that Silvery Pigeons lay in early to mid June, the eggs hatch in late June, and chicks fledge around early August.

Next day (4 July 2021) we visited Tepi with the local people who had collected the chicks. Half a day was spent making bird observations during which we confirmed the presence of at least 20 Silvery Pigeons on the island (Fig. 3), and possibly more.

The local man showed us the Coconut Palm where the chick was collected. It was c.12 m tall, with the nest around 10 m above ground. Baptista *et al.* (1997) and Gibbs *et al.* (2001) reported that Silvery Pigeon builds flimsy stick nests in trees or shrubs, and its nests on Tepi appeared to be very rudimentary structures wedged between palm fronds (Fig. 4). The local man stated that he had taken the chick only because he had found it while climbing the palm to get a coconut to drink, and he had not been searching for chicks. On approaching the palms, we disturbed an adult Silvery Pigeon from the highest fronds, perhaps from a nest. No attempt was made to climb it for fear of disturbance. Another of our local guides reported that he had seen Silvery Pigeon nests on branches of trees and shrubs, including Clove *Syzigium aromaticum* and figs *Ficus* sp. On 8 July 2021, whilst surveying Linggam Island around Nasreuhe village, our guide, a coconut harvester based on the island, also reported that he had chanced upon and taken Silvery Pigeon chicks from coconut fronds.

Other ecological data

Two main local languages are spoken on Simeulue, with local names for Silvery Pigeon being 'Bakuk' or 'Boklem'. These names are different to those used for Pied Imperial Pigeon,



Figure 3. Adult Silvery Pigeon *Columba argentina*, Tepi Island, Aceh province, Sumatra, 4 July 2021 (Muhammad Iqbal)



Figure 4. Coconut frond where the Silvery Pigeon *Columba argentina* chick in Fig. 1 was reportedly found, Tepi Island, Aceh province, Sumatra, 4 July 2021 (Muhammad Iqbal)



Figures 5–6. Fig fruits *Ficus* sp., a food resource of Silvery Pigeon *Columba argentina*, Linggam Island, Aceh province, Sumatra, 8 July 2021 (Muhammad Iqbal)



Figure 7–8. Chinese Bayan fruit *Ficus microcarpa*, reportedly a major food resource of Silvery Pigeon *Columba argentina*, Bulu Hadik, Teluk Dalam subdistrict, Aceh province, Sumatra, 10 July 2021 (Muhammad Iqbal)

further indicating that they are capable of distinguishing between them. On Linggam Island, we found that Silvery Pigeon feeds on a fig *Ficus* sp. (locally known as ‘Sini-sini’). Figs are common on the island (Figs. 5–6). On both Linggam and Tepi, our guides reported they had seen Silvery Pigeon regularly feeding on seeds of cultivated Melinjo trees *Gnetum gnemon* (‘muling’). A large flock of Green Imperial Pigeons *Ducula aenea* was seen feeding on Melinjo by MI on Enggano Island, Bengkulu Province, Sumatra. It is therefore likely that Melinjo is a common food resource for large Columbidae on the west Sumatra islands.

On 10 July 2021, we visited Bulu Hadik village, Teluk Dalam subdistrict, Simeulue Island. Members of the local community reported that many species of pigeon, including Silvery Pigeon, feed on Chinese Bayan *Ficus microcarpa* fruit (‘Buah Rambung’) in the coastal zone (Figs. 7–8).

Following Baptista *et al.* (1997: 81), pigeons and doves can be divided into frugivorous and granivorous species, i.e. fruit-eating and seed-eating. Clearly, Silvery Pigeon is a frugivorous species. The man that we spoke to who had an adult captive Silvery Pigeon stated that he had fed it on cooked rice for a long period, suggesting that species is able to tolerate a varied diet, given that captive birds sometimes survive for several years (Svensson & Yong 2016, BirdLife International 2021).

Local people also reported that Silvery Pigeons are often seen drinking from freshwater rockpools on beaches (in this case, they presumably visit these areas for minerals, like other pigeons), both on smaller islands and in Simeulue's coastal zone.

Conservation challenges

Based on our observations of Silvery Pigeon on Simeulue and surrounding islands in Aceh province, the collection of chicks from nests appears to be relatively common, be it opportunistically or deliberate. We presume that other Silvery Pigeons, including captive individuals from Hong Kong and Nias, could also have been collected in the same way (Svensson & Yong 2016).

Coconut Palms are commonly planted on the western Sumatra islands, with harvesting of fruits being a significant source of income for local people. Many people we met during our survey, including forestry and conservation staff, are unaware that Silvery Pigeon is Critically Endangered and protected by Indonesian law. Columbids are commonly hunted on Simeulue, especially Green and Pied Imperial Pigeons, Nicobar Pigeon, and *Treron* spp.

Greater conservation awareness is urgently required to address the hunting of Silvery Pigeon throughout its limited range. Integrating this into general Simeulue conservation work should be considered. Managed by Ecosystem Impact Foundation (www.ecosystemimpact.com) a conservation community ranger programme on Bangkaru (in the Banyak Islands, 70 km south-east of Simeulue), is focused on protecting threatened bird and turtle species (Amey 2021a). Ecosystem Impact Foundation is now in the early phase of developing a similar conservation project on Babi and Lasia islands, 25 km south-east of Simeulue, and to operate a breeding project for Simeulue endemic and endangered songbirds (Amey 2021b). The foundation's next focus is to develop a community ranger and environmental education project on Simeulue, focusing on conserving the island's Critically Endangered bird species, and securing a release site for songbirds bred in captivity. By protecting habitat, and monitoring Silvery Pigeon populations, these projects will aim to positively impact the species' conservation on Simeulue and surrounding islands.

Acknowledgements

We thank Lingkungan Hidup Simeulue (Simeulue Environment Sector), Aceh Provincial Environment and Forestry Service (Lingkungan Hidup Aceh), the Simeulue Forest Management Unit (Bagian Kesatuan Pengelolaan Hutan) and local people at each location surveyed. Without the support of these government organisations and local communities, this survey would not have been possible.

References:

- Amey, T. 2021a. Bangkaru Island: the challenges and successes of protecting one of Indonesia's last refuges for three Critically Endangered taxa. *BirdingASIA* 35: 22–26.
- Amey, T. 2021b. Simeulue Barusan Shama breeding programme. *News. IUCN SSC Asian Songbird Trade Specialist Group* 1: 29–30.
- Baptista, L. F., Trail, P. W. & Horblit, H. M. 1997. Family Columbidae (pigeons and doves). Pp. 60–243 in del Hoyo, J., Elliott, A. & Sargatal, J. (eds.) *Handbook of the birds of the world*, vol. 4. Lynx Edicions, Barcelona.
- Collar, N. J., Andreev, A. V., Chan, S., Crosby, M. J., Subramanya, S. & Tobias, J. A. 2001. *Threatened birds of Asia: the BirdLife International Red Data book*. BirdLife International, Cambridge, UK.
- BirdLife International. 2021. Species factsheet: *Columba argentina*. <http://www.birdlife.org> (accessed 23 September 2021).
- Eaton, J. 2011. Silvery Wood Pigeon *Columba argentina* rediscovered. *Suara Enggang* 19: 6–7.
- Eaton, J. A., van Balen, B., Brickle, N. W. & Rheindt, F. E. 2021. *Birds of the Indonesian archipelago, Greater Sundas and Wallacea*. Second edn. Lynx Edicions, Barcelona.
- Eaton, J. & Rossouw, J. 2011. Little-known Asian bird: Silvery Pigeon *Columba argentina* on Simeulue and the Batu islands, Sumatra, Indonesia. *BirdingASIA* 15: 78–79.
- Gibbs, D., Barnes, E. & Cox, J. 2001. *Pigeons and doves*. Yale Univ. Press, New Haven.
- Iqbal, M. 2005. New and noteworthy bird records from Sumatra, Indonesia. *Forktail* 21: 167–169.

- Iqbal, M. 2010. In search of the Silvery Pigeon *Columba argentina* in South Sumatra province, Indonesia. *BirdingASIA* 13: 9–10.
- Lee, M. T., Yong, D. L. & Ong, T. P. 2009. A photographic record of Silvery Pigeon *Columba argentina* from the Mentawai Islands, Indonesia, with notes on identification, distribution and conservation. *Bull. Brit. Orn. Cl.* 129: 122–128.
- Mackinnon, J. & Phillips, K. 1993. *A field guide to the birds of Borneo, Sumatra, Java and Bali*. Oxford Univ. Press.
- Mann, C. F. 2008. *The birds of Borneo: an annotated checklist*. BOU Checklist 23. British Ornithologists' Union & British Ornithologists' Club, Peterborough.
- Rheindt, F., Gwee, C., Baveja, P., Ferasyi, T., Nurza, A., Rosa, T. & Haminuddin. 2020. A taxonomic and conservation re-appraisal of all the birds on the island of Nias. *Raffles Bull. Zool.* 68: 496–528.
- Svensson, B. & Yong, D. L. 2016. A first record of the Critically Endangered Silvery Pigeon (*Columba argentina*) on Nias Island, Indonesia. *BirdingASIA* 26: 73–75.
- Verbelen, P. 2010. Silvery Pigeon on Siberut, Mentawai Islands, Sumatra, Indonesia. *BirdingASIA* 13: 9.
- Wilson, K. J. 2004. A provisional sighting of the Silvery Pigeon on the Talang Talang Islands, Sarawak, Malaysia. *BirdingASIA* 1: 55–57.
- Yong, D. L. 2009. Notes on the status and identification of the Silvery Pigeon *Columba argentina*. *BirdingASIA* 11: 53–58.

Addresses: Muhammad Iqbal (corresponding author), Biology Programme, Faculty of Science, Sriwijaya University, Jalan Padang Selasa 524, Palembang 30139, Indonesia, e-mail: kpbsos26@yahoo.com. Tom Amey, Ecosystem Impact Foundation, Jalan Tgk Banurullah, Desa Nancala, Teupah Barat, Simeulue, Aceh Province, Indonesia, e-mail: tom@ecosystemimpact.com. Irda Kusuma, Ecosystem Impact Foundation, Jalan Tgk Banurullah, Desa Nancala, Teupah Barat, Simeulue, Aceh Province, Indonesia. Satri Sara Alim, Dinas Lingkungan Hidup Kabupaten Simeulue, Jalan Teuku Umar, Desa Amiria Bahagia, Simeulue Timur, Aceh Province, Indonesia. Akmal Husni, BKPH Simeulue, Desa Suka Maju, Simeulue Timur 24782, Aceh Province, Indonesia.

Breeding ecology of Rufous Potoo *Nyctibius bracteatus* in central Amazonian Brazil

by Marcelo Henrique Mello Barreiros, Mariana Tolentino & Gabriel Augusto Leite

Received 16 October 2021; revised 29 December 2021; published 11 March 2022

<http://zoobank.org/urn:lsid:zoobank.org:pub:11C7C4B8-1BEF-4B71-9700-6A78DAD07CFD>

SUMMARY.—The smallest potoo, Rufous Potoo *Nyctibius bracteatus* is a little-known and inconspicuous species of the understorey in Amazonian *terra firme* forests, where it roosts by day. Currently, there are few published observations describing its natural history and reproductive ecology. We present data on nest and egg characteristics, nestling appearance, behaviour and development, and parental care, based on three different nests in three consecutive years at Reserva Florestal Adolpho Ducke, Manaus, central Amazonian Brazil. All nests had similar characteristics and the single egg at one nest was cream-coloured with brown spots. The young at one nest fledged when *c.*40 days old, but the other two nests were both predated by ant swarms, constituting the first report of such predation in the Nyctibiidae.

The seven species of potoos comprise the exclusively Neotropical family Nyctibiidae, whose centre of diversity is Amazonia (Cohn-Haft 1999). In central Amazonian Brazil, five species occur, with the others in the Andes (Andean Potoo *Nyctibius maculosus*) and Central America and the Greater Antilles (Northern Potoo *N. jamaicensis*), respectively. One of the principal distinctive features of potoos is their habit of remaining motionless by day, mimicking the branches on which they perch, often almost unnoticeable to human eyes (Cohn-Haft 1999). Whilst most species occur in the forest canopy and midstorey, Rufous Potoo *N. bracteatus* inhabits the understorey of Amazonian forests (Cohn-Haft & Kirwan 2020).

Rufous Potoo is the smallest potoo (21–25 cm) and is restricted to the Amazon lowlands, from western Amazonia east to the Rio Tapajós (Cohn-Haft 1999, Solano-Ugalde 2011). Molecular studies revealed that *N. bracteatus* represents the oldest lineage in the family (Brumfield *et al.* 1997, Braun & Huddleston 2009, Costa 2014, White *et al.* 2017) and, due to its unique morphological and behavioural characteristics, a monotypic genus *Phyllaemulor* has been erected to accommodate the species (Costa *et al.* 2018). Despite being the only understorey potoo (Ingels *et al.* 2008, Cleere 2010), which might make *N. bracteatus* easier to observe, its breeding ecology is poorly known, and few published data are available on even basic aspects of the species' natural history (Cohn-Haft 1999, Cleere 2010, Solano-Ugalde 2011). The species is unique in that by day it mimics suspended dead leaves, whereas all other potoos mimic branches and stumps (Cohn-Haft 1999, Lopes & Anjos 2005, Mendonça *et al.* 2009, Cestari *et al.* 2011, Costa *et al.* 2018).

Rufous Potoo lays a single egg sited atop a smaller tree stump (Cohn-Haft 1989, Cisneros-Heredia 2006, Ingels *et al.* 2008). A recent study suggested that reproductive ecology and behaviour recall those of other potoos, but reinforced the need for additional studies (Vinueza-Hidalgo *et al.* 2019). Here we present novel data on the species' breeding, based on observations at three nests in central Amazonian Brazil, and discuss egg morphology, parental care, and nestling appearance, development and behaviour.

Methods

Our study was conducted at Reserva Florestal Adolpho Ducke (RFAD; Fig. 1), north of Manaus, Amazonas, Brazil (02°55′56.88″S, 59°58′26.58″W). The reserve protects approximately 10,000 ha of well-drained, relatively undisturbed *terra firme* forest not subject to seasonal flooding (Ribeiro *et al.* 1999). Canopy is *c.*30–37 m high, with scattered emergents reaching 40–45 m, and the understorey is dominated by palms (Ribeiro *et al.* 1999). The rainy season typically extends from November to May, with a dry season in June–October (Marques Filho *et al.* 1981). Some 409 species of birds have been reported from the region north of Manaus (Cohn-Haft *et al.* 1997, Rutt *et al.* 2017), of which at least 289 have been recorded at RFAD (Willis 1977). On 5 September 2015, a singing Rufous Potoo was heard around 18.00 h from the main trail, *c.*400 m from the RFAD headquarters. After five song sequences, the bird was found perched in the top of a dead tree where it remained for 15 minutes. After four days, a bird was seen again on the same roost (Fig. 2), rocking characteristically back and forth like a dead leaf (Cohn-Haft 1999, Solano-Ugalde 2011, Costa *et al.* 2018). It was perched on a live but broken *Inga* sp. sapling, which we subsequently discovered was the nest (for measurements see Table 1).

We collected data at three nests during 2015–17. In 2015, observations were made weekly between 5 September and 9 November. In 2016, they were again made weekly, during 5 September–5 October. In 2017, the third nest was observed for only one week, 5–12 September. During our observations, we photographed and video-recorded the presence of an egg or chick, and adult behaviour, and recorded nest measurements (height



Figure 1. Map of the Reserva Florestal Adolpho Ducke, north of Manaus, Amazonas, Brazil, and the distances between the three nests.

TABLE 1

Measurements at two nests of Rufous Potoo *Nyctibius bracteatus* at the Reserva Florestal Adolpho Ducke, north of Manaus, in central Amazonian Brazil

Nest ^a	2015	2017
Height above ground	4.3 m	5.1 m
Diameter at breast height	not measured	37.3 mm
External diameter of nest	27.7 mm	33.8 mm
Internal diameter of nest	19.8 mm	28.2 mm
Depth of nest	23.1 mm	22.2 mm

^aThe nest tree in 2016 was not studied in detail because it was damaged before it could be measured.



Figure 2. Adult Rufous Potoo *Nyctibius bracteatus* on the nest, Reserva Florestal Adolpho Ducke, north of Manaus, Amazonas, Brazil, 2015 (Marcelo Henrique Mello Barreiros)

above ground, diameter at breast height, depth, internal and external diameter). On each visit, we recorded the presence of an egg or chick, and the adult's movements. Photos and videos were made using a Canon 5D MK III digital camera and a 300 mm-lens. At the 2016 nest, we measured the egg and took a blood sample (50 μ l from brachial venipuncture stored in 95% ethanol in 1-ml microtubes) from the adult incubating by day to determine its sex. Additionally, we installed a camera trap (Bushnell HD) c.2 m from the nest, which monitored activity at the site over 240 hours during both day and night.

Results

Interestingly, we found potoos nesting in the same general area during all three years of the study, 85–163 m apart from each other (Fig. 1). At all three nests, a single egg was incubated by one adult, while the other adult remained nearby, once being observed flying over the nest and the incubating adult. We visited the roost site in 2015 several times, and



Figure 3. Nestling Rufous Potoo *Nyctibius bracteatus* observed alone on the nest for the first time, Reserva Florestal Adolpho Ducke, north of Manaus, Amazonas, Brazil, 2015 (Marcelo Henrique Mello Barreiros)

on 28 September we confirmed the presence of a nest. The adult was rocking frequently, and we noticed dishevelled feathers on its belly. After two hours, the chick emerged from below the adult. After confirming the presence of the chick, we continued to document its growth and changes in appearance. Both the adult and chick made rocking motions, apparently more frequently when the wind blew in the understorey, time when they often used to stretch their wings. The adult also rocked when a group of monkeys (Brown Capuchin *Sapajus apella*) passed over the nest and when an understorey mixed-species flock came close. Similar behaviour was observed by Vinueza-Hidalgo *et al.* (2019) in Ecuador, with the bird adopting an alarm posture (slow rocking motion) when approached too closely. On 19 October the chick was alone on the nest for the first time (Fig. 3). We continued to monitor the nest until 9 November, when the chick was first observed away from the nest tree (Table 2).

Almost a year later, on 6 September 2016, MB, Bret Whitney and Pepe Rojas found another nest *c.*160 m from that in 2015. It was again atop a dead tree, 4.05 m tall. After several visits, we confirmed that the egg had not hatched, so used a ladder to scale the tree, carefully removed the adult from the nest and measured the egg that was placed in a shallow depression. The egg was pale beige with medium and dark brown blotches, mainly at the blunt end. It measured 26.77×19.56 mm, mass 5.3 g (Fig. 4). The images collected by the camera trap showed that on 5 October the nestling was predated by an ant swarm (ML 369270341), after which the adult was no longer seen in the vicinity. The blood sample we took from the adult incubating during the day determined that it was a male.

The next year, at 18.07 h on 5 September 2017, MB & Bret Whitney, with colleagues from Instituto Nacional de Pesquisas da Amazônia, Manaus, heard a *N. bracteatus* singing in the same area and found an adult perched on a broken branch of a different live tree (Fig. 5). This nest differed from the others in that it was on a very slightly angled branch, not an

TABLE 2

Adult and chick behaviour and plumage development at the nest in 2015, from the first days after hatching until the day the young left the nest.

Date	Behaviour	Chick appearance
28/9/2015	Nestling observed for first time; adult perched nearby.	Basically pale beige.
29/9/2015	Adult and nestling on nest. Nestling more active and visible (head protruding from adult's belly)	Basically white.
9/10/2015	Nestling partially visible. Both birds observed making the rocking motion. Adult alert while chick constantly scratched and defecated.	Pale; no feathers on face; wings and tail rachis developing. First feathers light brown with dark brown tips.
14/10/2015	Adult and nestling observed stretching their wings and performing rocking movements.	Face and body with mid-brown feathers and more dark brown tips noted. Medium brown primaries also had dark tips.
16/10/2015	Adult facing differently and chick more obvious. This was the last time we saw the adult brooding the fledging by day.	Darker, especially on the back. Both wings and tail longer. All feather tips darker, almost black.
19/10/2015	Nestling observed alone on nest for first time. One adult was seen perched on a horizontal branch c.20m away.	Longer contour feathers with darker tips noted. Difference between darker back and paler belly easily visible. The pointed feathers over the eyes, evident on adults, now present. Iris brighter than a few days earlier.
25/10/2015	Chick notably larger and performing a rocking motion. No adults seen.	Rufous coloration, predominant in adults, starting to be evident, especially on wing and tail feathers. First white spots on back and wings now visible.
1/11/2015	An adult fed the young at dusk a few times, remaining less than a minute at the nest.	Rufous colour, especially on primaries and tail, more evident. Smaller black spots on feather tips and more white feathers with black tips visible. Some bars on tail.
7/11/2015	The last day when the chick was observed at the nest.	Rufous tail feathers much longer and barred. Also, wings longer, and secondaries had some narrow bars. Body feathers in general darker and uniform, with some brighter brown feathers on belly.
9/11/2015	Fledgling seen away from nest, perched on a branch c.3 m from the nest and lower than it.	Very long and heavily barred tail feathers, more rufous on back and head. Primaries light brown and secondaries rufous with black tips.



Figure 4. Egg of Rufous Potoo *Nyctibius bracteatus*, Reserva Florestal Adolpho Ducke, north of Manaus, Amazonas, Brazil, 2016 (Gabriel Augusto Leite)



Figure 5. Adult Rufous Potoo *Nyctibius bracteatus* on the nest, Reserva Florestal Adolpho Ducke, north of Manaus, Amazonas, Brazil, 2017 (Marcelo Henrique Mello Barreiros)

absolutely vertical stump. The next day we found a small chick, but on our next visit on 11 September, we found the chick dead surrounded by ants, and the adult gone.

Discussion

The breeding biology of Common Potoo *Nyctibius griseus* has been well documented (e.g., Mendonça *et al.* 2009, Cestari *et al.* 2011), however, the other species are poorly known. The eggs of *N. griseus* are white in general with brown and lilac spots (Goeldi 1896, Lopes & Anjos 2005, Mendonça *et al.* 2009, Cestari *et al.* 2011) similar to those of Great Potoo *N. grandis* (Cohn-Haft 1997). Eggs of *N. jamaicensis* are described as white with grey-brown and purplish blotches at the large end (Holyoak 2001). Those of Long-tailed Potoo *N. aethereus*, White-winged Potoo *N. leucopterus* and *N. maculosus* are all undescribed. In this study, we found a single egg, pale beige with medium and dark brown blotches, concentrated at the blunt end, which matches the description provided by Cohn-Haft (1989), a photograph in Suriname (<https://twitter.com/MarcHoogeslag/status/1464201735560384512>) and a video of the young at the same nest in Suriname (<https://www.youtube.com/watch?v=FvijvfaTalc>). Mean nest height was 4.48 m, which is higher than the nests described by Ingels *et al.* (2008) in French Guiana (2.25 m) and Vinueza-Hidalgo (2019) in Ecuador (2.8–3.0 m), but lower than the average for all other species of potoos, whose nests are typically sited 1.25–34.0 m higher (Cohn-Haft 1989, Lopes & Anjos 2005, Ingels *et al.* 2008, Cestari *et al.* 2011).

The first report of a *N. bracteatus* nest was in September 1981, also north of Manaus (Cohn-Haft 1989), in the same month, suggesting that in this part of Amazonia the species consistently breeds in September. The nests reported in French Guiana were from October 1999, during the dry season, and January 2006, at the start of the rainy season (Ingels *et al.* 2008), whilst in Ecuador a nest was found in August, in the dry season (Vinueza-Hidalgo

et al. 2019). In Ecuador, both the adult and young remained at the same roost for *c.*20 days (Vinueza-Hidalgo *et al.* 2019), a similar period to that we observed, as the adult was no longer present on the same branch during the day when the young was *c.*21 days old. Data on *N. griseus* suggest adults stay with the fledging for *c.*25 days after hatching (Cestari *et al.* 2011, Sazima 2011). If we consider the entire period from hatching to the young fledging, the Ecuadorian study evidenced a period of *c.*54–56 days (Vinueza-Hidalgo *et al.* 2019). Ingels *et al.* (2008) suggested that *N. bracteatus* has a fledging period of *c.*2 months, like other potoos for which data are available; however, in our study the young was observed on a different branch when it was just *c.*40 days old. The adult we caught at dusk was sexed as a male; Cohn-Haft (1989) also found that individuals at nests during daytime were males.

Of the three nests we studied, only one was successful—the other two failed due to ant predation. Indeed, predation is the primary source of nestling mortality (Martin 1995, Robinson *et al.* 2000), but data on the role of ant swarms in these losses is scarce in the literature. There are many observations of ant swarms preying on nests, for example: nests of hummingbirds (Sick 1997), and a nest of Chestnut-bellied Euphonia *Euphonia pectoralis* in the Atlantic Forest (Pizo 2000). Such predation at a nest of *N. bracteatus* is unprecedented for the genus and, although the species is not considered threatened, it is uncommon throughout its distribution (Cohn-Haft & Kirwan 2020).

Acknowledgements

We thank the Instituto Nacional de Pesquisas da Amazônia (INPA), especially Mario Cohn-Haft, for authorisation to enter Reserva Florestal Adolpho Ducke (RFAD). Bret Whitney and Pepe Rojas helped with the field work and Micah Riegner and Thiago V. V. Costa made valuable comments on the manuscript.

References:

- Braun, M. J. & Huddleston, C. J. 2009. A molecular phylogenetic survey of caprimulgiform nightbirds illustrates the utility of non-coding sequences. *Mol. Phyl. & Evol.* 53: 948–960.
- Brumfield, R. T., Swofford, D. L. & Braun, M. J. 1997. Evolutionary relationships among the potoos (Nyctibiidae) based on isozymes. Pp. 129–145 in Remsen, J. V. (ed.) *Studies in Neotropical ornithology honoring Ted Parker. Orn. Monogr.* 48.
- Cestari, C., Guaraldo, A. C. & Gussoni, C. O. 2011. Nestling behavior and parental care of the Common Potoo (*Nyctibius griseus*) in southeastern Brazil. *Wilson J. Orn.* 123: 102–106.
- Cisneros-Heredia, D. F. 2006. Notes on breeding, behaviour and distribution of some birds in Ecuador. *Bull. Brit. Orn. Cl.* 126: 153–164.
- Cleere, N. 2010. *Nightjars, potoos, frogmouths, Oilbird, and owlet-nightjars of the world*. Princeton Univ. Press.
- Cohn-Haft, M. E. 1989. Biologia reprodutiva e comportamento reprodutivo de *Nyctibius bracteatus* (Aves; Nyctibiidae). *Res. XVI Congr. Bras. Zool. (João Pessoa)* 145–146.
- Cohn-Haft, M. 1999. Family Nyctibiidae (potoos). Pp. 288–301 in del Hoyo, J., Elliott, A. & Sargatal, J. (eds.) *Handbook of the birds of the world*, vol. 5. Lynx Edicions, Barcelona.
- Cohn-Haft, M. & Kirwan, G. M. 2020. Rufous Potoo (*Nyctibius bracteatus*), version 1.0. In del Hoyo, J., Elliott, A., Sargatal, J., Christie, D. A. & de Juana, E. (eds.) *Birds of the world*. Cornell Lab of Ornithology, Ithaca, NY. <https://doi.org/10.2173/bow.rufpot1.01>.
- Costa, T. V. V. 2014. Osteologia e filogenia das Aves Caprimulgiformes, com ênfase em Nyctibiidae e Caprimulgidae. Ph.D. thesis. Univ. de São Paulo.
- Costa, T. V. V., Whitney, B. M., Braun, M. J., White, N. D., Silveira, L. F. & Cleere, N. 2018. A systematic reappraisal of the Rufous Potoo *Nyctibius bracteatus* (Nyctibiidae) and description of a new genus. *J. Orn.* 159: 367–377.
- Goeldi, E. A. 1896. On the nesting of *Nyctibius jamaicensis* and *Sclerurus umbretta*. *Ibis* (7)2: 229–310.
- Holyoak, D. T. 2001. *Nightjars and their allies: the Caprimulgiformes*. Oxford Univ. Press.
- Ingels, J., Cleere, N. & Pelletier, V. H. 2008. Recent records and breeding of Rufous Potoo *Nyctibius bracteatus* in French Guiana. *Cotinga* 29: 144–148.
- Lopes, E. V. & dos Anjos, L. 2005. Observações sobre reprodução de *Nyctibius griseus* no campus da Universidade Estadual de Londrina, norte do Paraná. *Ararajuba* 13: 109–112.
- Marques Filho, A. O., Ribeiro, M. N. G., Santos, H. M. & Santos, J. M. 1981. Estudos climatológicos da Reserva Florestal Ducke – Manaus-AM. IV. Precipitação. *Acta Amazonica* 11: 759–768.
- Martin, T. E. 1995. Avian life history evolution in relation to nest sites, nest predation and food. *Ecol. Monogr.* 65: 101–127.

- Mendonça, L. G. A., Blamires, D. & Tubelis, D. P. 2009. Nesting of the Common Potoo, *Nyctibius griseus* (Gmelin, 1789) (Aves: Nyctibiidae) in an urban environment in central Cerrado. *Lundiana* 10: 77–90.
- Pizo, M. A. 2000. Attack on Chestnut-bellied Euphonia nestlings by army ants. *Wilson Bull.* 112: 422–424.
- Ribeiro, J. E. L. S., Hopkins, M. J. G., Vicentini, A., Sothers, C. A., Costa, M. A. S., Brito, J. M., Souza, M. A. D., Martins, L. H. P., Lohmann, L. G., Assunção, P. A. C. L., Pereira, E. C., Silva, C. F., Mesquita, M. R. & Procópio, L. C. 1999. *Flora da Reserva Ducke. Guia de identificação das plantas vasculares de uma floresta de terra firme na Amazônia Central*. Ed. INPA, Manaus.
- Robinson, W. D., Robinson, T. R., Robinson, S. K. & Brawn, J. D. 2000. Nesting success of understory forest birds in central Panama. *J. Avian Biol.* 31: 151–164.
- Rutt, C. L., Jirinec, V., Johnson, E. I., Cohn-Haft, M., Vargas, C. F. & Stouffer, P. C. 2017. Twenty years later: an up-date to the birds of the Biological Dynamics of Forest Fragments Project, Amazonas, Brazil. *Rev. Bras. Orn.* 25: 277–296.
- Sazima, I. 2011. The baby shall stay safe: the Common Potoo leaves the daytime perch and protects its nestling from rainstorm. *Rev. Bras. Orn.* 19: 424–427.
- Sick, H. 1997. *Ornitologia brasileira*. Ed. Nova Fronteira, Rio de Janeiro.
- Solano-Ugalde, A. 2011. Notes on the roosting site, foraging behaviour, and plumage crypsis of the Rufous Potoo (*Nyctibius bracteatus*) from the Ecuadorian Amazon. *Bol. Soc. Antioqueña Orn.* 20: 39–42.
- Vinueza-Hidalgo, G. S., Mosquera, D. & Blake, J. G. 2019. Notes on the breeding biology of Rufous Potoo (*Nyctibius bracteatus*) in lowland Ecuadorian Amazon. *J. Field Orn.* 90: 229–234.
- White, N. D., Mitter, C. & Braun, M. J. 2017. Ultraconserved elements resolve the phylogeny of potoos (Aves: Nyctibiidae). *J. Avian Biol.* 48: 872–880.
- Willis, E. O. 1977. Lista preliminar das aves da parte noroeste e áreas vizinhas da Reserva Ducke, Amazonas, Brasil. *Rev. Bras. Biol.* 37: 585–601.

Addresses: Marcelo Henrique Mello Barreiros, Field Guides Inc., 9433 Bee Cave Road, Building 2-105, Austin, TX 78733, USA, e-mail: marcelomope@hotmail.com. Mariana Tolentino, Laboratório de Biologia Evolutiva e Comportamento Animal, Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil, e-mail: marianatolentino@gmail.com. Gabriel Augusto Leite, Rainforest Connection, San Francisco, CA, USA, e-mail: gabrielzoobio@hotmail.com

