Adding value to collections: improving the data associated with Crested Ibis Nipponia nippon specimens held in the Natural History Museum, Tring

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Adding value to collections: improving the data associated with Crested Ibis *Nipponia nippon* specimens held in the Natural History Museum, Tring

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Summary.—In the bird collection of the Natural History Museum at Tring (NHMUK), and no doubt in many analogous collections elsewhere, older specimens are increasingly likely to have become divorced from some, or even all, of the data that once accompanied them. As the utility of such specimens for research depends in large part on their accompanying data, it is important, though time-consuming, to try to restore missing data to them. Stimulated by a genomic research project request to sample all Crested Ibis *Nipponia nippon* specimens in the NHMUK collection, this paper presents a case study of such an attempt. The results are used to highlight the importance that such investigation is factored into projects aiming to make museum specimen data available online.

In early 2014, the Natural History Museum at Tring (NHMUK) received a request for DNA samples from all of its skin specimens of Crested Ibis *Nipponia nippon* as part of a genomic research project examining the genetic changes the species has undergone during the crash in its population size and distribution over the past 150 years (Feng *et al*. 2019). The most recent published catalogue of such specimens is that presented by Knox & Walters (1994), from which all relevant data are summarised in Table 1. Since then no additional specimens of the species have been received by NHMUK.

Table 1 indicates that NHMUK formerly held 23 or 24 relevant specimens collected between *c*.1840 and 1910, the uncertainty arising because one of two specimens found unregistered when the data were gathered (1988) was considered potentially to have been a previously registered specimen that had become detached from its label. As at least three specimens appeared to be missing from the collection, this left 20 available for sampling. To place this in context, from museums worldwide in total only *c*.60 historic museum specimens of this now extremely rare species were available to the genomic research project (Feng *et al*. 2019).

Contributing specimen molecular samples to a project such as this provides both obligations and opportunities to museum curators. Considering obligations first, both the quality and quantity of data on the label(s) attached to each specimen, in particular that associated with collection locality and date, are key to its utility, as indeed such data are to most research undertaken on museum specimens. Given the relative ease with which older specimens in particular might have become separated from their relevant data, and the problems with interpretation that can arise in relation to the available information (Rasmussen & Prŷs-Jones 2003, Steinheimer 2010), this suggested that a close study of museum register, catalogue and other archival data, in conjunction with the published literature, might improve the data quality and quantity available in Knox & Walters (1994) and shown in Table 1.

Turning to opportunities, where genomic data permit specimens to be grouped geographically, this can provide a cross-check as to the origin of specimens of vague or

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TABLE 1
Data for NHMUK Crested Ibis *Nipponia nippon* skin specimens from Knox & Walters (1994), listed in the order and in accordance with the headings they use. Information in brackets is inference. The column 'CBBM' refers to the specimen's entry in Sharpe & Ogilvie-Grant (1898).

	Reg. no.	Locality	Country	Date	Source	Age	Sex	Posture	CBBM	Notes
1			Japan			ad		mount	*b*	Not found 1988.
2		Shanghai	China		J. Webb	ad		mount		Not found 1988. Details taken from CBBM.
3	1842.1.19.90		Japan		Leyden Museum; Temminck; Leadbeater	ad		skin		
4	1852.2.5.12							skin		Reg. no. appears incorrect.
5	1891.10.19.20	Seoul	Korea		C. W. Campbell		female	skin		
6	1892.4.2.492	Shanghai	China		Tweeddale coll.	ad		skin		
7	1892.4.2.493	Shapooshan dist., Chekiang	China	May	W. Pryer; Tweeddale coll.	imm	male	skin		
8	1897.10.30.2		Korea	1 Feb 1891	C. W. Campbell	ad	female	skin		Not found 1988.
9	(1897.10.30.3)	Hakodate, Hokkaido	Japan	April	Blakiston; Seebohm coll.		female	skin		Reg. no. inferred.
10	1897.10.30.4	Yokohama	Japan		H. Pryer	ad		skin		
11	1897.10.30.5	Ningpo	China	18 Nov 1872	R. Swinhoe	ad	male	skin		
12	1897.10.30.6	Ningpo	China	18 Nov 1872	Swinhoe coll.	imm	female	skin		
13	1900.9.9.12	Shenshi	N China		Rev. Father Hugh			skin		
14	1900.9.9.13	Shenshi	N China		Rev. Father Hugh			skin		Not found 1988. Details from register.
15	1908.1.5.20	Anhuei	China	6 Jun 1901	Styan coll.	ad	female	skin		
16	1980.1.5.21	Anhuei	China	2 Jun 1901	Styan coll.	ad	male	skin		
17	1908.1.5.22	Anhuei	China	2 Jun 1901	Styan coll.	ad	male	skin		
18	1908.1.5.23	Anhuei	China	4 Jun 1901	Styan coll.		male	skin		
19	1908.1.5.24	Anhuei	China	4 Jun 1901	Styan coll.	ad	female	skin		
20	1908.1.5.25	Lu man Lsien, Shansi	China	Nov 1896	Styan coll.	ad	male	skin		
21	1908.1.5.26	Lu man Lsien, Shansi	China	Nov 1896	Styan coll.	ad	female	skin		
22	1912.9.23.14	Feng Hsiang, Shensi	China	1 Jan 1910	Duke of Bedford coll.	ad	male	skin		
23	1988.17.1		(Asia)					skin		
24	1988.17.2		(Korea)	15 Jan 1901			male	skin		Damaged; bill broken

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TABLE 2

Data for NHMUK Crested Ibis *Nipponia nippon* skin specimens based on the archival and molecular research outlined herein. Information in brackets is inference. Chinese locality names given in each case are modern Anglicised ones where possible, notably for provinces; otherwise, they are from the original label, with spelling standardised where possible using Bartholomew (1922). The column 'CBBM' refers to the specimen's entry in Sharpe & Ogilvie-Grant (1898). Plumage colour data are pers. obs.

	Reg. no.	Locality	Country	Date	Collector	Donor/vendor	Plumage	Sex	Posture	CBBM	Notes
3	1842.1.19.90		Japan	pre-1843	? H. Bürger	Leiden Museum via Leadbeater	white	female	skin	*a*	
1	?		Japan	?	?	?			mount	*b*	Not found 1988 or 2018
4	1852.2.5.2		China	1843–51	R. Fortune	H. Cuming	white	male	skin		
2	1852.3.19.2	Shanghai	China	pre-1853	J. Webb	J. Russell Reeves			mount	*e*	Not found 1988 or 2018.
5	1891.10.19.20	Seoul	Korea	Dec 1888 or Jan 1889	C. W. Campbell	C. W. Campbell	white	female	skin	*c*	
6	1892.4.2.492	Shanghai	China	pre-1893	?	Marquess of Tweeddale	white	female	skin	*d*	
7	1892.4.2.493	Shapooshan dist., Zhejiang Province	China	May 1875	W. Pryer	Marquess of Tweeddale	dark grey	male	skin	*f*	
8 & 23	(1897.10.30.2)	Seoul	Korea	Dec 1888 or Jan 1889	C. W. Campbell	H. Seebohm	white	male	skin		Almost certainly specimen re-reg. as 1988.17.1.
9	(1897.10.30.3)	Hakodate, Hokkaido	Japan	27 Apr 1873	T. Blakiston	H. Seebohm	dark grey	female	skin		Reg. no inferred.
10	1897.10.30.4	Yokohama, Honshu	Japan	pre-1888	H. Pryer	H. Seebohm	white	male	skin		
11	1897.10.30.5	Ningbo, Zhejiang Provine	China	18 Nov 1872	R. Swinhoe	H. Seebohm	grey flecks	male	skin		
12	1897.10.30.6	Ningbo, Zhejiang Provine	China	18 Nov 1872	R. Swinhoe	H. Seebohm	grey flecks	female	skin		
13	1900.9.9.12	Shaanxi Province	China	pre-1901	Rev. Father Hugh	Rev. Father Hugh	white		skin		
15	1908.1.5.20	(Kienteh area), Anhui Province	China	6 Jun 1901	F. W. Styan	F. W. Styan	pale grey	female	skin		
16	1980.1.5.21	(Kienteh area), Anhui Province	China	2 Jun 1901	F. W. Styan	F. W. Styan	pale grey	male	skin		
17	1908.1.5.22	(Kienteh area), Anhui Province	China	2 Jun 1901	F. W. Styan	F. W. Styan	pale grey	male	skin		
18	1908.1.5.23	(Kienteh area), Anhui Province	China	4 Jun 1901	F. W. Styan	F. W. Styan	pale grey	male	skin		
19	1908.1.5.24	(Kienteh area), Anhui Province	China	4 Jun 1901	F. W. Styan	F. W. Styan	grey	male	skin		
20	1908.1.5.25	Luonan, Shaanxi Province	China	Nov 1896	F. W. Styan	F. W. Styan	white	female	skin		
21	1908.1.5.26	Luonan, Shaanxi Province	China	Nov 1896	F. W. Styan	F. W. Styan	white	female	skin		
22	1912.9.23.14	c.50 km S of Feng-hsiang fu, Shaanxi Province	China	1 Jan 1910	M. P. Anderson	Duke of Bedford coll.	white	male	skin		
24	1988.17.2	Seoul	Korea	15 Jan 1901	Miss E. Scarlett	Miss E. Scarlett	white	female	skin		

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uncertain provenance. Most generally important, however, the genomic results would provide unambiguous sex determination. Many specimens, especially older ones of phenotypically monomorphic species, including Crested Ibis (He *et al*. 2013), lack label indication of sex, and even where this is provided it is likely to be unclear whether it is based on gonad examination. In practice, sexing is found to be erroneous in a non-negligible minority of cases (e.g. Rasmussen & Prŷs-Jones 2003).

Using the approaches mentioned above, this paper reports on a specimen-by-specimen examination of all such issues and summarises the results in Table 2, an updated version of Table 1 to facilitate comparative assessment of the added value that such an approach can bring. The archival methodology is outlined below; the molecular methodology is presented in Feng *et al*. (2019). Although the Natural History Museum was legally part of the British Museum for more than 200 years from the 1750s until 1963 (Stearn 1981), using first the acronym BM and later BM(NH), I use the current official acronym NHMUK throughout this paper for simplicity, as no confusion should thereby be caused.

Archival methodology

The assembly of a bird collection by NHMUK began in the 1750s, with the great majority of its constituent material being either donated or purchased. However, due both to poor preparation techniques and inadequate curatorial care, few specimens from pre-1800 survive, and the vast majority date from the great era of bird exploration and collecting spanning 1850–1950. Even post-1800, documentation of what was received, its provenance, and what was subsequently disposed of left much to be desired until the 1830s, when the first systematic attempts both to register (on arrival, with a unique identification number both in the register and on the specimen's label) and to catalogue (i.e. place within a taxonomically ordered list) individual specimens commenced (Knox & Walters 1992, Wheeler 1996, Thomas 2012).

The search for archival data pertaining to each Crested Ibis specimen drew on the following potential sources:

1. The label(s) attached to the specimen in question, usually comprising an original collector's label and a museum curator's label. However, at least half of all specimens received up to *c*.1860 were mounted for display (Günther 1912), whereupon they normally had their original label removed, giving considerable scope for data to be lost or incorrectly transcribed.
2. From 1837, the specimen register entry made on its museum arrival, which in addition to the individual specimen's number includes an identification, often only to genus or less in earlier years, and highly variable additional data concerning provenance, date of collection, collector, etc. Pre-1945, each specimen received a four-part registration number, in which the first three parts represented respectively the year, month and day of the earliest registration of the particular collection in which it was received, and the fourth part the number of the specimen within that collection; subsequently, three-part registration numbers were used (year, batch no., specimen no.). In the absence of other, more precise dating, the first part of the registration number therefore defines the latest possible year in which the specimen could have been collected.
3. Various NHMUK catalogues, including: the partial, manuscript Vellum Catalogues (*c*.1835–43), in which entries from *c*.1840 onwards were increasingly erratic; the published G. R. Gray catalogues of the 1840s / 1850s, which were very incomplete in their taxonomic coverage; and the invaluable, complete 27-volume *Catalogue of the birds*

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in the British Museum, published 1872–98. The relevant volume (no. 26) for Crested Ibis in the last-named is Sharpe & Ogilvie-Grant (1898).

4. Information contained in surviving correspondence, notably from the donor / vendor. Occasionally this may include relevant data not transcribed onto the specimen's label or into its register or catalogue entries. NHMUK has voluminous archives, but searching for such information from before the 1880s, when NHMUK was moved to a new building in South Kensington and thereby physically separated from the rest of the British Museum, is complicated because potentially relevant material often remained at the latter or, indeed, may have subsequently been passed by that organisation to the British Library.
5. Specimen collectors' catalogues or diaries that may have survived and been deposited in a public institution, not infrequently NHMUK itself.
6. The published literature, where information relating to many specimens was included in journals or books either before or after their arrival in the NHMUK.

Searching of sources 1–3 above is usually relatively straightforward and comprehensive, but exhaustive searches are rarely feasible for 4–6. The analysis provided below should therefore not be considered the final word in restoring data to the specimens under consideration, but rather one that took account of the 'law of diminishing returns' in the context of time spent vs. information retrieved.

Results

The results of the investigation undertaken are summarised in Table 2, arranged in approximate chronological order of each specimen's arrival in NHMUK, as revealed by their registration number. Individual specimens are best cross-referenced between Tables 1 and 2 by means of the numbers (1–24) in the left-hand column of each, as a few registration number errors / omissions occurred in Knox & Walters (1994). The sources of information additional to, or altered from, that in Table 1 are summarised below, considering archival results first, listed by registration number in the order presented in Table 2, and molecular subsequently.

Archival

1842.1.19.90.—This was almost certainly the first Crested Ibis specimen to reach NHMUK, being the only one mentioned in Gray (1844: 91), who stated: 'Japan. – From the Leyden Museum.'; no Crested Ibis entry appears in the Vellum Catalogues. The specimen was received from the London dealers Leadbeater within a batch of duplicates from Leiden Museum (Sharpe 1906), whose director from 1820 was C. J. Temminck. In 1835 Temminck provided the first description of the Crested Ibis from a single complete skin received from P. F. von Siebold in Japan. Leiden subsequently received further Japanese specimens, notably from Heinrich Bürger, who was Siebold's assistant in Japan during 1825 to 1835, and NHMUK's specimen is probably one such (H. van Grouw pers. comm.). The specimen was formerly mounted, but the annotation 'No 13 Burton 14.5.84' on its only label shows it was sent for demounting by the taxidermist Burton on that date. This was part of a programme for turning much of the former (mounted) display collection into a (skin) research collection (Knox & Walters 1992); in consequence the subsequent entry for the specimen ('*a*') in Sharpe & Ogilvie-Grant (1898: 16) is annotated '*sk*' (skin) and not '*st*' (stuffed).

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Specimen lacking known reg. no.—This is mounted specimen '*b*' in Sharpe & Ogilvie-Grant (1898: 16), who otherwise merely stated 'Japan. Purchased'. Neither it nor the other mounted specimen ('*e*'—see below) mentioned by Sharpe & Ogilvie-Grant (1898), who regrettably do not provide registration numbers, is now at NHMUK. As it was not mentioned by Gray (1844), the specimen almost certainly arrived subsequently. Precisely when is almost impossible to determine without knowledge of its vendor, as its registration, if undertaken, was seemingly made at most at the generic level ('*Ibis*') alone.

1852.2.5.2.—This is the specimen referred to by Knox & Walters (1994: 45) as 1852.2.5.12, with the comment 'reg. no. appears to be incorrect, as the register claims it was assigned to a different species.' Examination of its only label, a museum one, on which is written only the registration number, reveals the number is in fact 1852.2.5.2, as the digit '1' has been faintly crossed out. This is confirmed by the tiny metal preparation tag also present (see Varley *et al*. 2016 for a photo of such a tag), on which the registration number is very faintly scratched and for which the final part can be confirmed as '2'. The register entry for this specimen gives '*Ibis* China', part of a batch of five specimens (1852.2.5.1–5) noted as being 'Fortune colln.' and purchased from Hugh Cuming, a well-known conchologist who also dealt in a wider array of natural history specimens including birds (Sharpe 1906, Dance 1980). The collector was almost certainly Robert Fortune, who spent much time in south-east China during the decade preceding 1852, initially collecting plants on behalf of the Royal Horticultural Society and later tea varieties for the East India Company (Rose 2009). For unclear reasons, the specimen is not included in Sharpe & Ogilvie-Grant (1898).

1852.3.19.2.—Knox & Walters (1994) had no registration number for this mounted specimen, now missing, listed as '*e*' by Sharpe & Ogilvie-Grant (1898). However, a register search for the collector J. Webb reveals that it is almost certainly 1852.3.19.2 ('*Ibis*. Shanghai'), part of a series of 25 registered specimens presented via John Russell Reeves.

1891.10.19.20 and **1897.10.30.2**.—Both specimens were collected in Seoul, Korea, by Charles W. Campbell, the former (specimen '*c*' in Sharpe & Ogilvie-Grant 1898) being received by NHMUK directly from him, whereas the latter was acquired subsequently as part of the Seebohm collection. On specimen 1891.10.19.20, the original Campbell label contains a mixture of English and Korean writing, the former indicating it was bought in a Seoul market. Knox & Walters (1994) suggested specimen 1897.10.30.2 was missing, but that a detached label found probably belonged to it. This is clearly correct as the label is in the same style as that on 1891.10.19.20, but with 'Seebohm Coll.' also appended. They further suggested that the detached label included a date '1/2/(18)91', but this appears to be a misinterpretation. No obvious date of collection is given for either specimen, but Campbell (1892) reveals, firstly, that he was in Seoul in 1888 and 1889 and, secondly, that he obtained his Crested Ibis specimens in December and January. Finally, 1897.10.30.2 is almost certainly the supposedly data-less specimen 1988.17.1 of the two 'unregistered' specimens located and registered by Knox & Walters (1994).

1892.4.2.492.—As Knox & Walters (1994) indicate, the only data available that can be linked to this specimen ('*d*' in Sharpe & Ogilvie-Grant 1898) are 'Shanghai' and 'Tweeddale Coll.' In particular, who the collector might have been is unknown.

1892.4.2.493.—William Pryer, the collector of this specimen ('*f*' in Sharpe & Ogilvie-Grant 1898) acquired by NHMUK via the Tweeddale collection, was brother to the ornithologically better known Harry Pryer (Sharpe 1906). Although Knox & Walters (1994) give merely 'May' for date of collection, the label clearly indicates it was taken in May 1875, in wet fields. The Zhejiang province collection locality of 'Shapooshan district' on the original label was

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untraced by Collar *et al*. (2001), but may well be Shapushan, Wuding County (F. Steinheimer *in litt*. 2019).

1897.10.30.3.—Knox & Walters (1994) are clearly correct in concluding that 1897.10.1.3, as written on a label on this Thomas W. Blakiston specimen acquired via the Seebohm collection, is a curatorial *lapsus*. Furthermore, although its original Blakiston label states merely '♀ April Hakodadi, Japan 1199', more can be inferred. In Blakiston's own catalogue which, together with many of his specimens, remains in Japan (Yamashina *et al*. 1932, Kato 2012), the entry for specimen no. 1199 reveals that its collection date was 27 April 1873 and that Blakiston sent it to Robert Swinhoe in February 1875 (M. Kato *in litt*. 2018). As it is in grey plumage, there is little doubt that it must be the specimen referred to by Swinhoe (1875: 455), in a paper on specimens he received from Blakiston, as 'A full-grown immature grey specimen of this species has come …'. On his death, Swinhoe's collection was acquired by Seebohm.

1897.10.30.4.—As Harry Pryer, the collector of this specimen acquired by NHMUK via Seebohm, died early in 1888 (*Ibis* 30: 381, 1888), it must have been collected prior to this.

1897.10.30.5 and **6**.—Both of these Swinhoe specimens were acquired via the Seebohm collection. Swinhoe (1873) wrote an account of their taking, along with a third bird, at Western Lake, Ningpo. A. Anderson is given as the collector of 1897.10.30.6 in the NHMUK register, which is contradicted by the specimen's labels and clearly a curatorial registration error.

1900.9.9.12 and (13).—Knox & Walters (1994) stated that NHMUK received two specimens from Father Hugh (born John Aloysius Scallan), but that they could only find 1900.9.9.12. In fact, the supposed 1900.9.9.13 almost certainly never existed. In his write-up of material received from Father Hugh, Sharpe (1901: 175) refers to just one specimen: 'Un mâle parfaitement adulte, en plumage blanc, montrant une belle nuance rose, et portant la huppe complètement développée.' Furthermore, the NHMUK register entry line for specimen 1900.9.9.13 is left blank, rather than having the ditto marks expected if a specimen existed whose data matched 1900.9.9.12. Blank registration lines not infrequently occur in registers from this period and earlier, either in error or because even a genus-level identification of the specimen under consideration had not been reached when registration occurred.

1908.1.5.20–26.—All of these specimens were acquired as part of a large collection received from Frederic W. Styan following his return to Britain in 1904 after more than 25 years in China (*Ibis* 77: 210, 1935). Styan made extensive use of one or more native collectors, but nevertheless his specimens generally possess good data. The five specimens 1908.1.5.20–24 were all collected in June 1901, with the label locality being noted merely at the province level; however, Styan (1902) indicated that shortly thereafter his collector was 'near Chinteh, in Anhwei Province, on the south bank of the Yangtse'. Previously, Styan (1891: 337) had defined the 'Chin Teh Hills' as being *c*.110 km downstream of Kiukiang (modern Jiujiang), which provides a potentially more precise indication of provenance in south-west Anhui province, i.e. in the vicinity of Kienteh (Bartholomew 1922). For specimens 1908.1.5.25–26, the statement in Knox & Walters (1994) that they were collected in 'Shansi' (= modern Shanxi province) is a misleading mis-transcription of 'Shensi' (= modern Shaanxi province, immediately west of Shanxi) on their original labels. The original label collection locality 'Lu Nan hsien' is the modern Luonan (Collar *et al*. 2001).

1912.9.23.14.—As noted on its original label, the specimen was taken by Malcolm P. Anderson, who collected extensively in China for the 11th Duke of Bedford. During late

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1909 and early 1910 he was in south-east Shensi (modern Shaanxi) province (Thomas 1911), initially around Shangchou (*c*.33°40′N, 110°20′E) and later near Mt. Tai-pei-san (*c*.34°N, 107°30′E). Based on locality names in Bartholomew (1922), it appears that his Crested Ibis specimen came from *c*.50 km south of either Fêng-hsien (*c*.33°50′N, 106°40′E) or, more probably, Feng-siang-fu (*c*.34°30′N, 107°20′E).

1988.17.1.—See under 1897.10.30.2 (above).

1988.17.2.—This is the second of two specimens that Knox & Walters (1994) found to lack a registration no. and therefore provided one. As they noted, its label states it was collected in Korea on 15 January 1901, but they failed to determine the collector / donor name. This is in fact 'Scarlett', subsequently confirmed by checking labels of other specimens from this donor. The next step of tracking this name down in the registers was complicated because Sharpe (1906) had overlooked it. A register search showed that 'The Hon. Miss E. Scarlett' passed a total of 12 Korean specimens to NHMUK, two registered as 1900.12.15.1–2 and space for ten created in the series 1901.9.18.1–10, although only the first five were actually registered, all also collected in January 1901. It appears probable that a decision was made during the registration process not to register the other five specimens, but instead to retain them as duplicates for potential gift or exchange, as not infrequently happened in the late 1800s and early 1900s (Günther 1912). That the Crested Ibis specimen both had a broken bill and belonged to a species then already well represented in the NHMUK collection makes such a decision more likely. Had the collector's name and the relevant registration series been recognised earlier, the appropriate registration number to have been used would have been in the series 1901.9.18.

Molecular

Based on their genomic analysis, Feng *et al*. (2019) could group the 57 Crested Ibis specimens for which they had extracted usable DNA, including 19 from NHMUK (1900.9.9.12 failed), into three major, discrete geographical areas: north-west China, eastern China and north-east Asia (including north-east China, the Russian Far East, Korea and Japan). For all 16 NHMUK specimens labelled with reasonably precise geographical provenance, the molecular results confirmed their areas of origin. For two further specimens (1897.10.30.2 and 1988.17.2), for which it had been necessary to infer their provenance as being Korea in both cases, the molecular data placed them in the appropriate north-east Asian grouping. For the final specimen (1852.2.5.2) with only 'China' noted on its label, its molecular grouping with eastern China specimens agrees with the archival demonstration that it was a Robert Fortune specimen, as his collecting activity appears to have been confined to this area. Archival and molecular results are therefore fully congruent.

Regarding sexing, of the 19 NHMUK specimens that yielded usable DNA, eight had previously been sexed male, seven female and four were unsexed (Table 1). Based on the molecular sexing, ten were found to be male and nine female, but this included a sex change for four of the 15 supposedly sexed birds, i.e. 27% (Table 2). For a rare species in which any phenotypic differences between the sexes appears to be at most slight, this substantial improvement in sexing knowledge for museum specimens is clearly important.

Discussion

Comparison of Tables 1 and 2 highlights how much additional data can be added or re-attached to historical specimens by means of a focused archival search. Moreover, whereas Knox & Walters (1994) implied NHMUK had accessed 23 or 24 Crested Ibis

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specimens, of which either three or four could not currently be found, in fact it appears only ever to have held 22, of which just the two mounted ones are missing. Specimens that remained mounted and on display after the separation made between a mounted display collection and a skin / demounted research collection in the late 1800s (Günther 1912) were at particular risk in this regard. They usually no longer had labels attached to them, any data deemed necessary for the public being stuck on their stands, and they suffered the wear and fading associated with long-term display. Many such specimens were eventually disposed of and, although numerous data-less ex-display specimens survive, no Crested Ibis is among them.

Regarding the molecular sexing results, although a significant percentage of older bird specimens of many species tend to be mis-sexed (e.g. Rasmussen & Prŷs-Jones 2003), Crested Ibis is a species whose phenotypic sexing and ageing had historically been particularly confused due to its long-misunderstood plumage changes associated with breeding. Despite a factually correct interpretation being published in the late 1800s, it was widely overlooked (Yasuda 1984). Only during the second half of the 1900s did it become widely understood that the birds acquire a grey breeding plumage in early spring (late January–February) by cosmetic application of a tar-like secretion from a specialised skin region of the head and neck. Non-breeding plumage is white (Uchida 1970, Wingfield *et al*. 2000). Details from NHMUK specimens confirm that birds are dark grey during the breeding period in April / May, lightening in colour during June, and by November showing at most slight grey flecks in some; others taken in November and through January are white (Table 2).

This paper's core message is not intended to be a criticism of Knox & Walters (1994) who, with a limited budget and time, produced an important catalogue of all then recognised extinct and endangered birds in the NHMUK collections using the data conveniently available. Rather, it is meant to highlight the extent to which older specimens in particular may have become divorced from relevant data that can be restored, but only via time-consuming curatorial searching (*cf*. Steinheimer 2010). These results can be further enhanced with more accurate sexing data from genomic analysis, which can also potentially cross-check provenance information. Although the discussion here has focused on Crested Ibis, a similar situation is doubtless true for most other species for which many specimens were collected pre-1900, as I discovered in relation to NHMUK holdings of Seychelles Kestrels *Falco araea* for an earlier molecular study (Groombridge *et al*. 2009).

Understanding of this point has assumed special importance in the light of the ever-increasing practice of databasing museum specimen information to make it available online. Although in principle clearly highly desirable in order to facilitate a wide array of research, this creates a situation in which the research users of such data become increasingly isolated from the museum curatorial staff who can advise them regarding its reliability and pitfalls. Although time-consuming, and consequently expensive, in projects aimed at creating online databases it is important that resources be made available so that knowledgeable curatorial staff can validate and, if possible, enhance the information before it is disseminated.

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