Data in Brief 59 (2025) 111325

Contents lists available at ScienceDirect

Data in Brief

journal homepage: www.elsevier.com/locate/dib

Data Article

Distribution-wide morphometric data of Jungle Crows (*Corvus macrorhynchos*)

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ARTICLE INFO

Article history:
Received 24 September 2024
Revised 22 December 2024
Accepted 17 January 2025
Available online 23 January 2025

Dataset link: Distribution-wide morphometric data of Jungle Crows (Corvus macrorhynchos) (Original data)

Keywords:
Morphology
Bird
Corvidae
Museum specimens
Digital measurements
Photography
ImageJ

ABSTRACT

Understudied, widespread species may harbour underappreciated variation in morphology. Museum specimens represent a rich source of morphometric data, and for many species this information is untapped. Here we present a dataset derived from standardised photography of museum specimens of Jungle Crows (*Corvus macrorhynchos*), a widespread Asian Corvid. We photographed 1105 crows, for which 1069 we managed to collect measurements of hard tissue (i.e., bill characteristics and tarsus length). We combined these measurements with museum-curated data on the locality of the specimens, resulting in a geotagged dataset of Jungle Crow morphology. The measured crows originated from across their distribution, representing the most comprehensive morphometric dataset for *Corvus macrorhynchos* to date. The dataset is a valuable resource for exploring the driving forces behind morphological variation in *Corvus macrorhynchos*, as well as a foundation for intraspecific comparison of proposed subspecies and interspecific comparisons of other bird species.

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https://doi.org/10.1016/j.dib.2025.111325

Specifications Table

Subject	Zoology
Specific subject area	Morphological measurements of bird hard tissue
Type of data	Table (.csv format) Raw, Processed
Data collection	Data consists of measurements made from standardised photographs of museum specimens, as well as metadata about the museum specimens' origins. Photographs were taken of museum specimens against a standardised grid or ruler. The grid and ruler allowed for digital measuring of the specimens using imageJ.
Data source location	Specimens were from the Cornell Lab of Ornithology in Ithaca, USA (CUMV); The Field Museum of Natural History in Chicago, USA (FMNH); The American Museum of Natural History in New York, USA (AMNH); The Smithsonian National Museum of Natural History in Washington, D.C., USA (USNM); and the Natural History Museum at Tring, UK (NHMUK). Specimen origins cover the extent of *Corvus macrorhynchos*' distribution.
Data accessibility	Repository name: Zenodo Data identification number: 10.5281/zenodo.12788353 Direct URL to data: https://zenodo.org/records/12788353 Instructions for accessing these data: All .csv data files can be downloaded from enclosed URL.
Related research article	*None*

1. Value of the Data

- These data are useful for exploring the patterns of bird morphology on a continent-wide scale, as well as the relationship between morphology and external environmental factors. The measurements taken of the tarsus and bill are often involved in direct interactions with the environment; therefore, examination of these measures could highlight how *Corvus macrorhynchos* has adapted to different conditions throughout their distribution. Body size can be inferred from tarsus length [1] and presents a potential adaptation to temperature [2]. Bill shape and size similarly can aid with temperature regulation via heat transfer [3,4]. The bill also plays a fundamental role in foraging and object manipulation [5]. All of these behaviours are likely critically important in *Corvus macrorhynchos'* ability to persist in urban, agricultural, and natural environments. Hard tissue measures provide an accessible insight into the interactions of crows and their environment.
- The standard hard tissue measurements obtained allow for comparisons to other bird species, as well as comparisons to other aspects of natural history or behaviour. For example, the bill morphology of New Caledonian Crows is suggested to play a role in their ability to use tools during foraging [6], as well as sexual dimorphism [7]. Identification of unique morphology in *Corvus macrorhynchos* could direct efforts to uncover previously undocumented behaviours and ecologically important intraspecific variation.
- The publication of these data enhances the value of the museum specimens by facilitating the use of commonly sought-after measures of hard tissue. The creation of broad databases that cover hard tissue measures speaks to the importance and utility of these data in identifying ecological patterns [8].
- The coverage of these data could enable more targeted genetic studies to determine whether patterns in morphology are indicative of genetic structure in *Corvus macrorhynchos*. Studies across several taxonomic groups have highlighted how widely distributed species across Asia are better classed as separate species [9–11]. Consistent morphological differences can present a useful component of the species definitions, and present an additional line of evidence when separating species complexes [11]. The hard tissue measurements presented here can present a key component for *Corvus macrorhynchos* species reassessment.
- Studies of *Corvus macrorhynchos* have already used hard tissue morphology to infer colonisation events and the biogeographic history of *Corvus macrorhynchos*, as well as revealing

how their morphology has been shaped by climate [12]. This dataset broadens the area over which such investigations could be conducted, and whether the species more broadly follows general biological tendencies such as Bergman's rule.

2. Background

The Jungle Crow (*Corvus macrorhynchos*) is a widely distributed crow species whose morphological variation has been noted for nearly a century [13]. Multiple field guides and studies already suggest that Jungle Crow morphology differs significantly on regional scales [14–16], but the variation remains inadequately described. The most comprehensive taxonomic examinations of *C. macrorhynchos* have relied on feather parasites [16], and vocalizations [17], both of which suggest *C. macrorhynchos* as a likely species complex. More specific studies have revealed sex differences in hard tissue and potential for broad trends connected to climate [12]. Until now, a distribution-wide investigation has yet to be conducted and presents the opportunity to highlight macro-patterns of morphological variation.

3. Data Description

The data consists of three .csv files:

1. 2024-07-19 Museum Crow Measurements Metadata.csv contains the information on the columns contained in 2024-07-19 Museum Crow Measurements.csv split into Column and Details, where column names match those found in 2024-07-19 Museum Crow Measurements.csv, and details provide information on the data within that column. This information is also available below.
2. 2024-07-19 Museum Crow Measurements.csv represents the core data table containing all hard tissue measurements of C. macrorhynchos alongside museum-derived location fields and manually reviewed location fields. Each row equals an individual specimen, and missing data are denoted with ⟨NA⟩.
3. 2024-07-19 Museum Crow Measurements Epicollect.csv contains the information collected alongside the images taken via Epicollect. The data was used to link photos and subsequent measurements to museum metadata.

All three files can be downloaded from https://zenodo.org/records/12788353, either as a single combined .zip file containing the three csv files (direct download link: https://zenodo.org/api/records/12788354/files-archive), or individually [24].

2024-07-19 Museum Crow Measurements.csv is the file of primary importance, as it contains measurements from the images. It contains the following fields:

Crow.ID- A unique numeric identifier for each crow specimen.

Museum.catalogue.number - A code derived from museum tag information. Prefix denotes the museum the specimen was in Cornell Lab of Ornithology in Ithaca, USA (CUMV); The Field Museum of Natural History in Chicago, USA (FMNH); The American Museum of Natural History in New York, USA (AMNH); The Smithsonian National Museum of Natural History in Washington, D.C., USA (USNM); The Natural History Museum at Tring, UK (NHMUK). This catalogue number matches the museum records and museum tags attached to the specimens.

Form.ID - A unique ID formed of the date and time that also describes the time and date which the specimen was examined. This ID can be used to connect measurement data with other metadata files.

Tarsus.length - In mm, derived from photographs. Length of the inner bend of the tibiotarsal articulation to the lowermost full scale at the base of the foot.

Bill.base.width - In mm, derived from photographs. Width of lower bill at the base of the jaw uncovered by feathers.
Bill.width.at.skin.border - In mm, derived from photographs. Width of lower bill at soft to hard tissue boundary, as parallel to reference grid as possible.
Bill.base.length - In mm, derived from photographs. Length of lower bill from skin transition to tip of the lower bill.
Width.at.nares - In mm, derived from photographs. Width of the upper bill at nares.
Height.at.nares - In mm, derived from photographs. Top of upper bill to base of lower bill at the nares.
Nares.to.bill.tip - In mm, derived from photographs. Forward edge of nares to upper bill tip.
Exposed.culmen - In mm, derived from photographs. Edge of exposed culmen to tip of the upper bill.
Juvenile - Life stage of crow as reported by the museum metadata: Adult, Juvenile, or NA (where NA is unknown, unreported). We infilled clearly juvenile individuals, all remaining NAs are presumed to be adults.
Photo.notes - Notes collected at the time the photographs were taken.
Sex - Sex of crow as reported by the museum metadata: Male, Female, or NA (where NA is unknown, unreported, sexually immature).
Age - Life stage of crow as reported by the museum metadata: Mature, Juvenile, or NA (where NA is unknown, unreported). NA are presumed to be Adults.
Date.Collected - Date crow was killed and collected as reported by the museum, prefixed with date_. Date format is YYYY-MM-DD. Where day, month, or year was unknown XX has replaced the digits. Instances where day, month, or year was missing but it is unclear which, have been left with as much information as possible.
Collector - Person(s) reported by the museum to have killed and collected the specimen in the field, as reported by the Museum.
Expedition - Named expedition during which the crow was collected, as reported by the Museum.
Elevation - Museum-reported meters above sea level where the crow was collected.
Country - Museum-reported country where the crow was collected, in-filled where possible.
State.Province - Museum-reported sub-country named region where the crow was collected, in-filled where possible.
County - Museum reported sub-provincial named region where the crow was collected, in-filled where possible.
Precise.Locality - Museum reported description of exact locality where the crow was collected, in filled where possible.
Museum.Latitude - Museum reported latitude of where the crow was collected.
Museum.Longitude - Museum reported longitude of where the crow was collected.
Geo.Latitude - The decimal degrees latitude created via the use of Google Geocoding API and the geocode() function from ggmap. Input was a concatenated string of Precise.Locality, County, State.Province, and Country.
Geo.Longitude - The decimal degrees longitude created via the use of Google Geocoding API and the geocode() function from ggmap. Input was a concatenated string of Precise.Locality, County, State.Province, and Country.
Corrected.Latitude - The decimal degrees latitude selected after manual review of locality data and geocoded suggestions.
Corrected.Longitude - The decimal degrees longitude selected after manual review of locality data and geocoded suggestions.
Location.Notes - Additional notes taken during location review process.
This dataset contains data on 1105 crows, of which 1069 have corresponding measurements. Crows with measurements originate from across *C. macrorhynchos*' distribution (Fig. 1).

*2*024-07-19 Museum Crow Measurements Epicollect.csv was generated during data collection and its goal was to record the relationship between the specimen being examined and the pho-

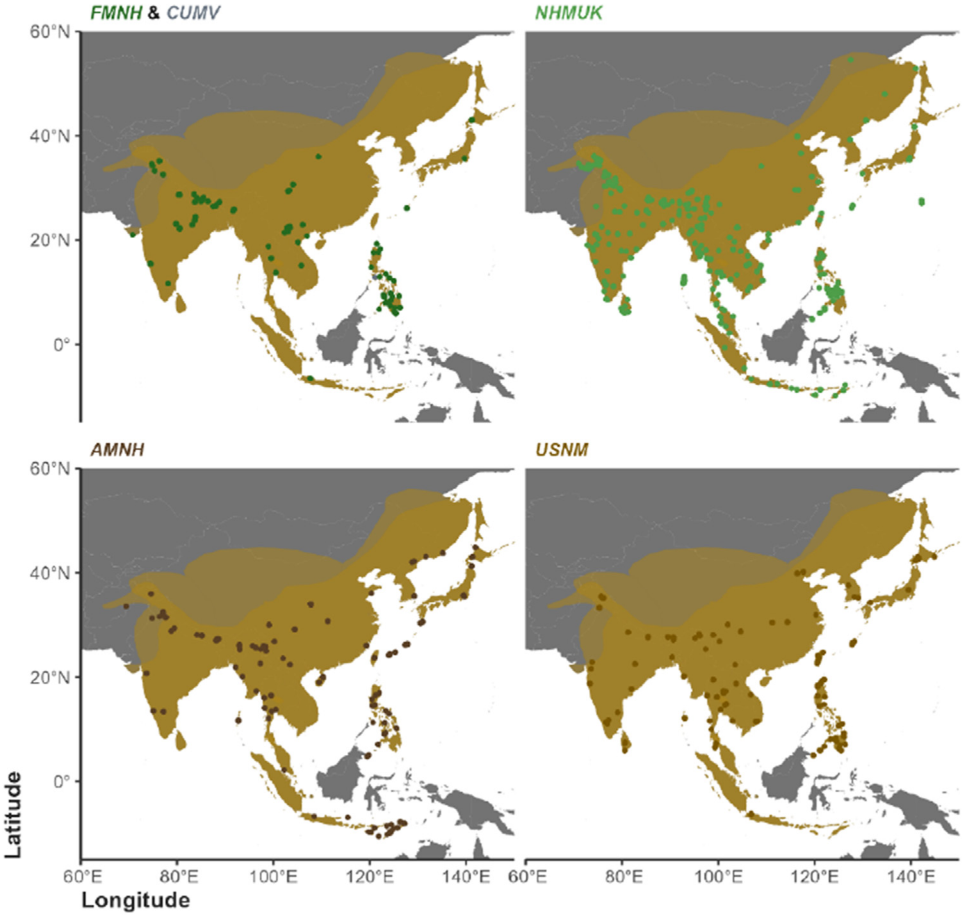

Fig. 1. The locations of all measured adult crow specimens, split between the different museums. Golden area shows the overall distribution of *Corvus macrorhynchos* as suggested by Martens et al. (2000), and Klockenhoff (1969).

tos taken. This enabled automated renaming of the images, and a redundant source of specimen ID next to the photographed tags/labels. This file is not required for re-use of the measurement data, and serves as a means of double-checking original images and specimen identities. It contains the following fields:

ec5_uuid – A unique auto-generated ID for the data entry.
created_at - The date the data entry was created, formatted in ISO 8601.
uploaded_at - The date the data entry was created, formatted in ISO 8601.
title - A unique data entry ID that combines "2_museum" and "3_date".
2_Museum - A four or five letter code denoting the museum: CUMV, FMNH, AMNH, USNM, NHMUK.
3_Date - The date the specimen was examined, formatted as YYYY/MM/DD.
4_Time - The time the specimen was examined, formatted as hh:mm:ss in the timezone local to the museum.
5_Full_Photo - A field that includes a reference image taken via Epicollect using the phone camera.
7_Crow_Number - A unique number for each individual specimen, in the order photographed.

8_Museum_Catalogue_N - Museum catalogue number, unique ID specific to each museum specimen. We added a four-letter prefix that denotes the museum it originated from, and removed any non-numeric characters describing the specimen type (e.g., SKIN).
9_First_Image_Number - The image number provided by the DSLR camera for the blank reference grid image that started each specimen image sequence.
10_Camera_Adjusted - Not used.
11_Photographs_Taken - List of angles photographed for each specimen separated by commas. Possible angles included: Tag, Tarsus, Hallux, Head Bottom, Head Left, Head Top, Head Right.
12_Additional_Photos - How many additional photographs were taken that did not fit within the "11_Photographs_Taken" list.
13_Additional_Notes - Text descriptions of any unusual features, justification for missing images, and notes on life stage when applicable. The field "8_Museum_Catalogue_N" in the Museum Crow Measurements Epicollect.csv and "Museum.catalogue.number" in the Museum Crow Measurements.csv file, is the key field that connects the information collected during photography with the data derived from the photographic measurements. This connection can be double checked using the fields "title" and "Form.ID" in their respective csv files.

4. Experimental Design, Materials and Methods

We visited 5 collections containing specimens within the *C. macrorhynchos* group: The Cornell Lab of Ornithology in Ithaca, USA (CUMV), The Field Museum of Natural History in Chicago, USA (FMNH); The American Museum of Natural History in New York, USA (AMNH); The Smithsonian National Museum of Natural History in Washington, D.C., USA (USNM), and the Natural History Museum at Tring, UK (NHMUK) to photograph all of the *Corvus macrorhynchos* specimens available. These included specimens listed as *Corvus philippinus, Corvus levaillantii, Corvus japonensis, and Corvus coronoides*, that have subsequently been grouped by the museums under *Corvus macrorhynchos*. We examined and documented all *Corvus macrorhynchos* specimens available at these institutions. We downloaded museum metadata from each museum's public archives:

FMNH:https://collections-zoology.fieldmuseum.org/list
AMNH:https://emu-prod.amnh.org/db/emuwebamnh/Query.php
USNM:https://collections.nmnh.si.edu/search/birds/
NHMUK:https://data.nhm.ac.uk/search
CUMV: https://webportal.cumv.cornell.edu/cumvbirds/

We then collated all museum specimen metadata, renaming and standardizing fields across museums as needed.

Locality data as recorded in the metadata was often incomplete or imprecise, necessitating a manual review. Therefore we created a new set of latitude and longitude columns entitled "Corrected.Latitude" and "Corrected.Longitude" where we recorded the best locality data we could find using the following steps: We concatenated Precise.Locality, County, State.Province, and Country into a single character string, then passed this string to the *geocode()* function provided by the *ggmap* package in r [18,19]. The geocode() function uses the Google Geocoding API to convert a place name into a proposed latitude and longitude. We then manually reviewed each latitude and longitude to ensure they matched the available location fields. Where the proposed latitude and longitude matched the reported location data, and the location information provided was adequately detailed, we accepted the coordinates. Where the proposed latitude and longitude did not match the reported location data, and the location information provided was adequately detailed, we manually located a set of coordinates based upon the provided location data. Where the location information provided was inadequately detailed, we used other information provided including date collected, collector, and expedition to locate the most likely location from which the specimen was collected. For example, notes from the expedition during which the crow was reportedly collected might give a specific location on a specific date that could be used to approximate a set of coordinates. Where location data was undiscoverable, we left latitude and longitude as NA. We recorded any documents used to guide the identification of locality in a “Location.notes” column alongside the other metadata. We have retained the museum-provided locality information in the metadata file to enable future data users to verify and confirm the accuracy of our corrected latitude and longitude coordinates.

4.2. Measurement Methods

We first used the two available specimens at the Cornell Lab of Ornithology in Ithaca, USA (CUMV) to refine and standardize the methods. After extensive re-measuring for replicability with both hand measurements using calipers and digital measurements from photographs, we elected to use a digital method over the traditional hand measurement. Our digital method involved photographing the specimens from multiple, standardized angles against a reference grid or rule. We could then use digital measuring tools to derive measurements from the photographs against a standardised grid/scale.

This digital approach comes with several benefits. The specimens require less handling and are exposed for a shorter period of time [20]. This lowers the wear and chances of damage to the specimens, while also allowing us to document more specimens in a shorter period of time. The use of photographs enhances repeatability, allowing for both remeasurements or additional measurements from the already collected photographs without the need to handle specimens again. The photographs also double as an additional record of the specimens (when stored in a stable repository), that may enable future researchers to collect or verify measurements without having to visit the museums.

Williams et al. [20] demonstrated the accuracy of this digital approach on smaller passerines. We verified the accuracy of the digital method for larger *Corvus sp*. by comparing repeated hand caliper measurements with those derived from repeated photographs on two *C. macrorhynchos* specimens at the Cornell Lab of Ornithology. We found repeated measures of photographs and measures from repeated photographs to be more repeatable and precise than repeated measures using hand calipers. To maximise the internal consistency of the photographs and specimen positioning, the same researcher filled the same role for all specimens (ALA - specimen handling; BMM - photography).

We used a single photographic set-up that consisted of a Canon Rebel T5 DSLR camera mounted on an overhead tripod and positioned 565 mm directly above a 280 × 200 mm reference grid (Fig. 2). The camera was fitted with a Canon EF 50 mm f/1.8 macro lens to ensure all photographs had the same focal length and minimal edge distortion. We used a spirit level to ensure the camera was parallel to the reference grid for each photograph.

In the frame for every photograph, we included a label with the crow ID and museum catalogue number, along with white balance reference cards. We modified shutter speed and aperture according to the light conditions but prioritized an aperture that allowed for as much of the specimen to be in focus as possible. We used an off-camera shutter release to minimize camera shake in lower light conditions.

For each specimen, we took a series of photographs: first an empty reference grid with only the label and white balance cards; second, the museum tags that were attached to the specimen (all sides with information), to provide a back-up source of metadata, as well an easy way to verify the specimen’s identity from the photographs. We then proceeded to take photographs suitable for measurement from the following angles:

- **Tarsus**: We identified the tarsus most visible from above the crow as it lay on its side and placed a small ruler parallel to the tarsus with a marker aligned with the lowermost full scale at the base of the foot. At the same time, we ensured the inner bend of the tibiotarsal articulation was clearly visible.

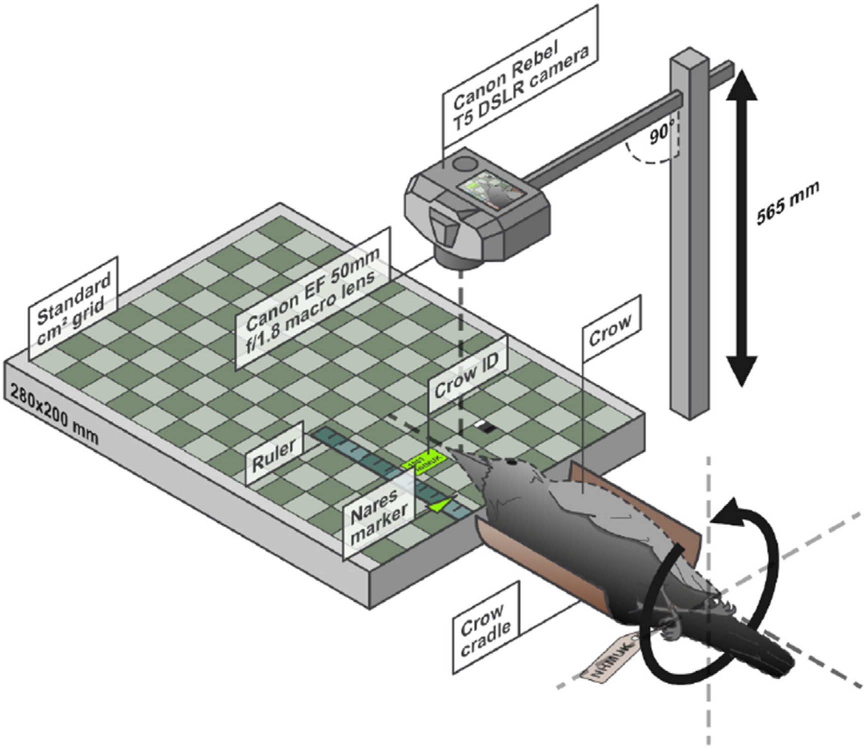

Fig. 2. Diagram illustrating set-up for photographing the crow specimens in a standardised way against a standardised background to calibrate digital measurements.

- **Hallux**: We determined which hallux was most visible and undamaged. We placed a white card below the hallux to make the shape clearly distinguishable from the background. Note that the hallux and tarsus could be from opposite sides.

For all subsequent photographs after the tarsus and hallux, specimens were placed in a “cradle” constructed from a cardboard tube cut in half lengthwise. We padded the cradle with tissue paper as needed to ensure the specimen’s security, stability, and positioning in relation to the reference grid.

- **Head Bottom**: The specimen was placed with the underside of the bill facing up and parallel to the reference grid, while ensuring the top of the bill was in contact with the reference grid. We used a spirit level placed on the underside of the bill to aid positioning.
- **Head Left**: We placed the specimen with its left side facing up and the base of the right side of the bill in contact with the reference grid. We positioned the bill so that the centre line of the top of the bill was parallel to the reference grid.
- **Head Top**: The specimen was positioned with the ventral side of the lower bill in contact with and parallel to the reference grid for “head top” photographs. To aid future digital measurements from this angle, we located the nares and placed a marker on the reference grid in line with the forward edge of the nares.
- **Head Right**: The specimen was positioned right side up, with the base of the left side of the bill in contact with the reference grid. We placed a marker denoting the forward edge of the nares, and a second indicating the start of the exposed culmen.

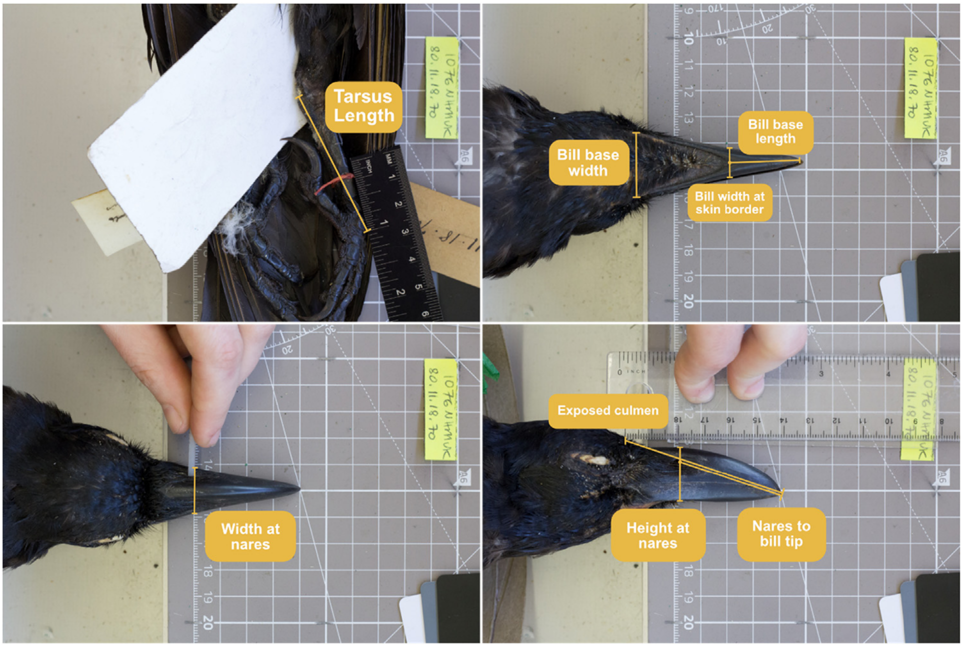

Fig. 3. Example images used for measuring, and the visualisation of all measurements taken from crow specimens.

Not all specimens were photographed from all angles due to damage or specimen fixing/posture. Where specimens could not be positioned aligning the area of interest parallel with the reference grid, we did not take photographs. This tended to be the result of specimen fixing that deviated from the standard straightened spine position (as depicted in Fig. 2). For all possible angles, we took as many photographs as required to feel confident that we had images suitable for measuring (i.e., checking images were correctly exposed and in focus). During this process we collected data pertaining to the order of specimens examined and photographs taken.

We converted images from the proprietary Canon format (.CR2) to TIFs, using Adobe Lightroom v.5.7.1 and preserved the accompanying EXIF data. TIFs have the advantage of being a more accessible uncompressed file format that is also readable by ImageJ. TIFs have been highlighted as the preferred format for archiving images [21]. During this process we renamed all images in the following convention: Subfolder, image number from the camera, and crow ID (e.g., C100_IMG_2345_0111.tif would be in subfolder CANON100, image number 2345, of crow number 111). This ensured all image names are unique and connected to the specimen.

Only adult specimens were used in this study. We took tag and “Full Photo” (see above) pictures for juvenile crows but did not measure them. Juveniles were identified by their grey chest feathers, short tails, and the presence of pink around the mouth. For each adult specimen, we opened all corresponding images in ImageJ [22]. Prior to taking measurements on each specimen, we calibrated ImageJ’s measurement tool using the reference grid (for bill measurements), or ruler (tarsus measurements). We calibrated to 100 m when using the reference grid, and 50 mm when using the ruler. For some tarsus calibrations, the full 50 mm was not visible; in these cases, the largest possible distance was used. We did not use the head left photographs for measurement unless we were unable to obtain the head right angle.

We took the following measurements (Fig. 3): Bill base width (BBW: width of lower bill at the base of the jaw uncovered by feathers), Bill width at skin border (SBW: width of lower bill at soft to hard tissue boundary, as parallel to reference grid as possible), Bill base length (BBL:

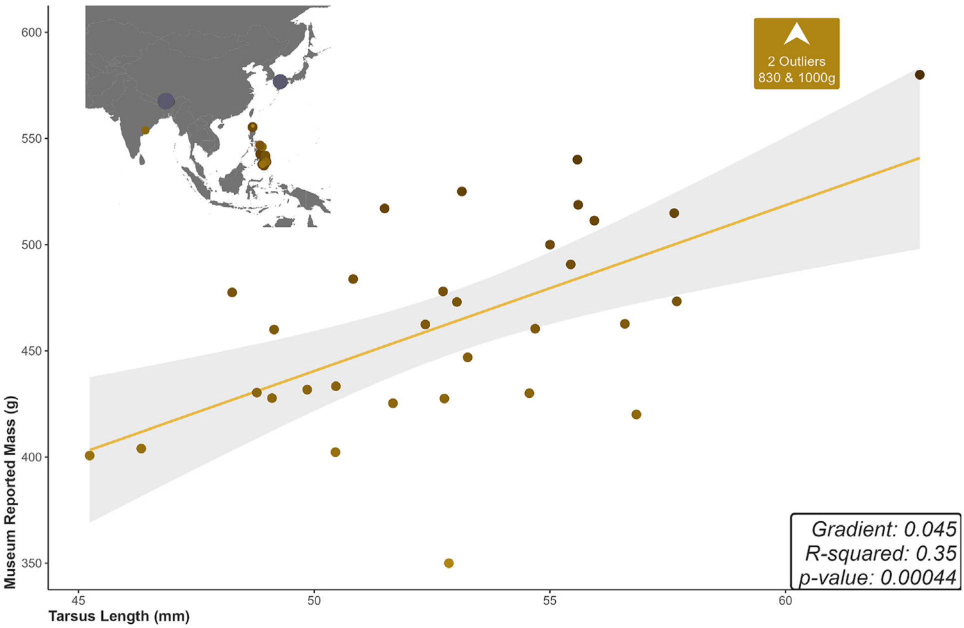

Fig. 4. Linear relationship between the museum-reported mass and the tarsus length measured from photographs, and their location. Two outlying specimens with a masses of 830 and 1000 g are not pictured in the relationship plot, but are highlighted with blue-grey colouration on the specimen map where larger darker dots are heavier specimens.

length of lower bill from skin transition to tip of the lower bill), Width at nares (WN: width of the top bill at nares), Height at nares (HN: top of upper bill to base of lower bill at the nares), Nares to bill tip (NtBT: forward edge of nares to upper bill tip), Exposed culmen (ExCu: edge of exposed culmen to tip of the upper bill), and Tarsus length (TaLe: inner bend of the tibiotarsal articulation to the lowermost full scale at the base of the foot). All measurements were recorded in mm. One person (ALA) collected all measurements for consistency. Not all specimens allowed for all photographs and measurements to be collected, but this was for less than 5% of the specimens in most cases. We obtained the following coverage: 95 % Bill base width, 95 % Bill width at skin border, 95 % Bill base length, 91 % Width at nares, 96 % Height at nares, 95 % Nares to bill tip, 95 % Exposed culmen, and 96 % Tarsus length.

The differing sizes of the specimens' bills meant that the reference grid could be a marginally different distance from the point of interest on the bill (e.g., nares); this variation could alter how the calibration grid relates to the measured area. The distortion would become a greater source of concern and warrant correction, if this method was adapted for larger species. In this dataset, the measurement most vulnerable to this distortion (i.e., furthest from the grid) was height at nares. With the set-up described, the field of view of the 50 mm lens would produce an approximately 1 % smaller measurement. This 1 % would be largely consistent across the dataset, as the variation in width at nares (i.e., a measure that would describe the distance between specimen and grid when positioned on the side) would only lean to <1 % variation in this 1 % underestimation. Tarsus length measurements are subject to the least underestimation, as the calibration ruler was photographed at the same distance from the lens (Fig. 3).

Limitations

Damage or specimen fixing/posture lead to suboptimal positioning of some specimens, this meant that some individuals could not have the full suite of measurements taken.

The locations of origin for specimens were largely dependent on the quality of locality data supplied alongside the specimen. The precision of the locality information could range from specific villages or latitude and longitudes to broader areas such as region or province. Every effort was made to cross-check more imprecise localities with expedition notes. However, expedition notes similarly ranged in detail. As such the reported latitudes and longitudes range in quality and may not be suitable for smaller-scale comparisons.

Further improvements to geolocating the specimens could be achieved via the use of tools like Geopick [23], that would provide greater clarity regarding the uncertainty surrounding the conversion of described localities to coordinates. We have retained the museum locality data alongside our suggested latitude and longitudes to aid future improvements and verification of specimen origins.

Some museum specimens ($n = 33$) were paired with records of body mass. However, the presence of mass measurements was inconsistent, and clustered in the Philippines (Fig. 4). In lieu of consistent mass data, tarsus length can serve as a proxy for mass [1]. We relied on tarsus length as a proxy for body mass. A linear regression on 31 specimens with mass data (2 specimens excluded due to outlying masses over 830 g) suggest a correlation in *Corvus macrorhynchos* ($\beta = 0.045$, R^2 of 0.35 m $p\text{-}value = 0.00044$; Fig. 4). Inclusion of the outliers does not alter the significance of the relationship.

Ethics Statement

The authors confirm that this work does not involve human subjects, animal experimentation, or social media data. The authors have read and followed the ethical requirements of Data in Brief.

All specimens were handled in accordance with the guidelines and guidance of the hosting institutions. All data collection was non-destructive and occurred on-site at the museums minimising transport and associated risks. We are ensuring that the outputs of the specimen examinations are available to the museums (measurement and photographs), and they are notified of any resulting scientific publications. All museum specimen identification numbers remain in the dataset to allow for connections back to the original sources/metadata, and due credit.

CRediT Author Statement

Aubrey Lynn Alamshah: Conceptualisation, Methodology, Investigation, Resources, Data Curation, Writing - Original Draft, Writing - Review & Editing, Visualization, Project administration, Funding acquisition. **Benjamin Michael Marshall:** Methodology, Investigation, Data Curation, Writing - Review & Editing, Visualization.

Data Availability

Distribution-wide morphometric data of Jungle Crows (Corvus macrorhynchos) (Original data) (Zenodo).

Acknowledgments

We thank Dr. Anne Clark for the immense amount of financial, logistical, and intellectual support she provided throughout the collection of this data, without which this would not have been possible.

We also thank Dr. Kevin McGowan, not only for access to the museum at the Cornell Lab of Ornithology but also for his advice and support throughout development and implementation of this project.

We thank the following museum curators for graciously allowing access to their collections and providing their expertise and logistical support: Augie Kramer at the American Museum of Natural History, Ben Marks at the Field Museum of Natural History, Christopher Milensky at the Smithsonian National Museum of Natural History, and Hein van Grouw at the Natural History Museum at Tring.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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