

# Notes on Darwin's Finch Morphology Data

## About the Database

The "DFMorph" (Darwin's Finch Morphology) database contains data, mostly morphological (e.g., beak dimensions), on individual Darwin's finches. The data are from a number of published and unpublished sources.

Additional information includes the publication, source of the specimen, the original specific or subspecific name assigned by the author(s), museum location and catalog number, and other information of historical importance. In particular, Sulloway's (1982) measurements of existing Beagle specimens have been included.

This version contains data from four sources. The first three were in BIRDD version 1, the last is new with version 2.

- +The largest published collection of measurements, taken from Snodgrass & Heller's important early work (1904).
- +Sulloway's historically significant examination of the history of all surviving finch specimens collected by members of the *Beagle* expedition (1982).
- +Measurements published in Swarth's (1931) monograph.
- +Over 6,500 specimens that David Lack measured for his 1945 monograph and 1947 book. Lack deposited copies of his measurements in the British Museum (Natural History) and the California Academy of Sciences (CAS); we optioned copies of the latter from the CAS Archives. These more extensive data provide many opportunities for students to explore variation among individual finches and island populations, and to try to understand how taxonomists separate specimens into species and subspecies.

There is considerable overlap among these subsets of data. Some specimens, such as those of the *Beagle* expedition, may appear in all of them. The *Dataset Choice* field on the Table of Contents allows you to determine which set of data to examine and export.

## Bibliography

- Lack, D.L. (1945). "The Galápagos finches (Geospizinae): a study in variation." *Occasional Papers of the California Academy of Sciences* **21**: 1-159.
- Lack, D.L. (1947). *Darwin's Finches: an essay on the general biological theory of evolution*. Cambridge, England, Cambridge University Press.
- Lack, D.L. (1969). "Subspecies and sympatry in Darwin's Finches." *Evolution* **23**: 252-263.
- Snodgrass, R. E. and E. Heller (1904). "Papers from the Hopkins-Stanford Galapagos Expedition, 1898-99 XVI. Birds." *Proc. Wash. Acad. Sci.* **5**: 231-372.
- Sulloway, F. J. (1982). "The Beagle collections of Darwin's Finches (Geospizinae)." *Bulletin of the British Museum (Natural History), Zoology series* **43**: 49-94.
- Swarth, H. S. (1931). "The avifauna of the Galapagos Islands." *Occ. Pap. Calif. Acad. Sci* **18**: 5-299.



# Notes on Darwin's Finch Morphology Data

## Notes About the Data

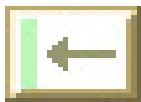
### Taxon Names and IDs

The initial confusion and debate over the classification of Darwin's finches settled down in 1931 with Swarth's monograph. Lack made relatively minor changes (1945, 1947, 1969) and with some exceptions, that is the system used by most modern workers. We have elected to use Lack's 1969 classification as our standard. Lack's names for genus and species names plus subspecies if appropriate are the "modern" taxa and are listed with ".L69" at the end of the field name. In addition, wherever possible we have also recorded the original author's name. See references and notes in the *Species* database for more details.

Some of the taxonomic names are lengthy, so we also have a more compact *Species.ID* as well as a *Subspecies.ID* where necessary. The *Species.ID* is made up of the first 3 letters of Lack's genus, a period, and the first 3 letters of Lack's species name. For subspecies, a period and the first 3 letters of Lack's subspecies name are added.

For example, the specimens of sharp beaked ground finches on Darwin/Culpepper have the following values:

<b>Field Name</b>	<b>Example Taxon</b>
Taxon.Original:	<i>Geospiza septentrionalis</i>
Taxon.L69:	<i>Geospiza difficilis septentrionalis</i>
Genus.L69	<i>Geospiza</i>
Species.L69	<i>difficilis</i>
Subspecies.L69	<i>septentrionalis</i>
Species.ID	<i>Geo.dif</i>
Subspecies.ID	<i>Geo.dif.sep</i>



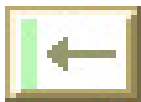
# Notes on Darwin's Finch Morphology Data

## Notes on Data Fields

The terms "beak" and "bill" are used interchangeably.

Here are notes on commonly used data and measurements. Specific definitions and procedures for that source's data are described later. Click on the *Measurement Diagrams* button on the Table of Contents to see pictures summarizing the various measurements.

Attribute	Database Field and Notes
Sex	<b>Sex</b> We coded as M, F or U for unknown; a few marked with "?" in originals were coded as the indicated with the appropriate letter plus "u" for "uncertain", i.e., <i>Mu</i> and <i>Fu</i> .
Age	<b>Age</b> Several authors coded Adult and Juvenile and we had previously accepted their designation. However, most of those assignments were based on plumage and the assumption that for, <i>Geospiza</i> at least, black males were adult and "streaked" or "partially black" males were juvenile. This is now known to be incorrect, so we no longer export age information.
Plumage	<b>Plumage</b> Some authors designated Age as "black" or "streaked"; we put these designations into Plumage.
Wing	<b>Wing.Length</b>
Tail	<b>Tail.Length</b>
Culmen	<b>Upper.Beak.Length</b> "Culmen" is the technical term; we use a more easily understood, if longer, term. Note that Lack measured culmen from beak tip "to where it joins the skull", while Swarth measured "exposed culmen" beyond feathers.  Both of the above differ from "Nostril-to-Maxilla" (Snodgrass & Heller), "Culmen from Nostril" (Lack) and "Lip of nostril to tip of beak" (Sulloway). To avoid confusion, these latter are code in the <b>Nostril-Upper.Beak.Length</b> field.
Gonys	<b>Lower.Beak.Length</b> Again, a technical term made more easily understood. The lower beak typically is shaped like a "Y"; the measurement is usually from the fork of the Y (throat) to the bottom (tip of beak).
Basal Width of Bill	<b>Beak.Width</b>
Basal Depth of Bill	<b>Beak.Height</b> "Depth" may be interpreted as front-to-back length, so we use "height".
Tarsus	<b>Tarsus.Length</b> Length of "leg". Actually, the majority of a bird's leg is a single bone, the tibiotarsus, that extends from the "ankle" joint to the toes, or phalanges.



## Notes on Darwin's Finch Morphology Data

- + Sources used a variety of English island names; we display island names in our "Common / English" format.
- + All measurements are in millimeters.
- + There are a number of duplicate museum catalog numbers within the Snodgrass & Heller data, and between the S&H, Sulloway and Swarth data. The measurements of these birds typically differ because of inherent variability in the way measurements are made (e.g., how much pressure is applied to a wing), as well as to differences in definitions of measurement (e.g., whether culmen is defined as from tip to feathers or from tip to skull). We have tried to note duplicates in the *Notes* field for each bird, but left the data as in the original tables.

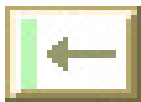
### Museum Abbreviations

- + Museum abbreviations (mostly used by sources):

BM(NH):	British Museum (Natural History)
Brit Mus:	British Museum
UMZC:	University Museum of Zoology, Cambridge
LRNH:	Leiden Rijksmuseum van Natuurlijke Historie
Stanf. Univ. Mus.	Stanford University Museum
Calif Acad Sci	California Academy of Sciences
U S Nat Mus	United States National Museum
W Johnson	private collection of Captain W. Johnson, of San Francisco

### Snodgrass & Heller (549 specimens)

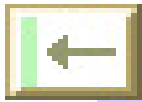
- + Snodgrass & Heller used the following approach to designating subspecies: "Trinomials are applied according to A. O. U. canons of nomenclature, i.e., when forms overlap in their variations, regardless of the possibility or impossibility of their interbreeding, they are called subspecies." (p. 234)
- + All measurements are in millimeters. (p. 235)
- + "Measurements of length are in all cases of the specimen before being skinned." (p. 235) These measurements must thus have been made in the field and recorded in catalogs or on specimen catalogs. All other sources made measurements on dried specimens.



## Notes on Darwin's Finch Morphology Data

### Swarth (75 specimens)

- + Swarth made all measurements himself, but did not repeat each measurement. He noted that "extremes were gone over several times."
- + **Age:** Originally coded as "black" and "streaked". We originally followed Swarth usage and coded "Adult" for black and "Juv" for streaked. We have left the data in the database, but no longer export age data (see "Age" in the table above).
- + **Date:** We recoded collection date from Mon. Day, Year format to mm/dd/year.
- + **Wing Length:** measured as the "straight line from bend of closed wing to tip of longest primary, with those feathers in their natural position (not straightened)." (p. 9) This may differ from Sulloway's and Lack's "flattened" measurement.
- + **Tail Length:** measured from "point of insertion of middle rectrices to tip of the longest." (p. 9)
- + **Culmen (Upper Beak Length):** Measured in a straight line from a point where the feathers cease to hide the culmen, to tip of maxilla; the chord of the exposed culmen." (p. 9)
- + **Depth of Bill at Base (Beak Height):** measured from the "base of culmen to angle formed by feathers at lower edge of ramus of mandible." (p. 9)
- + **Width of Mandible (Beak Width):** measured at "base of lower mandible." (p. 9)
- + **Tarsus (Tarsus Length):** measured as a "straight line from center of heel joint on posterior side to joint between metatarsus and middle toe on anterior side." (p. 9)
- + **Middle toe with claw (Middle Toe Length):** measured "along upper side, from joint between metatarsus and middle toe to tip of claw." (p. 9)
  
- + Swarth measured a small number of "the type series of *Geospiza magnirostris* in the British Museum" and these data are included. There has been considerable confusion over the exact collection locality of Darwin's and other Beagle specimens (Sulloway, 1982), so those designations are enclosed in quotes and they should not be taken at face value. See Sulloway's records for the best data on the Beagle collections.
- + Swarth provided a number of profiles of individual specimens, mostly natural size. These have been scanned and included in the data on each finch.



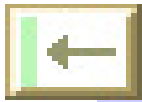
## Notes on Darwin's Finch Morphology Data

### Sulloway (51 specimens)

Sulloway has studied Darwin's Galápagos collections and manuscripts and clarified many of the confusing points that confounded previous workers. In particular, Darwin neglected to record the localities where he collected his finches. Sulloway tracked down and measured all of the existing Beagle specimens and his (1982) paper is the best source of data on the Beagle finch collections.

Sulloway tried as much as possible to use Lack's (1945) methodology in taking measurements:

- + Beak (bill) measurements were made with calipers accurate to better than 0.1 mm (less than typical range of error in making repeated measurements).
- + Each beak measurement was taken six times on the specimen's right side; the high and low were discarded and the remaining four were averaged.
- + **Culmen (Nostril-Upper Beak Length):** measured from superficial anterior lip of nostril to tip of bill.
- + **Depth of Bill:** measured from greatest height from base of bottom mandible to top of upper mandible before the curved culmen begins to descend (i.e., not where mandible meets skull). This may be different from those of other authors who were less specific about their procedures.
- + **Wing Length:** measurements were taken from both wings, when present, using a millimeter rule; the flattened wing was measured from carpal joint to tip of longest primary, to the nearest 0.5 mm. We report only the measurement of the right wing, unless that wing was missing, in which case we report the left wing.
- + Sulloway's table reports both the island on the specimen's label and his best determination from other sources (e.g., field notes, museum catalogues and specimen measurements). We report his best guess in the Island field and his full report in the record's Note field. Sulloway presented the label's locality first followed by a colon. Where an island name alone follows the colon, Sulloway determined locality on the basis of manuscript evidence. Where the colon is followed by "*island* form of subspecies", the locality was estimated based on "the specimen's measurements and plumage, which coincide with only one possible island form, given the various islands known to have been visited by the collector.



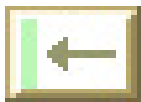
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### Lack (6,758 specimens)

David Lack's monograph (1945) and book (1947) have had an enormous impact on evolutionary research and his illustrations have become icons in textbooks. The data in BIRDD are from a copy of his measurements deposited in the archives of the California Academy of Science.

Here are salient points on Lack's methodology (1945):

- + Lack specifically tried to exclude specimens that had just left the nest, although he notes that it was impossible to determine whether they were sexually mature.
- + Lack doesn't state whether he took multiple measurements and averaged them, as Sulloway did. It's clear however that he tried to assess the reliability of his measurements (see notes below for the Culmen).
- + Beak measurements were made with dial calipers to nearest 0.1 mm.
- + **Culmen (Upper Beak Length):** measured from the tip of the bill to the place where the culmen joins the skull. This differed from Swarth's approach and with several species Lack "was unable to estimate accurately the exact place where the culmen ended on the skull ... measurements of the same specimens taken a month or two later sometimes gave different results." (1945, p. 75). Unfortunately, Lack appears to have decided to stop collecting, or tabulating, this measurement. This reduces the comparability of his data with those of earlier workers.
- + **Culmen-From-Nostril:** The distance from the anterior edge of the nostril to the tip of the upper beak. This is the measurement that Lack (and Sulloway) decided to use in place of Swarth's exposed culmen. In his published work Lack typically used "culmen" to refer to this measurement.
- + **Bill Depth (Bill Height):** measured at the base, with the bill closed. Some specimens had been stuffed with the bill slightly open and these were not measured.
- + **Wing Length:** measured from the carpal joint to the end of the longest primary in the flattened wing; measured with a millimeter rule to the nearest 1 mm. Note that Lack (and Sulloway) flattened the wing, while Swarth measured the "wing in natural position."



# Notes on Darwin's Finch Morphology Data

## Exported Data

The export script and button produce a tab-delimited text file with the following column headings:

Field/Column Heading	Comment
Source	Source of data
IslandID	Short name of island
TaxonOrig	Name of taxon assigned by author
SpeciesID	Short species name (Gen.spec)
SubspID	Short subspecies name (Gen.spec.subs)
Sex	Sex of specimen
Plumage	Plumage state
BodyL	}
WingL	}
TailL	}
BeakW	}
BeakH	} measurements described in Notes About the Data
LBeakL	}
UBeakL	}
N-UBkL	}
TarsusL	}
MToeL	}

Age is no longer exported (see *Notes on Data Fields* above).

To avoid duplicate records in exported data, the All dataset cannot be exported. If the Export button is clicked when All is selected, BIRDD provides an error message.

## Miscellaneous Notes

### Version History

#### Version 2.0

- + Lack's data stored at the California Academy of Sciences were added to the database.
- + Minor changes and corrections were to many layouts.
- + Added new statistical summaries.
- + Added buttons and scripts to list data sets and original taxa.
- + Changed most buttons and scripts to display the data from only one dataset.
- + Moved Sulloway Upper Beak data to the correct Nostril-Culmen field instead of the incorrect Culmen field.
- + Modified list of exported data and rearranged columns; removed Age; modified to export data from only one dataset at a time.
- + Added diagram of measurements

#### Version 1.1

- + Font and layout changes as covered in notes to Main file
- + All images converted and reimported to work on Windows computers





# Measurements Used by Sources

