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# BIRD SPECIMENS AND DOCUMENTATION: CRITICAL DATA FOR A CRITICAL RESOURCE[1]

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*Abstract.* As governments impose increasingly stringent regulations on the collection of bird specimens and as man alters ever greater areas of habitat with the loss of many of their contained species, museum specimens increase immeasurably in importance. Yet at present, museum collections do not contain an adequate representation of the world's avifauna and, unfortunately, are not likely to do so. Thus, it is imperative that data associated with specimens that are obtained be as complete as possible. To this end, we describe categories of information with wide application to many types of studies, outline character states, and recommend standard forms of data notation. We recognize that under certain circumstances, it may be appropriate to record more limited data. However, we encourage at least those engaged in general collecting to record as many of these standard data as possible.

*Key words: Museum specimens; data labels; scientific collecting.*

## INTRODUCTION

One of today's most pressing environmental problems is the extensive destruction, degradation, or alteration of natural habitats and the loss of plant and animal species that they contain (Myers 1980, Diamond and Lovejoy 1985, Wilson and Peter 1988). At the same time, regulations governing scientific work are restrictive in many countries, and permits to collect specimens are increasingly difficult to obtain. As a result, museum specimens continue to increase in scientific value not only as vouchers delimiting past and present ranges of species and identifying areas of high species diversity for protection, but also as the basis for entire fields of scientific endeavour. As scientists continue to develop new techniques using museum materials (e.g., Higuchi et al. 1984, Houde and Braun 1988), these specimens will assume even greater importance.

Current museum collections do not adequately sample the earth's avifauna (e.g., Jenkinson and Wood 1985). Cannell et al. (1988) addressed some ways in which the value of specimens might be maximized. Here we address the equally important topic of the types of data that should be associated with individual specimens, and their manner of notation. We stress that data must be clearly written (or printed) and as complete as possible. Specimens and their data serve as permanent records of a limited, often dwindling, resource. Recorded data must remain clear through time and must be understandable to workers in other countries and scientific disciplines. Because the amount of data recorded may influence the number of specimens that can be collected, some balance must be struck between the quality and quantity of information noted. We recognize that some collecting efforts, di-

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rected toward specific projects, are, by necessity, specialized and must emphasize large numbers of specimens with restricted data. In other instances, however, the inclusion of high-quality data with a specimen makes it so much more useful that it compensates for any decline in numbers of specimens collected.

For general collecting, we describe below categories of information with wide application in many types of studies, and outline character states suitable for most species. We also recommend standard forms of notation. Although others have addressed this issue, previous publications (e.g., McCabe 1943, Van Tyne 1952, Harrison and Cowles 1970, Pettingill 1970) are scattered, deal with only one or a few types of data, do not address the methods of recording data, or do not reflect recent advances in our knowledge.

## FIELD NOTEBOOKS

Data associated with a specimen may be preserved in different ways. In this paper we focus on types of data that we believe should be noted on a label attached to the specimen (or appropriately associated with it, as in the case of fluid preserved materials or skeletons). This information should also be recorded in a field notebook along with classes of data that pertain to whole blocks of specimens or that are too detailed to note on a label (see below, and Remsen 1977). Original field notebooks or copies ultimately should be deposited in the museum where the specimens are housed to provide a permanent source of supplementary information.

## ABBREVIATION AND NOTATION

Collectors often abbreviate the data they record on labels because space is limited. This is understandable, but use of abbreviations does increase the risk of confusion and misinterpretation by subsequent users of the specimens. We recommend that abbreviations be avoided or that only standardized abbreviations (see Appendix II) be employed. When abbreviations are used, they always should be explained in the field notebook, even if they follow accepted standards. Although many names are available and appropriate for different body parts and conditions (e.g., skull, cranium, occiput), use of common terms will decrease the likelihood of confusion and will facilitate coding of data for entry into computer data bases.

## DATA

### COLLECTOR'S NAME AND SPECIMEN FIELD NUMBER

Each specimen should be assigned a unique field number with which supplementary data in the field notebook can be associated. We recommend use of consecutive lifetime numbers (e.g., M. S. Foster 2677) in preference to those based on particular collecting trips (e.g., F. Eleanor-127-Cyprus-1985), because computerized museum catalogues and certain sort algorithms often have limited numbers of characters per field. If the collector and preparator are different individuals, the names of both should be noted.

### SPECIES IDENTIFICATION

Species identification should be determined to the extent possible in the field and noted on the specimen label in pencil. This is imperative for specimens prepared as skeletons; in fact, we recommend retention of the skin (or at least the primaries and rectrices) until the identification can be verified.

### LOCALITY

The data recorded should allow anyone to locate the precise collecting site on a map or in the field. We recommend that collectors include direction and distance by road from a standard map location. Coordinates of longitude and latitude, and elevation should also be noted along with country, state (province/department), county, city, etc.

### DATE AND TIME OF DAY

Names of months should be written in full or noted in Roman numerals rather than with a three-letter abbreviation. Year should be indicated with a four-digit number. Although time of collection is not essential, it can be useful for interpreting diet or behavioral observations, weight, and fat condition, which tend to vary with time of day. Times should be noted with a 24-hr clock (e.g., 05:00, 17:00).

### WEIGHT AND WING LENGTH

Weight and wing length are primary indicators of size and may also serve as indices to body condition and migratory status. With the advent of the small, relatively inexpensive, and readily available spring balance, recording of weights has become more practical. We recommend that birds be weighed as close to the time of collection as

TABLE 1. System for the designation of fat classes as adapted from Helms and Drury (1960) and Manomet Bird Observatory *Fat codes for banders* (1989, in litt.).

| Fat class | Visible fat | |
|---|---|---|
| | Interclavicular region | Abdomen |
| None | None or slight | None |
| Trace | Fat present; region deeply concave, clavicles visible | Trace |
| Light | Filling, but still concave; some covering of clavicles | Some fat between intestinal folds, and/or in small patches |
| Moderate | Filled; fat level with breast muscles; clavicles covered | Pad covering abdomen not obviously mounded |
| Heavy | Filled; fat over interclavicles and anterior pectoral muscles | Pad mounded, becoming distended |
| Very heavy | Convex pad extending over the length of the furculum, may meet layer of abdominal fat | Pad greatly distended |

possible. Collectors should note factors that may significantly influence weight (e.g., full stomach, excessive fat). Some individuals make a practice of recording weights of stomach and crop contents in addition to total body weight. Scales graduated in 0.2-g increments are optimal for birds weighing less than 10 g, in 0.5-g increments for birds from 10 to 50 g, in 2-g increments for birds from 51 to 300 g, and in 10-g increments for those between 300 and 1,000 g. Types of scales used should be recorded in the field notebook.

Wing length is especially useful to record for specimens to be prepared as skeletons. Collectors should note the method of measurement (chord, flattened wing) on the label.

## SOFT PART COLORS

The colors of the irides, bill, mouth lining, feet (including soles and claws, if different), tarsi, and other bare skin (cere, orbital or other facial skin, gular pouches, etc.) should be recorded as soon after collection as possible, since colors fade and disappear rapidly. If a particular color standard is used (e.g., Ridgway 1912; Munsell 1929–1942; Smithe 1974, 1975, 1981), it should be identified in the field notes.

## AGE

Data that indicate age or, at least, broad age categories are important. Various publications (e.g., Pyle et al. 1987; Dept. Interior, U.S. Fish and Wildlife Service and Dept. Fisheries and Environment, Canadian Fish and Wildlife Service 1980) describe a variety of techniques useful in this regard.

*Skull pneumatization.* The degree of skull pneumatization can serve as an indication of age for most passerines (see Dept. Interior, U.S. Fish and Wildlife Service and Dept. Fisheries and Environment, Canadian Fish and Wildlife Service 1980, for information regarding North American species). A standard recording method generally applicable to any species is an indication of the degree of pneumatization in 10 to 25% increments, often with a notation or sketch of the general size and location of skull windows. Because skull pneumatization proceeds at different rates in different species and is not necessarily indicative of reproductive maturity or plumage stage, we recommend against the designations "juvenal," "immature," or "adult" to denote skull condition.

*Plumage.* Presence of downy or juvenal plumage should be noted if recognizable, particularly if the specimen is skeletonized or fluid preserved. Notation of the number and location of down feathers can also be useful.

*Bursa of Fabricius.* The cloacal bursa is a pouch-like structure lying above and opening into the dorsal wall of the caudal portion of the cloaca (proctodeum). The bursa reaches maximum size when a bird is 4 to 6 months old and then gradually disappears, so its absence or presence and size can be used as an indication of age in some species (Davis 1947 and references therein). The structure (or usually the opening) is most easily observed in large birds (Pettingill 1970). We recommend that status be recorded only by those experienced in identifying the structure.

## FAT CONDITION

The deposition and loss of fat, long known for temperate migrant species, is probably charac-

teristic of many tropical forms as well (Foster, unpubl.) and should be noted for all specimens. As McCabe (1943) observed, however, precise measures of fat, comparable among different species, are difficult to define. In Table 1 we provide categories of fat notation adapted from systems developed by Helms and Drury (1960, p. 13) and by the Manomet Bird Observatory (1989, in litt.) for use by banders. Whatever system is used should be noted or described in the field notebook.

## SEX AND REPRODUCTIVE CONDITION

The sex of the bird should be determined by examination of the gonads. If the gonads are not located but the species has sexually dimorphic characters, sex should be enclosed in brackets and the determining character indicated (e.g., "[♀] by plumage"). Such notations are especially important in specimens prepared as skeletons. Measurements should be recorded in millimeters. We recommend using measurements rather than drawings. Drawings are rarely precise, and measurement of the illustration by another provides additional opportunity for error.

Several authors discuss features of the reproductive organs and their cyclic changes in detail (e.g., McCabe 1943, Lofts and Murton 1973, Gilbert 1979, King 1981, Lake 1981).

Pertinent data for females include:

*Ova.* Diameter of largest one or several ovarian follicles: these increase significantly in size in the few days prior to ovulation and egg laying. Color: white, yellow, orange, as an index to yolk deposition. Occasionally one collects a specimen with a shelled egg in the oviduct. Length, width, and weight should be recorded along with background color and markings on the shell.

*Ovary.* Size: length × width. Surface texture: smooth, granular, or lumpy. Ovaries of some species remain tiny and completely smooth until the female first reproduces. Between subsequent reproductive periods, the ovary generally is granular or lumpy, and though it may decrease in size, never reaches the tiny undeveloped state of the immature bird. Ruptured, collapsed follicles: number present, if any. Some expertise is required to recognize these structures, which indicate recent ovulation; they are described and pictured in Lofts and Murton (1973) and Gilbert (1979).

*Oviduct.* Greatly hypertrophied, or not. When a female is laying, and for a few weeks before and after, the oviduct is greatly enlarged.

*Brood or incubation patch.* Absence or presence (and condition). Brood patches may be found in males and/or females depending on the species. Timing of appearance before and persistence after egg laying also vary by species. Thus, descriptions of degree of development, though not essential, are often useful for denoting stage in the breeding cycle. Bailey (1952) described four stages of brood patch development in the area of the ventral apterium. Defeathered: loss of down. Vascularized: blood vessels of the dermis increase in size and number. Edematous and hyperplasic epidermis: the area is thickened and may be soft and puffy. Recovered: vascularity and edema subside; the skin is often wrinkled and scaly.

Pertinent data for males include:

*Testis.* Size: length × width of the left testis, or both when they differ noticeably. With both measurements, testicular volume can be calculated, which allows for more meaningful size comparisons since testis shape may vary. Some collectors sketch irregularly shaped testes. Color: if other than white or cream colored, e.g., black, dark green, gray. Melanin in the interstitial tissue generally becomes inconspicuous as the germinal epithelium proliferates and the seminiferous tubules expand, paralleling the increase in testis activity. Vascularization: present or absent.

*Cloacal protuberance.* Present or absent, size (inconspicuous, moderate, large). This protrusion, seasonally present in the area surrounding the cloacal opening, is formed by cloacal and other adjacent tissues, as well as by the proliferation of the seminal glomera (Salt 1954, Quay 1986). These glomera, much coiled and sperm laden ends of the vasa deferentia, also produce nutritive fluids for sperm transmission. Development of the protruberance varies by species and individual but is usually indicative of reproductive activity when it is present. However, males lacking a protuberance also may have large numbers of normal sperm in the cloaca (Quay 1986). The shape of the external protrusion may vary by species (see illustrations in Salt 1954); females also may exhibit external cloacal swelling, although it usually is less pronounced.

## STOMACH AND CROP CONTENTS

Data of this type can be infinitely detailed. However, most bird collectors are not trained in entomology or botany and must settle for less than specific identification of the items consumed.

Stomach and crop contents can, however, be described as fruit pulp, seeds, vegetable material, insect parts, vertebrate remains, or unidentifiable. Whenever possible, more precise designations should be given (e.g., plant family, insect order, seed size) even if only in "generic" terms (e.g., caterpillar, grass seed, mouse). If the bird species collected is especially rare, we encourage collectors to preserve stomach contents in 70% ethanol for examination by experts.

### MOLT

Recording molt condition can be time-consuming, and most workers who study molt prefer to take their own data. Nevertheless, there is an obvious need for such data for specimens prepared only as skeletons. Indeed, we urge that all birds undergoing flight feather molt be prepared as skins. Notation of certain minimal data is important even for study skins and fluid specimens to minimize the extent of handling by subsequent workers and to describe areas inaccessible in dried skins (e.g., under wing coverts). In addition, growing feathers are frequently lost during specimen preparation.

Only symmetrical molt should be noted and should refer to missing feathers and those with sheaths. Minimally, remex and rectrix molt should be noted by feather number, and body molt as present or absent. Information on lengths of growing feathers (e.g., pin, in 25% intervals of full growth) or molt completed, or the designation of body areas with molt are useful. This is particularly true for areas expected to renew more frequently than the rest of the plumage or at special seasons (e.g., crown patches, tail plumes). Such information is normally noted in the field notebook. For specimens examined in detail, it is useful to note the absence of molt.

### SPECIMEN TREATMENT

Collectors frequently prepare and store parts of a specimen separately (e.g., skin, skeleton, stomach contents, frozen tissues). These parts and associated materials (e.g., nest, eggs, parasites) should all carry the same collector's field number and should be cross-referenced on the label and in the field catalogue.

The manner in which specimens are handled initially is also important since this can determine how they are treated in subsequent studies. Collectors should note if specimens were frozen before preparation, if fluid specimens were fixed in formalin, if the formalin was buffered, if arsenic was used on skins, and so on (see Cannell et al. 1988). Generally, such treatment history can be recorded for blocks of specimens in the field notebook.

### HABITAT

Since locality notations often refer to collecting areas that cover several square kilometers, a brief designation of specific habitat (e.g., rainforest canopy, bamboo thicket, cattail marsh) on specimen labels is useful. If detailed habitat descriptions are made, they should be included in the field notebook, along with reference to any botanists in the field party, who may provide more extensive habitat information.

### PARASITES

Even "generic" descriptions, with the location of the parasite, can prove useful (e.g., "worms" in stomach, lice on head). More precise designations should be given, if possible. If the host species is especially rare, we encourage collectors to preserve parasites in 70% ethanol for examination by experts. Instructions for the collection of parasites can be found in Watson and Amerson (undated). If external parasites are noted, it is imperative that there have been no opportunity for transfers among hosts between collection and preparation of specimens.

### BEHAVIOR AND ECOLOGY

Such data are usually recorded in the field notebook. They provide useful additions to information on reproductive condition (male singing, territorial encounter, courtship display, feeding young, etc.) or diet (foliage gleaning, probing mud, etc.). In all instances, behavioral observations recorded in the field notebook should be tied to particular birds by specimen field number. Notation of individual associations (e.g., mates, parent-offspring) by specimen numbers is particularly useful.

### MISCELLANEOUS

Plumage abnormalities (e.g., albinism, melanism), or deformities of bill, feet, or other structure. Any other relevant observation.

## DISCUSSION

We have outlined what we believe to be the standard data for specimens. For reference, we have summarized data categories and recommended abbreviations in brief checklists that can be photocopied and carried into the field (Appendices

I and II, Table 1). Sometimes space on the specimen label may be insufficient to accommodate the extensive data outlined here. If so, then more than one label should be affixed. On the other hand, it may be appropriate to increase the size of the label used. Although there are limits to the size and weight of tags that can be supported by skins of some small species (e.g., hummingbirds), most could easily carry labels up to 50% larger than those generally used by the ornithological community. Recording all pertinent data on a tag(s) affixed to the specimen minimizes the likelihood that important data recorded elsewhere will be lost and facilitates its availability to those using the specimens.

Although we argue strongly for the inclusion of the data outlined above, we do recognize that under some circumstances recording more limited data may be appropriate. For example, the training in avian anatomy and morphology of those collecting birds as vouchers for other types of work (e.g., anthropological studies, environmental assessments, etc.) may be limited. In these instances, we recommend that the collector record his/her name and field number, the locality, date, and time of day, bird weight and soft part colors, and then that the specimen be preserved as soon as possible in 10% buffered formalin. Internal characteristics are thus maintained and can be determined by more experienced individuals at a later date.

We hope that those involved in general collecting and those for whom large samples are not mandatory will direct their efforts toward recording as many of the standard data as possible for each specimen. Specimens accompanied by data sufficiently brief to limit their usefulness in a wide range of contexts are a luxury that the scientific community can no longer afford.

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APPENDIX I. Checklist of standard data for scientific specimens.

*Collector's (and preparator's, if different) name and specimen field number*
*Species identification:* critical for skeletal preparations
*Locality:* location, latitude, longitude, and elevation
*Date:* day, month (written), year (four-digit number)
*Time of day:* 24-hour clock
*Weight:* grams
*Soft part colors:* irides, bill, mouth lining, feet, tarsi, and all bare skin
*Age:* skull pneumatization (passerines)
  plumage—if recognizably downy or juvenal
  bursa of Fabricius—present or absent (use caution)
*Fat condition:* fat class (none, trace, light, moderate, heavy, very heavy)
*Sex and reproductive condition:*
  ova—diameter of largest, or largest several ovarian follicles
    —color: white, yellow, orange
    —oviducal egg: length, width, weight, background color, and shell markings
  ovary—size: length × width
    —surface texture: smooth, granular, or lumpy
    —ruptured, collapsed follicles: number present, if any
  oviduct—greatly hypertrophied, or not
  brood patch—absent or present: defeathered, vascularized, edamatous and hyperplasic, recovered
  testis—size: length × width of the left (or both if noticeably different)
    —color: if other than white or cream colored
    —vascularization: present or absent
  cloacal protuberance—absent or present, size (inconspicuous, moderate, large)
*Stomach and crop contents:* identification
*Molt:* symmetric absence or replacement of feathers
  primaries, secondaries, and rectrices—absence or percentage regrowth by feather number
  body—present or absent; area
*Specimen treatment:* cross-reference of specimen parts and associated materials
  treatment history—methods of specimen preparation
*Habitat:* designations on specimen labels, with descriptions in field notes
*Parasites:* type and location
*Behavior and ecology:* descriptions
*Miscellaneous:* abnormalities, deformities, other relevant observations

APPENDIX II. Recommended standard abbreviations.

| | |
|---|---|
| ad | adult |
| BF | bursa of Fabricius |
| BP | brood patch |
| CP | cloacal protuberance |
| enlrg | enlarged |
| g or gm | gram |
| h or hrs | hours |
| juv | juvenal |
| lrg | large |
| lrg ov | largest ovarian follicle(s) |
| mm | millimeter |
| oss | pneumatized |
| sk | skull |
| sm | small |
| tes | testis |
| wg len | wing length |
| wt | weight |