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Herbarium Practices and Ethics, III

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Abstract—The Systematics Collections Committee of the American Society of Plant Taxonomists has updated the recommendations on herbarium practices and ethics that were previously published by the Society in 1958 and 1973. The recommendations and considerations presented here are intended to provide a set of guidelines for proper management and care of herbarium collections.

Keywords—Best practices, collections management, ethics, herbarium, natural history collections.

The first report on desirable procedures in herbarium practices and ethics, under the auspices of the American Society of Plant Taxonomists (ASPT), was published in 1958 (Kobuski et al. 1958). That report, as well as a revised version in 1973 (Nevling 1973), was well received by and proved useful to curators, collections staff, and herbarium users alike. Because the number of practicing taxonomists has declined, it is more likely that non-systematists may find themselves in charge of a collection, and since many new methods and challenges have arisen since 1973, the ASPT Systematics Collections Committee has prepared this updated document. This report follows the basic outline of the previous reports and is concerned primarily with the updating of several sections and adding commentary on basic herbarium operation and destructive sampling. While this is primarily aimed at curation of herbaria in the United States, we believe that basic information on the curation of an herbarium will apply, and be of interest, to international readers as well. Besides the content provided here, we encourage herbarium staff to keep up with current developments by joining the Herbaria Listserv (herbaria@nacse.org) and participating in organizations such as the Society of Herbarium Curators (SHC) and the Society for the Preservation of Natural History Collections (SPNHC) to take advantage of community input and involvement. The ASPT Systematics Collections Committee also hosts a Curators' Meeting during the annual Botany conference.

As the botanical equivalent to natural history museums, herbaria are archives of plant biodiversity through space and time. Although their most fundamental role is to provide taxonomic and nomenclatural documentation for systematic botany, herbarium specimens are increasingly used outside of systematics (see Soltis 2017). Institutions holding these collections, and their curators, are responsible for (i) ensuring the preservation and protection of specimens in perpetuity, (ii) making specimens and their data available for study, both physically and digitally, and (iii) fostering collections-based research. Access to the collections and data is normally facilitated by curators in several different ways, including: digitizing specimens and making the data available online, lending specimens to qualified scientists at other institutions with appropriate infrastructure for proper care, providing facilities for visitors, and handling reasonable requests for specimen information. At the same time, curators are obliged to preserve the specimens for future use and should refuse the use of specimens whenever their safety or integrity is in question.

Basic Herbarium Operation

The Director or Curator of the herbarium should be aware of, and practice, sound management and preservation techniques. At the broadest scale, the collection should be housed in a pest-free environment where climate, specifically humidity and temperature, can be controlled. Many herbaria store their specimens in solid herbarium-style cases that close with a tight seal (e.g. like that of a rubber gasket); the use of open-face shelving for storage is also found in some herbaria. A carefully controlled operation plan, ideally maintaining the collections at temperatures between 60–65°F (15–18°C) and a relative humidity of about 50%, prevents the proliferation of pests. However, this may not be desirable when office or visitor working space is integrated with the collections (see Bridson and Forman (2010), Hall (1988), and Lull and Moore (1999) for additional suggestions on climatic regimes).

Thermometers and hygrometers should be placed throughout the herbarium to monitor (and record, if possible) temperature and relative humidity, respectively. Integration of these instruments with an alarm system which would notify appropriate herbarium staff to any problems in real time would be desirable.

Policies and procedures should be documented for general use of the collection, including physical and virtual loans, destructive sampling, specimen acquisition, data sharing, deaccessioning, image and data copyrights (if applicable), and others as required. Each specimen should bear the insignia or logo of the institution, a unique identifier (i.e. accession number), and/or a barcode (if the specimen has been digitized). Every transaction should be documented, including accessioned and deaccessioned specimens, exchanges, gifts, loans, and transfers, and these records should be kept in an accessible format indefinitely at the institution. Compiling these records into a collection management system is recommended for this purpose. Herbaria should be sure that the specimens were collected with proper permission and/or permits when applicable, and that the collectors are following best practices when collecting plants that are rare. Ideally, copies of the permits should be received with the specimens, and the permit number noted on the specimen and in its digital record (including an acquisition number and/or a link to a PDF of the permit), if there is one. When researchers wish to deposit specimens collected in United States National Parks, an agreement between the park personnel and the herbarium must be reached prior to acceptance of the specimens. Specimens collected within National Parks in the United States remain the property of the National Park Service (NPS) and are considered on long-term loan to the non-NPS repositories. The NPS may periodically ask for confirmation that their specimens are still on deposit and for any updates on the specimens (e.g. annotations, damage, or destruction).

Digitization of herbarium specimens has increased recently, in part driven by participation in projects funded by the National Science Foundation's Advancing Digitization of Biodiversity Collections (ADBC) program. It has become part of the specimen processing workflow in many herbaria; a review of techniques and possible workflows can be found in Nelson et al. (2015).

Herbarium Arrangement and Organization

The arrangement of an herbarium has often been debated and several schemes are possible. Major groups (e.g. fungi, bryophytes, vascular plants, ferns, gymnosperms), and sometimes type specimens, are often segregated and within such groups the arrangement often varies, usually influenced by tradition and herbarium size. In angiosperms, an arrangement that is often followed is that of Engler (1900), in which plant families (and sometimes genera, following Dalla Torre and Harms (1900–1907)) are numbered in an order based on the concept of relationships at that time. Since there have been many advances in our knowledge since then, particularly following the emergence of the Angiosperm Phylogeny Group in the late 1990s, many of the placements in that system are now significantly outdated.

Current choices for organizing a vascular plant collection include (i) arranging the entire herbarium alphabetically by family, possibly recognizing major groups such as monocots, etc., (ii) for flowering plants, following the current APG IV (Angiosperm Phylogeny Group 2016) system, arranging the families in a linear representation of the current concept of relationships, (iii) retaining a traditional scheme, such as Engler (1900), or (iv) creating a hybrid system, in which much of a traditional framework is retained and the newer family concepts are integrated into that scheme (see Pace et al. 2017). Below family level, genera and species are typically arranged alphabetically, though they are sometimes broken into large geographic areas first. No matter what filing system is used, it is critical that employees and visitors be able to locate specimens in an efficient manner and that confusion about proper location is minimized.

Materials and Supplies

Herbaria, like other types of museums, are charged with preserving their collections in perpetuity. One of the most basic methods of preservation is using archival-quality materials for all products that come into contact with the specimen itself. Acid-free, cotton fiber (minimum of 25%) paper should be used for mounting sheets and cryptogam packets, specimen labels, fragment packets, and annotation labels. Likewise, archival-quality paper products should be used for the genus/species folders used for storage. Acid-free, archival-quality glue should be used for mounting the specimen and for the attachment of all packets and labels. Avoid the use of standard metal paper clips and cellulose tape, which will rust or deteriorate over time (stainless steel paper clips or pins and cloth tape can be used in their place). Fragment packets should, ideally, be included on every individual sheet—whether loose material is present at the time of mounting or not—as material is likely to fall off throughout the life of the specimen through regular use. Likewise, archival quality pens should be used for any annotations not printed from a digital document, and all labels should be printed using archival ink.

Shipping Herbarium Specimens

Tightened customs regulations since September 11, 2001 and increased efforts to restrict entry of alien plants in many countries have made shipping herbarium specimens more complicated than before. There are several reasons for these restrictions. One is because of the possibility that herbarium specimens could be vectors for the transfer of disease or invasive species (see Godefroid et al. 2011), and thus are of interest to regulatory agencies (USDA 2017a). Secondly, herbarium specimens contain genetic resources, and thus are subject to regulations and protocols outlined by the Convention on Biological Diversity (CBD). The Convention on International Trade in Endangered Species (CITES) restricts the transport of species listed as rare or endangered. The Nagoya Protocol on Access and Benefit-Sharing (Convention on Biological Diversity 2011), discussed in more detail below, also may restrict the shipment of specimens. Within the United States, shipments of most herbarium specimens, either mounted or unmounted, require no special permitting and are eligible to be sent by United States Postal Service Library Mail (see the USPS Library Mail overview, https://pe.usps.com/dmm300/173.htm; USPS tracking options, https://pe.usps.com/text/dmm300/503.htm#7_0) or via courier services. Exceptions involve the shipment of fungi, federal noxious weeds, or parasitic plants. Movement of these, either between states or internationally, is governed by the Plant and Pest

Quarantine unit of the United States Department of Agriculture's Animal and Plant Health Inspection Service (USDA-APHIS-PPQ) and both the sender and recipient must possess a PPQ-526 permit and abide by permit requirements.

International shipments can be risky. In many (but certainly not all) cases, shipping via a postal service may minimize difficulties with customs clearance and possible brokerage fees. Since international regulations change often, it is good practice to check with the intended recipient to see if any specific permits are required for safe entry or if they recommend any particular method of conveyance (e.g. postal service or courier service). For example, any shipments to Australia must have specific documentation (Mele and Breeden 2017), often including copies of import permits from the Australian institution. The USDA maintains several lists of taxa that are of concern to that agency and that require additional permits to be imported into the United States (see USDA 2017b), whether as new field collections, or as loans or for exchange of existing material between herbaria. Similar to the Australian example, specimens of taxa on these lists being sent to the United States may need documentation provided by a US institution.

One distinction to be aware of is whether or not the specimens are "processed." Specimens that have been dried, mounted, and frozen prior to shipment are considered by APHIS to be processed and are regulated under the Miscellaneous and Processed Products Import Manual (M. Schori pers. comm.; USDA 2017b). Currently, a *PPQ-588* permit is required to import herbarium specimens of unprocessed, non-listed taxa as well as all field collections, which are likewise considered "unprocessed." Shipments entering the United States under the PPQ-588 permit should have the permit number written on the outside of the parcel as well as on the shipping notice. In addition, a copy of the permit should be supplied to the intended recipient and enclosed in the package by the sender.

International shipments of accessioned specimens of species that are subject to regulation by the Convention on International Trade in Endangered Species (CITES) can be sent to and from scientific institutions in countries that are Parties to the Convention, if the institutions are registered with their country's Management Authority (if allowed) and have been issued a CITES Certificate of Scientific Exchange (COSE). Such shipments can be sent to or from non-registered institutions only after obtaining CITES import or export permits from a country's CITES Management Authority (see the CITES website (http://www.cites.org) for lists of member countries, registered institutions, and Management Authorities). In the United States, CITES permits are managed by the US Fish and Wildlife Service (see https://www.fws.gov/international/cites/ for more information). In addition to the CITES COSE, the USDA is empowered to monitor the import and export of species covered by both CITES and the federal Endangered Species Act (ESA) via the PPQ-621 Protected Plant Permit (USDA 2017c).

The Convention on Biological Diversity (CBD) has recommended that shipments of specimens, including loans and transfers, between institutions be managed through Material Transfer Agreements (MTAs). An MTA for herbaria is an agreement that states the terms under which specimens originating in a particular country, or from a particular institution, are provided to another institution. MTAs generally outline the permitted uses of specimens and terms for sharing specimens with others, as well as requirements for any benefit-sharing that might arise from the use of the specimens. Most herbaria that have specimen transactions with international institutions will likely have a standard form that is signed by representatives of both herbaria (or their institutions) and applies to all future and past transactions between them.

The Nagoya Protocol (Convention on Biological Diversity 2011) is a supplementary agreement to the CBD that became effective October 12, 2014. It seeks to provide a legal framework for the sharing of benefits that arise from the exchange of genetic material. Even though the United States is not a signatory to the CBD, the Nagoya Protocol is likely to place additional reporting requirements on international shipments of specimens. While recommendations for United States collections are still being formulated, the Consortium of European Taxonomic Facilities (CETAF) has developed both a Code of Conduct (CETAF Legislation and Regulations Core Team 2017a) and a "Practical Guide" for dealing with access and benefits sharing (CETAF Legislation and Regulations Core Team 2017b). Curators and collections managers are strongly advised to follow discussions of the implementation of the Nagoya Protocol online and at conferences.

Loans

To enable adequate record keeping, all correspondence concerning loans should be addressed to the Director or Curator of the herbarium, or the Correspondent given in the entry for the herbarium in Index Herbariorum (Thiers 2018). Loans are made to institutions, not to individuals and should be requested for research purposes, not for the routine identification of specimens. Many herbaria now post their loan policies online for reference.

Requesting a Loan—Before requesting a loan of specimens from an herbarium, determine whether or not the herbarium has already digitized these specimens and has made them available online. Consulting digital specimen images may obviate the need for a loan (see also Virtual Loans section, below). Requests must come from the Director or Curator of the requesting herbarium and should include the following elements: a brief statement of the proposed research; the name of the family (families), genus (genera), and/or species desired, including authorities; synonyms (both generic and specific) under which the material might be filed; the geographic area(s) in which they occur or for which the request is intended (e.g. only specimens from Texas); and if any destructive sampling is planned. If a list of species names is included with the request, the names (both currently accepted and synonyms) should be presented in a single, alphabetical list, irrespective of taxonomy. If nomenclatural types are requested, the borrower should send the necessary bibliographic and collection data to facilitate locating such specimens. If the specimens requested have been digitized and are available online, the unique identifier for the digital record (likely also the barcode number on the specimen) should be included in the request, unless the request is for all collections of a given taxon. A borrower should expect queries from the lending institution if either inadequate information is provided with the request and/or when the lender has a large quantity of specimens that fit the request. Some herbaria put an upper limit on the number of specimens that can be borrowed in any one loan.

For requests involving types, the researcher should determine, to the extent possible, which herbaria house the types

that are needed. Primary resources may include *Taxonomic Literature II* (http://www.sil.si.edu/DigitalCollections/tl-2/), any previously published taxonomic work (e.g. protologues, monographs, etc.), and type specimen catalogues available online (e.g. JSTOR Global Plants, http://plants.jstor.org/). It is recommended that images of types be sent, if not already available for review online, to the researcher to ensure that the physical specimens are absolutely required to be loaned.

Sending a Loan—Loans should be sent only if they can be provided in accordance with applicable Material Transfer Agreements (and, eventually, the Nagoya Protocol) or any other pertinent permit or agreements. A borrower should realize that some herbaria retain one or two sheets of each species for reference purposes. The lending institution should indicate to the borrower whether specimens have been withheld and be willing to provide digital images or transcribed label data to the extent to which they have resources to do so. In addition, herbaria reserve the right not to send specimens being studied by researchers at their institutions unless permitted, and some may limit loans of types or other historical specimens, or liquid-preserved specimens. A drop tag should be placed in the collection where specimens were pulled for a loan, either at the level of species or genus if a large amount of the genus is being sent. At minimum, the tag should indicate the borrowing institution (including its Index Herbariorum code), the date the loan was initiated, and the loan or transaction number. Likewise, in the case of internal loans (i.e. specimens for an exhibit or a researcher at the same institution), a drop tag should be inserted into the collection indicating the borrower's name, date removed, and current location of the specimen(s).

In preparing the loan, the lending herbarium should prepare an invoice that states, at minimum, the method/courier of shipment; the number of boxes in the shipment; the number of sheets or specimens in the loan; and the length of time for which the loan is made. One copy should be placed in the box with the specimens and another should be sent by separate mail or electronically. Needed repairs to specimens should be made before the loan is shipped, and the material should be adequately packed to avoid damage or loss. To avoid any damage in transit, the loan should be securely packed by bundling specimens between stiff cardboard sheets, wrapping the bundles in paper, and placing them in boxes strong enough to withstand possible damage in transit. Starch-based "packing peanuts" should not be used for shipping (nor should these be stored in collection facilities) because they attract the same type of insect pests that prey on herbarium specimens. Every lent item (sheet, packet, box, etc.) should bear the logo or other identifying label establishing herbarium ownership. Because Index Herbariorum is often consulted for addresses, herbarium curators should periodically review their entries and make any changes (especially in mailing addresses and correspondents' names). If an herbarium has different addresses for letter and package delivery, this should also be specified in the Index Herbariorum entry.

It is common practice for lending herbaria to pay charges for shipping loans from their herbaria and for borrowing herbaria to pay charges to return the loans. Occasionally, some lenders may request the borrowing herbaria to pay the shipping charges in both directions. All shipments of specimens preserved in alcohol require special packaging and labeling based on regulations issued by both the United States Department of Transportation (DOT) and the International Air Transport Association (IATA) (see Bentley 2007).

Receiving a Loan—The herbarium requesting the loan (and therefore the Director or Curator of the institution, and not the researcher who is using the material) is responsible for the loaned material. Thus, the person in charge of the herbarium should ensure that all researchers using loaned material are fully aware of best practices and limits on specimen use instituted by the lending herbarium. The specimens should be subjected to pest control measures as soon as the shipment is received and before it is unpacked; freezing is the preferred option (see "Low Temperature Treatment" section from Integrated Pest Management Working Group (2017) for information on suggested time and temperature combinations). Subsequently, the shipment should be examined for damage in transit in order to establish that noted damage did not occur while the specimens were in the borrower's care. Any damage that appears to have occurred during shipment should be documented with photographs. Loose material found during unpacking should be placed in the available fragment packet (or a new packet clipped to the sheet), but only if it is reliably from the particular specimen involved. Repairs should only be attempted after consulting the lending institution. Specimens should then be stored in climate-controlled conditions in sealed herbarium cabinets and handled carefully to avoid damage.

The number of sheets or packets must be counted accurately to verify the number of specimens indicated on the shipping form, ideally both by an herbarium staff member and the researcher who will study the specimens. Receipt of the loan should be promptly acknowledged, especially if any discrepancies are noted. Finally, specimens should be examined to ensure each one bears a logo or some other indication of institutional ownership. If this is lacking, the lending herbarium's Index Herbariorum code can be penciled neatly at the bottom edge of the sheet. Penciling the loan number (either from the borrowing or lending institution) on the sheet will further facilitate organizing the loan for return.

Returning a Loan—A loan should be returned as soon as possible or at the expiration of the stated period of the loan. Researchers should request an extension if more time is required; approval of a requested extension is at the discretion of the lending institution. Partial loan returns are discouraged by some institutions and should not be made without consultation. The number of sheets to be returned should be counted accurately, have their ownership confirmed, and be reconciled against the original loan paperwork, with any discrepancies fully documented. To avoid damage in transit, the loan should be securely packed (see Sending a Loan section, above). Specimens should be returned in their original sequence, regardless of new identification. Wherever possible, use the same box and other packing material that were used in the original loan. A return invoice should document the return of specimens and include an accurate count of sheets/packets, the lender's loan number, and an explanation where specimens are being returned without annotation. It should be noted that all possible effort to annotate each lent specimen should be made by the researcher who originally instigated the loan, unless an exception to this standard practice was included in the loan agreement.

Transfers of loans from one herbarium to another are strongly discouraged as it may require substantial work on the part of borrower and lender to ensure all specimens are

accounted for and appropriate documentation is in place. If a transfer is absolutely necessary, prior written permission must be obtained from the lending institution and from the Director or Curator of the institution to which the loan will be transferred.

When a returned loan is received by the owner, it should be subjected to pest control measures (i.e. freezing), unpacked and processed, and acknowledged promptly, including confirmation of the number of sheets or packets along with their condition. Only after this confirmation is received should the loan be canceled.

Virtual Loans—Because many herbaria today have active digitization projects, it is becoming increasingly common for users to request the digitization of specimens needed for study, as a precursor to, or substitute for, a specimen loan request. Whenever possible, most herbaria are happy to comply with such requests, because the cost of digitization is often less than the cost of shipment, and the specimen is not subjected to the potential dangers of damage or loss during shipment. Digitization also makes the specimen(s) available to all users, not just the requestor, and provides a digital record in the case that the specimen is later damaged or lost. Most herbaria will have an upper limit to the number of specimens they can provide in a timely fashion; it is probably not realistic to ask for a virtual loan of more than 100 specimens, but the threshold will differ depending on size, staff, and equipment availability. The requirements for the loan request remain the same (see Requesting a Loan section, above). One disadvantage of virtual loans to the loaning institution is that the specimen will not be annotated directly by the borrower, though it may be possible to incorporate updated information through a comment function on the herbarium's website or via email communication. It is important to provide this feedback whenever possible.

Studying and Annotating Specimens

The researcher should annotate all sheets wherever possible. Annotations should be printed or written in a neat and legible script on archival quality labels using black, permanent, archival ink (not in marker, ballpoint pen, or pencil). Annotations should include the accepted name of the taxon with the corresponding author(s) of the species, the full name of the investigator, his/her institution, and the date of identification. The title of the study for which the specimens were used can also be included on the annotation label as a header or below the annotator's name and date of annotation. In addition, all type specimens should be annotated with the basionym (previously published name on which a new combination or name at new rank is based) and citation of its place of publication. Lectotype or neotype annotations should include citation of both the original publication and the lecto- or neotypification. Any publications resulting from the use of the specimens on loan should also be sent to the lending institution(s).

Typically, the annotation label should be placed as close to the original label as possible (usually above) without obscuring it, the herbarium logo, or any part of the specimen.

A researcher's clear confirmation of the current identification of the specimen is just as important as providing a new identification. Avoid the use of the affirmation symbol ("!"), as there may be multiple identifications/annotations per sheet and others may be added later. Annotations may supplement, when relevant, inadequate collector labels, specimens with mismatched labels, those that are duplicated, and those that are essentially worthless; each of these cases are examples of the "value-added" effect that the lender receives from the borrower. In the case of loaned specimens, the borrower should consult the lending institution for their policy on attaching annotation labels, if none has been provided. Note that under no circumstances should this information be added to the original label, previous annotation slips, or the sheet itself; a new annotation slip is required.

Destructive Sampling—Herbaria should develop policies for the removal or destruction of material from specimens to safeguard the scientific integrity of their collection. Borrowers should request permission for destructive sampling in the initial loan request. In all cases where material is to be removed from specimens, prior permission from the Director or Curator must be obtained, and any special institutional regulations must be observed. Anatomical, chemical, molecular, palynological, and other analyses requiring removal of material from specimens requires special care by the researcher and borrowing institution. Portions of specimens, especially of types, must not be detached without prior, expressed permission. Dissections should be carefully made without removing more material than necessary for study, and dissected parts placed in the packet on the sheets when complete. If no packet appears on the sheet, one can be added (clipped on) but should not be permanently affixed to the sheet without permission from the lending institution. Material from fragment packets should be consulted first before removing any material from the mounted specimen.

When routine examination requires removal of material (e.g. microscopic preparations), the researcher must exercise responsibility and judgment as to whether there is sufficient quantity to justify the partial destruction of the specimen, and curators should, whenever possible, loan any slides of such material that may have been prepared previously. Specimens sampled for these destructive studies should be annotated as such, and, if special preparations are made from the specimens, a portion of these preparations should be returned to the home institution, whenever feasible, in the case of a loan. In the event that the product of the special preparation is an image, a copy should be included with the specimen or returned with the loan to the lending institution. Any preparation returned to the lender should be identified by the taxon name, country, collector's name and number, and an identifier such as the accession or barcode number. Institutions often have policies regarding the use of material for DNA extraction and the ultimate repository for DNA extractions from their samples and must be followed. If the institution does not have a policy, these details should be worked out in advance with the lending institution. Specimens serving as vouchers for GenBank sequences should be indicated by an annotation label and the sequences reported to the lending institution. These should also be cited appropriately in any resulting publication, including the Index Herbariorum code (following Thiers 2018) of the lending institution.

Exchanges

Broad distribution of scientific materials between herbaria can be accomplished through exchange of duplicates. Generally, exchange is on an inter-institutional basis, although exchanges with individuals are sometimes arranged. It is important to maintain meticulous records of specimens

received and sent, and a written agreement between institutions should be in place at the time of the initiation of an exchange. It is recommended that exchanges be made on a specimen-for-specimen basis to avoid misunderstandings. The exchange balance between institutions should be confirmed by both parties after the receipt of each shipment. Ideally, specimens should be of high quality, reasonably well prepared, identified, and have adequate label data (e.g. taxonomic name, including authorities, collection locality, date, name of collector, and collector number). Whenever possible, specimens sent on exchange should not be permanently mounted, in order to accommodate the mounting practices at the receiving institution.

Gifts

Gifts are generally sent for three reasons: (i) returns in accordance with permits or other agreements, (ii) a curator's generosity where exchange material is not sought, or (iii) the so-called "exchange for identification" (or "gift for determination"). When collections are made outside of the researcher's own country, the permit under which those collections were made usually requires that a set of specimens be deposited in an herbarium in that country. Every effort should be made to identify such specimens before repatriation. Although in common herbarium transaction terminology such specimens fall under the category of a "gift," it might be better to label such shipments as "returns."

A gift for determination involves a prearranged agreement with a specialist, or the Director or Curator of their herbarium, that their institution can keep the duplicate specimen that has been gifted in exchange for an identification. These agreements should be made before specimens are sent. If all duplicates of a collection are sent to aid in identification, it is best to know of any restrictions (by the owner of the collection) that would apply in selecting the duplicate to be retained. Each duplicate of a collection should be annotated and, in the case of duplicates not seen by the specialist, they may be annotated "duplicate identified by" to avoid confusion if a collection is found to be mixed (i.e. comprising more than one taxon). Procedures for reporting determinations that were supplied by the gifting institutions should be followed.

Requests for Information

The degree to which requests for information from specimens will be fulfilled often depends on the effort required to comply. Requests for label data from many specimens are relatively easy to fulfill when the information is already in a database but can be much more time-consuming when not. Researchers should be cautioned that even when information from specimens is provided, there is no guarantee that the identifications of the specimens are accurate, and that taxonomic verification should be attempted to avoid introducing errors into the scientific literature. Requests for small amounts of tissue to be used for DNA analysis in lieu of borrowing the entire specimen must be carefully considered: there is not only the potential issue of misidentification, but also providing this service may cross the line between service (information provision) and research collaboration. Researchers making such requests should consider whether or not they are willing to offer co-authorship to the herbarium staff member(s) who selects their research material for them (see Rouhan et al. 2017). If material is removed and sent in this manner, it is suggested that a digital image of the specimen sampled be sent to the requester for positive identification.

Acknowledging Herbaria

Acknowledgments from users is often a primary way in which herbaria can justify their expense to their home institutions. Each institution from which researchers studied specimens, whether in person or via loan, images, digital data, or any other assistance such as collection site information, phenological data, or historical data should be explicitly acknowledged in published papers, reports, presentations, posters, or any other dissemination of the results using the official name and/or Index Herbariorum code of the institution. Even in cases when data or images are accessed via online portals, institutions should be acknowledged. When available and appropriate, globally unique identifiers (GUIDs) should be cited in "Supplemental Information" sections. Printed or digital copies of publications resulting from use of specimens should be sent to the lending institution(s). Where possible, specific specimens should also be cited so that they can be identified (i.e. with accession or barcode numbers). Data extracted from loaned specimens that are deposited in online repositories (e.g. GenBank, Dryad, MorphoBank, etc.) should also include the Index Herbariorium code, collector and number, and accession and/or barcode for the specimen(s) so that this information can be linked back to the physical specimen. These should also be reported to the lending institution.

Visitors

Professional, student, and serious amateur researchers have never been more welcome to visit herbaria than at the present time, because their use of a collection is a measurable indicator of its relevance to current research and because their annotations add scientific value to the collection. Visitors should contact the Director or Curator well in advance to ask permission to visit, describe the research project, and indicate the taxonomic group(s) the visitor wishes to examine. Upon arrival, they should be presented with the rules and regulations of the institution and trained as appropriate. Visitors should be warned about known specimen contaminants (e.g. elemental mercury and associated vapor (Havermans et al. 2015)) in the collections. It may be helpful to visitors to view these policies in advance by consulting the institution's website or through emailing the appropriate policy documents; a handout upon arrival is also highly encouraged. It is also important that there is a common understanding between the visitor and the herbarium about what equipment and services can be expected, for example: Will a microscope be available for the visitor's use? Are basic dissection tools and reagents available for visitors? Will reference books and databases be available for consultation by visitors? In some cases, visitors may be asked to sign documents (e.g. risk waiver, destructive sampling protocol, photographic guidelines, etc.) to comply with institutional policy.

Access to the collection allows the immediate examination and annotation of specimens and/or the opportunity of selecting one's own loan. Together, this ensures that only required specimens will be included in any future loan requests, reducing the operating costs of the herbarium. If a

visitor anticipates selecting a loan, he/she should make appropriate arrangements with the Director or Curator upon arrival. Visitors intending to bring specimens with them for comparative purposes should allow adequate time so that the specimens may be subjected to institutional pest control measures (which can represent upwards of a week). Users of collections should follow the procedures of the herbarium. For example, many herbaria prefer that all examined specimens (or at least those newly annotated) be left aside for staff to process so that updated information can be added into their database and re-filed accordingly. Taxonomic expertise is a resource that should be shared; when you have the ability to annotate specimens, even if simply confirming an identification, it is greatly appreciated and can facilitate future research. If your time is limited, be sure to ask if you could, for instance, simply sort specimens into stacks for "bulk" annotation by herbarium staff later.

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Author Contributions

RKR wrote the draft manuscript and made substantive editorial comments throughout. HTS added substantive comments and oversaw the revision and submission process. BT added substantive editorial comments throughout. JAM and CJF worked on earlier drafts and provided comments. LAP, LPL, and LCM supplied comments and additions throughout.

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