PROFILING NATURAL HISTORY COLLECTIONS: A METHOD FOR QUANTITATIVE AND COMPARATIVE HEALTH ASSESSMENT

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Abstract.—Quantitative methods for assessing the health of a natural history collection are of paramount importance for prioritizing the investment of time and resources and ensuring the long-term stability and usability of a collection's invaluable specimens. Proposed profiling methods have provided institutions with important data on the condition of their collections, but to date, no method has been implemented to permit comparisons across multiple, unrelated collections at the same institution. Presented here is a profiling method developed to allow comparisons among the ten natural history collections at the Illinois Natural History Survey (INHS). The method employs eight profiling indicators, conservation status, processing state, container condition, label condition, identification level, arrangement level, data quality, and computerization level, each graded on a scale of 1 to 4 (''problematic'' to ''ideal''), with 3, across all collections and all indicators, being considered ''acceptable.'' A database was developed for profiling data entry and analysis. Finally, in order to elucidate the value of collection profiling, the results of pilot studies in the insect and mollusk collections at the INHS are presented.

Introduction

In an era of declining funding for natural history collections, administrators need evaluative tools for prioritizing expenditures. Meanwhile, curators and collection managers need quantitative measures of the health of various parts of their collections in order to prioritize their efforts and make convincing arguments for their collections' financial support.

Although exhaustive evaluations have their place in collections management research (e.g., Cato 1990, Waller and Simmons 2003), collection profiling, as standardized collection health assessment is called, needs to be more efficient. Natural history collections are far too large to evaluate on a per-specimen basis, so profiling involves the assessment of a standard storage unit such as a drawer of pinned insects, an herbarium cabinet cubby, a shelved-box of fluid- preserved fish, a box of annelid slides, or a drawer of mammal or bird skins. The actual process involves the brief inspection of each storage unit in the collection and the evaluation of its condition in predefined categories on a predefined scale.

Various systems have been developed for profiling collections. One of the first such systems (McGinley 1989, 1993), developed in the Department of Entomology at the United States National Museum of Natural History (NMNH), was tailored for entomological collections. This system was used to compare different parts of the NMNH collection, and to compare it to entomological collections of other institutions. McGinley's (1993) profiling unit was a single drawer, vial rack, or slide box of insect specimens, graded on a single scale from 1 to 10 (Table 1). Williams et al. (1996) modified McGinley's (1993) method to assess vertebrate collections (Table 1).

The scales for both the McGinley (1993) and Williams et al. (1996) methods roughly followed the temporal process of specimen curation as performed by a typical taxonomist in his or her respective field, and were intuitive and easy to use. Also, because each system only had a single scale, collection profiling could be done relatively quickly. However,

Table 1. McGinley (1993) profiling system for insects and the Williams et al. (1996) modification for vertebrates.

Profile score	McGinley 1993 (insects)
1	Conservation problem (e.g., loose, unprepared specimens)
2	Specimens unidentified, inaccessible (e.g., pinned and labeled, but unsorted)
3	Specimens unidentified, accessible (e.g., rough-sorted)
4	Specimens identified but not integrated into collection
5	Specimens identified but curation incomplete (e.g., in substandard storage containers)
6	Specimens identified and properly curated in accordance with departmental collection standards
7	Data capture: species level inventory
8	Data capture: specimen label data capture
9	Data capture: research data capture
10	Scientific voucher material
Profile score	**Williams et al. 1996 (vertebrates)**
1	Acquisition: potential exists for loss of specimens, specimen parts, and/or associated data
2	Stabilization: basic preservation, processing, compilation and organization of records, and protection
3	Registration: cataloged and labeled (provisionally available for use)
4	Processing: supplementary processing and labelling completed
5	Curation: generally organized and retrievable
6	Storage: stored permanently with room for growth and associated materials
7	Maintenance: records quality-checked and cross-referenced and loan transactions updated

using a single profiling scale limits the assessment of particular problems. For example, in the McGinley (1993) method, a collection could be nearly perfectly curated, with full computerized data capture, yet still only rate a 5 out of 10 if the specimens were stored in substandard hard-bottom unit trays.

In order to address this weakness in assessing the true nature of a particular profile score, the NMNH developed an expanded profiling scheme. The method, as implemented by the Department of Invertebrate Zoology, included six dimensions, or profiling indicators, each scored on a scale of 1 to 5 (Table 2) (Bright et al. 2000, Moser et al. 2001). This new system provided for greater depth and usability of the profiling data. Scoring six profiling indicators takes longer than profiling on a single scale, however. Also, although the Moser et al. (2001) system allowed for comparisons among several natural history collections, it was not implemented beyond the NMNH Department of Invertebrate Zoology.

The mission of the Illinois Natural History Survey (INHS) is to ''investigate and document the biological resources of Illinois and other areas, and to acquire and provide natural history information that can be used to promote the common understanding, conservation, and management of these resources'' (www.inhs.uiuc.edu/welcome). Inherent to this mission is being a long-term repository of natural history specimens as

Table 2. Profiling system of the Department of Invertebrate Zoology at the NMNH (gray cells indicate unused profiling scores).

Profile score / indicator	1	2	3	4	5
Conservation Status	Unstable	Degraded	**Stable***	Optimal	
Processing State	Unprocessed	Sorted	**Fully Processed***		
Storage Containers	Substandard	**Musem-quality containers***			
Arrangement	Not arranged	Needs improvement	**Fully arranged***		
Identification	Not identified	Identified to gross level	**Identified to useful level***	Identified to accepted standard	Identified by expert
Inventory	Not inventoried	Full inventory of some lots	Collection-level inventory	**Lot-level inventory***	Full inventory

*These grades were considered "acceptable"

permanent records of the historic flora and fauna. To that end, the INHS maintains a diversity of natural history collections: fungi, plant, annelid, mollusk, crustacean, insect (and other arthropods), fish, reptile, bird, and mammal collections (geological and anthropological collections are the purview of the Illinois Geological Survey and Illinois State Museum, respectively).

Over the past several years, the Collections Resources Committee at the INHS developed a profiling system applicable and comparable across all of its collections. The assessments made possible by this profiling will permit 1) collection managers to quantify the relative health of various parts of their charges and develop informed priorities, 2) administrators to evaluate the relative needs and funding levels for the separate collections, and 3) a more persuasive argument to external funding agencies. The INHS collection profiling system is described herein, a FileMaker Pro® database for easy profiling data capture and analysis is described and offered to readers, and the usefulness of profiling is shown in comparing the INHS insect and mollusk collections.

Profiling Methodology

Ideally, collection managers would have a health assessment of every specimen in their collections, but since acquiring those data is not practical, collection profiling is done on groups of specimens. Each storage method requires its own profiling unit. The various profiling units for each collection are simply the standard container storage units, and are presented in Table 3.

Eight profiling indicators were selected, each of which was scored on a scale of 1 to 4. A score of 1 is ''problematic,'' and indicates that the immediate usability of the collection is in jeopardy. This would include fluid-preserved specimens that have desiccated, unsorted specimens, labels with nothing but a field notebook code, etc. A score of 2 is ''substandard,'' but the immediate health of the material is not at risk, including specimens with improper seals on jars, hard-bottom pinning unit trays, specimen data not computerized, etc. A score of 3 is deemed ''acceptable.'' These specimens are all curated to accepted standards, which may vary from collection to collection. There may be room for improvement, but all specimens are stable for the long term and readily accessible. A score of 4 is ''ideal'': all specimens in each profiling unit have been determined to the

Table 3. Profiling units for different INHS collections.

Collection	Storage method	Profiling unit
Annelids	Fluid-preserved in vials or jars	Vial rack or jar rack
Annelids	Microscope slides	Slide box
Birds	Stuffed skins, skeletons, eggs	Cabinet shelf/drawer
Crustaceans	Fluid-preserved in vials or jars	Specimen jar tray or vial rack
Fish	Fluid-preserved in jars	Specimen jar tray
Fish	Fluid-preserved in tanks	Shelf of tanks or single tank
Fungi	Herbarium sheets or boxes	Cabinet cubby hole
Insects	Dry, pinned, in envelopes	Insect drawer
Insects	Fluid-preserved in vials or jars	Vial rack or jar rack
Insects	Microscope slides	Slide box, or row in slide tray
Mammals	Stuffed skins, skeletons	Cabinet shelf/drawer
Molluscs	Shells	Cabinet shelf/drawer
Plants	Herbarium sheets	Cabinet cubby hole
Reptiles	Fluid-preserved in jars	Specimen jar tray
Reptiles	Skeletons	Cabinet shelf/drawer

Table 4. Summary of INHS profiling method (gray cells indicate unused profiling scores).

Profiling indicator	Collection type	1 = problematic	2 = substandard	3 = acceptable	4 = ideal
Conservation status	wet	specimens damaged or desiccated	fluid level low or dark	fluid topped off and clear	
	dry	pest infestation or specimens unusable due to damage	specimens damaged	specimens intact and stable	
	slide	slide broken or mountant deteriorating	improper mounting medium, not ringed	slide ringed or in Canada balsam	
Processing state	all	bulk, unprocessed specimens	mixed field sample	properly sorted and labeled	
	dry	bulk, unprocessed specimens	specimens lacking labels, or not properly prepared	properly sorted and labeled	
	slide		specimens not cleared and/or improperly oriented	specimens cleared and properly oriented	
Container condition	wet	bad stoppers/lids, loose vials/jars	degraded or poor stoppers/lids	neoprene stoppers, good containers	archival racks/trays
	dry	cigar boxes, pill boxes, paper bags	substandard containers	archival unit trays	herbarium sheets with archival glue and fragment folders
	slide	not stored in slide box or tray	slide boxes of non-standard size	good slide boxes or trays	slides stored flat
Condition of labels	all	faded to illegible, crumbling or missing	partially faded, on non-archival paper	labels on archival paper	
Identification level	all	all specimens not determined to any level	taxon dependent	taxon dependent	taxon dependent
Arrangement level	all	mixed taxa in same container	specimens crowded, arranged at higher taxonomic level	specimens arranged alphabetically, or with alphabetical list if arranged phylogenetically	specimens arranged geographically or numerically within a taxon
Data quality	all	data absent or in codes only	missing data can be inferred	all data fields intact	value-added data, including retrospective georeferencing
Computerization level	all		no computerization	mollusk and vertebrates databased, others with taxonomic information computerized	all specimens databased and localities georeferenced

species (or subspecies level), they are stored in modern, archival containers, and taxonomic and collection locality data are fully computerized and value-added at the specimen level.

Profiling scores were selected relative to the collection being evaluated. For instance, having all bird specimens determined to the species level would be considered acceptable, whereas the genus level, or even the family level, would be acceptable, albeit not ideal, for most insect groups. The normative practices of the different disciplines dictated the profile scoring criteria.

The various collections were profiled by scoring the lowest possible value for the profiling unit. For example, if even a single insect specimen had fallen off of a pin, the entire profiling unit (specimen drawer), even if it contained several hundred intact specimens, was given a ''1'' for conservation status. Remaining conservative in the scoring helped standardize the profiling by minimizing the amount of subjective evaluation: e.g., how many specimens have to have fallen off of pins before the drawer is scored differently?

A summary of the profiling method, its indicators, scores, and a brief description of each scoring criterion is presented in Table 4.

Conservation Status

The conservation status of the specimens is perhaps the most critical dimension to evaluate as it assesses the long-term stability of the specimens. Mammal skins with damage from dermestid beetles or mollusk shells with Byne's disease need immediate attention lest the specimens be lost or damaged permanently. Because the long-term, stable, archival storage of specimens is the only acceptable practice, there is no Level 4 (ideal) conservation status.

Fluid-preserved specimens.—Level 1. Specimens are desiccated. Fluid does not completely cover specimen(s). Alcohol is opaque.

Level 2. Fluid level is low, but completely covers specimens. Alcohol is dark.

Level 3. Fluid is topped-off and relatively clear.

Dry specimens.—Level 1. Shells have Byne's disease. Specimens (of any kind) have signs of pest infestation. Insect specimens have fallen off of pin. Specimens are damaged to the point of being unusable.

Level 2. Specimens are damaged: broken into multiple pieces, with past pest damage, loose teeth or bones. Insect pins are broken or significantly bent.

Level 3. All specimens are intact and stable.

Slide-mounted specimens.—Level 1. Slide or cover slip is broken. Mounting medium is crystallized, running, or has receded up to specimen.

Level 2. Aqueous mounting medium is not sealed (ringed) under cover slip. Mounting medium has receded. Cover slip or slide is cracked.

Level 3. Slide in good condition. Mounted in Canada balsam or cover slip has been sealed (ringed).

Processing State

Specimens are often first brought to a collection as bulk samples. Unless they are processed immediately, they tend to end up in storage, often referred to as ''backlog.'' As bulk samples are processed and incorporated into the collection, their profiling score improves. Processing is acceptable when it is complete, so there is no Level 4 (ideal) state.

Fluid-preserved specimens.—Level 1. Specimens stored in bulk and unprocessed. Unsorted samples stored in Whirlpac® bags, Nalgene® or other bottles, jars, or in the freezer.

Level 2. Mixed field sample, rinsed, stored in clean alcohol, in standard quality storage containers.

Level 3. Vertebrate samples sorted and tagged. Mollusk shells and soft body tissue separated. Insect specimens stored in proper vials with cotton and micro-vials, if necessary.

Dry specimens.—Level 1. Bulk insect specimens papered, or in jars, boxes, or cotton. Unsorted botanical specimens in newspaper or paper bags (backlog).

Level 2. Insect specimens pinned, but improperly mounted on pin or point. Mollusk and vertebrate samples not cleaned, cataloged, or numbered. Botanical material mounted to herbarium sheets with labels, but without accession numbers.

Level 3. Insects properly pinned, pointed, or enveloped. Vertebrate and mollusk specimens cleaned, cataloged and numbered. Herbarium sheets in folders with all labels and accession numbers.

Slide-mounted specimens.—Level 1. As soon as specimens are slide-mounted they are already semi-processed, so there is no Level 1.

Level 2. Specimens were not cleared prior to mounting, or were improperly oriented on slide.

Level 3. Specimens properly cleared and oriented on slide.

Container Condition

The condition of specimen containers predicts the longevity of the specimens themselves. The containers should be archival, easy to arrange, easy to retrieve, and easy to use (unlike hard-bottom insect trays, for example). The more degraded or complicated the storage system is, the more likely it is that specimens will get damaged.

Fluid-preserved specimens.—Level 1. Vial stoppers are cracked, broken, swollen, or disintegrating. Stoppers are made of cork. Vials are loose on shelf, or banded together, and not in vial rack. Jar lids are old and rusted (if metal), or are Bakelite® lids (which crack easily). Jar seals are missing, cracked, or shrinking. Five-gallon buckets have poor seals or loose lids.

Level 2. Hardened but intact vial stoppers. Vials aligned in wire-sided racks. Jar lids are metal or with non-polyethylene jar seals. Large specimens are stored in 5-gallon buckets.

Level 3. Vials have good quality stoppers. Vial racks are solid with no risk of vial loss. Jars are bail-topped with polyethylene gaskets, or have polypropylene lids. Large specimens are stored in archival barrels with clamping sealing mechanisms.

Level 4. Vials and jars in archival racks. Large specimens stored in stainless steel tanks.

Dry specimens.—Level 1. Specimens in old cardboard boxes, cigar boxes, pill boxes, or paper bags. Specimens not stored in unit trays. Plants mounted on cardboard with rubber cement.

Level 2. Specimens stored in new cardboard boxes or zip-lock bags. Vertebrate trays are unlined. Skulls or skeletal material are in substandard containers. Insects pinned in hard-bottom unit trays. Plants pressed in newspaper. Fungi kept in packets when they should be in boxes, or glued to paper in the packets.

Level 3. Unit trays are archival. Insects pinned in foam-bottom trays. Vertebrate trays are lined with acid-free paper. Plants and fungi are in/on acid paper/packet/box with Elmer's® or other non-archival glue, or lacking fragment folders.

Level 4. Plants and fungi in/on acid free paper/packet/box, fixed with acid free glue, and with fragment folders present.

Slide-mounted specimens.—Level 1. Slides not in slide box or tray. Slide box broken.

Level 2. Slide box not standard 100-slide box. Slides in trays are not protected by envelope or thick labels, which prevent the crushing of the cover slip on one slide by the adjoining slide.

Level 3. Good slide boxes or trays with rust-free hinges and substantial closure clasps.

Level 4. Tray slides stored flat.

Condition of Labels

As important as the specimen itself are the collection and determination data associated with it. For some taxonomic groups, an unlabelled specimen is not even worth keeping, so monitoring the health of the specimen labels is important. Similar to the specimen condition profiling indicator, impermanent labels of any kind are not acceptable, so there is no Level 4 (ideal) score.

Level 1. Labels are faded to illegible, crumbling, or missing. Labels have become detached from the specimen.

Level 2. Labels are partially faded, laser-printed in fluid or in pencil, or on non-archival paper.

Level 3. Labels are readily legible, printed with non-bleeding (if in fluid) archival paper and ink.

Identification Level

Specimens in a collection that have not been determined to any level are difficult to access and are not typically examined by taxonomists. Also, the more precise the determination is of a specimen, the more valuable it becomes to researchers. The level of determination useful for taxonomists will differ depending on the group.

Level 1. All specimens undetermined and major groups mixed.

Level 2. Insects determined to order or family (depending of the size of the group). Not all annelid slides in a slide box fully determined. All other groups determined to the family or genus level.

Level 3. Insects determined to the genus or family level. All other groups determined to species.

Level 4. Insects determined to the species level. All other groups determined to species or (often) subspecies and verified by a specialist.

Arrangement Level

Once specimens have been identified (to any level), they need to be put away. Different collections have different standards of arrangement. For instance, the INHS insect collection stresses an alphabetic arrangement, the herbarium arrangement is somewhat more phylogenetic, and the annelids are not stored taxonomically, but rather together with each collection event.

Level 1. Mixed taxa stored in the same vial, jar, unit tray, slide, etc. Annelid slides made from same collection are in different boxes.

Level 2. Specimens crowded. Species sharing trays, or taxa scattered in two or more places. Arrangement is only at a higher taxonomic level. More than one annelid sample or collection site is stored in the same box.

Level 3. Specimens arranged alphabetically by family, genus, and species, or, if arranged phylogenetically, with an alphabetical cross-referenced list. Annelid slides arranged in boxes according to collection event and/or locality.

Level 4. Specimens arranged geographically within a taxon, or arranged numerically by catalog number if specimens have been databased.

Data Quality

Even with intact specimen labels, the quality of the data can vary greatly, from simple codes referencing field notebooks or accession logs, to labels with full determination and locality data, including geo-reference coordinates (e.g., latitude and longitude or universal transverse mercator).

Level 1. Data are in codes or missing entirely.

Level 2. Some data are missing but can be inferred. Specimen containers (vials, jars, or slides) lack determination labels.

Level 3. All data fields are complete for all groups except pinned insects may have determination labels missing.

Level 4. Localities fully geo-referenced. All species-level insect pins have determination labels.

Computerization Level

Finally, most natural history collections have some level of computerization of specimen data. For some groups, such as vertebrates, it is standard practice that all specimens be computer-cataloged, whereas entomological collections remain largely undatabased. Because the lack of computerized data does not present a significant obstacle to the health and accessibility of the specimens themselves, there is no Level 1 (problematic) profile score for computerization.

Level 2. No computerization at all.

Level 3. All herbarium, mollusk, and vertebrate specimens databased. Taxonomic information of other groups electronically inventoried, but specimens themselves not yet databased and assigned catalog numbers.

Level 4. All localities geo-referenced and stored electronically. Invertebrates databased at the level of storage unit (pin, vial, jar, slide).

Pilot Projects

Two of the INHS collections have been largely profiled, allowing for comparisons both within and between collections. The insect collection profiling represented a significant investment in time and resources (see results), but the resulting data have allowed evaluation of priorities, including establishing an NSF-funded project to database the Hymenoptera (ants, bees, and wasps), which constitute one of the insect collection's more significant and important holdings. The databasing and concomitant specimen curation is a long-term goal of the INHS insect collection (Favret and DeWalt 2002).

Comparisons were made among four broad taxonomic groups of Hymenoptera: Symphyta (primitive, broad-waist wasps, including sawflies), Apoidea (the superfamily comprising all of the bees), Parasitica (a paraphyletic grouping comprising most of the parasitoid wasp families), and ''other Hymenoptera'' (ants, non-parasitoid wasps, and relatives). As most Hymenoptera research is conducted with pinned material, alcohol-preserved collections tend to be neglected. The dry and wet Hymenoptera collections were profiled and compared in an effort to quantify the differences in condition of these two methods of preservation. The Hymenoptera slide collection is comparatively small and, although it was profiled, the results are not presented here.

Over the recent past, the INHS has been responsible for the care and management of both the INHS collections and some of the University of Illinois Museum of Natural History (UIMNH) collections, the latter scheduled for incorporation into the INHS in the near future. Evaluating the condition of the UIMNH collections will help assess their relative need for curatorial attention before incorporation. To this end, the UIMNH mollusk collection was profiled, also permitting an opportunity to compare the profiling results of two dissimilar collections: specifically, the UIMNH mollusk shell collection and the INHS fluid-preserved beetles.

Profiling data can be presented in any number of ways. A mean profiling score provides a general overview of the profiling and allows for simple comparisons (Table 5). Alternatively, the actual number of profiling units with each profile score, 1 through 4, can be tabulated and presented as a chart on a per-profile indicator basis. For example, Figure 1 presents the relative proportions of profiling units (pinning drawers) that scored a 1, 2, 3 or 4 for identification level.

In order to expedite both profile data entry and analysis, a relational FileMaker Pro® database was developed. Related tables include one for the profiling units themselves, one for the data entry personnel, and a look-up table that provides customizable descriptions of each of the profiling scores. Each database record represents a single profiling unit. It contains fields for the exact location of the unit (room, cabinet, shelf, position on shelf), the type of unit (dry, wet, slide), taxonomy, date of entry, and all eight profiling indicators. On each tenth record (customizable to any n^{th} record), the database prompts the user to enter the number of specimens in the profiling unit; this allows for a sub-sampling regime and an eventual collection size estimate (see Table 5). The data entry can be done either with a notebook computer in the collection proper or on paper spreadsheets to be entered into the computer later.

Table 5. Average profiling scores for various collections. 1 = problematic, 2 = substandard, 3 = acceptable, 4 = ideal.

Insect groups/Profile indicators	All Dry Hymenoptera	All Wet Hymenoptera	Symphyta	Apoidea	Parasitica	Other Apocrita	UI Mussels (Unionidae)	INHS wet beetles
Estimated no. specimens	327,623	106,119	27,919	136,849	76,413	50,679	na	550,389
Number of profile units	979 drawers	893 vial racks	104 drawers	370 drawers	288 drawers	195 drawers	1,144 trays	4,569 vial racks
Conservation status	2.39	1.92	2.48	2.50	2.22	2.37	3.00	1.99
Processing state	3.00	2.90	3.00	3.00	3.00	2.99	2.85	2.85
Container condition	2.97	2.10	3.00	3.00	2.91	2.99	2.70	2.46
Label condition	1.60	1.60	1.81	1.65	1.38	1.41	2.73	1.56
Identification level	3.12	2.85	3.39	3.48	2.92	3.03	2.95	2.67
Arrangement level	2.09	2.00	2.11	2.12	2.23	2.03	2.23	2.11
Data quality	1.75	2.61	1.96	1.83	1.53	1.51	2.01	2.86
Computerization level	2.01	2.00	2.00	2.00	2.02	2.02	2.07	2.01

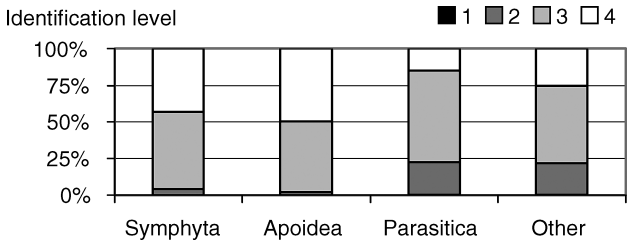

Figure 1. Proportional comparison of profiling scores for identification level of four taxonomic groups of Hymenoptera.

When profiling and computer data entry are complete, a simple query can be made of the database requesting a certain set of records, e.g., all the records of a particular collection, taxonomic group, preservation method, storage location. The user then proceeds to a summary layout and calculation fields return the average profiling score for each indicator in the found set, the number of records with each profile score, and the estimated number of specimens based on the sub-sampling. Interested readers are invited to contact the first author for a clone of the FileMaker Pro® database.

Results and Discussion

Three hourly workers profiled the insect collection over the course of three years. The profiling of the pinned collection averaged 28 drawers per hour, the wet collection 27 vial racks per hour, and the slide collection 18 slide boxes per hour. The pinned Hymenoptera, with 1,433 drawers, took 50 hr to profile, the alcohol-preserved Hymenoptera, with 893 vial racks, took 34 hr, and the alcohol-preserved beetles, with 4,569 vial racks, took approximately 172 hr. Results from the slide profiling are not presented here, but, the largest slide collection, the thrips, with 743 slide boxes, took 42 hr to profile. An estimate of the time required to profile the entire insect collection of approximately seven million specimens, preserved in 7,161 drawers, 23,132 vial racks, and 1,509 slide boxes/trays, is 1,200 hr, or approximately seven months of full time work.

Profiling within the pinned Hymenoptera showed that the groups that have received the most attention historically, the Symphyta and the Apoidea, scored higher than the others (Table 5, Fig. 1). The conservation status was lower than acceptable for all groups, probably the result of specimens falling off of pins, particularly within the frequently point-mounted (glued-on) Parasitica. Specimen label scores were low for all groups, a consequence of unlabeled material from the recently incorporated International Soybean Arthropod Collection.

The dry, pinned, Hymenoptera collection scored higher than the wet, ethanol-preserved, collection on several profile indicators, including: conservation status,

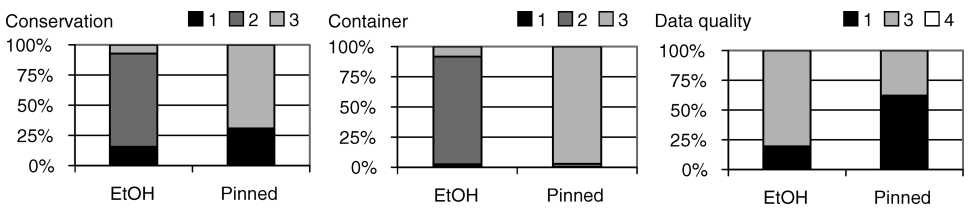

Figure 2. Proportional comparison of profiling scores for conservation status, container condition, and data quality in ethanol-preserved and pinned Hymenoptera collections.

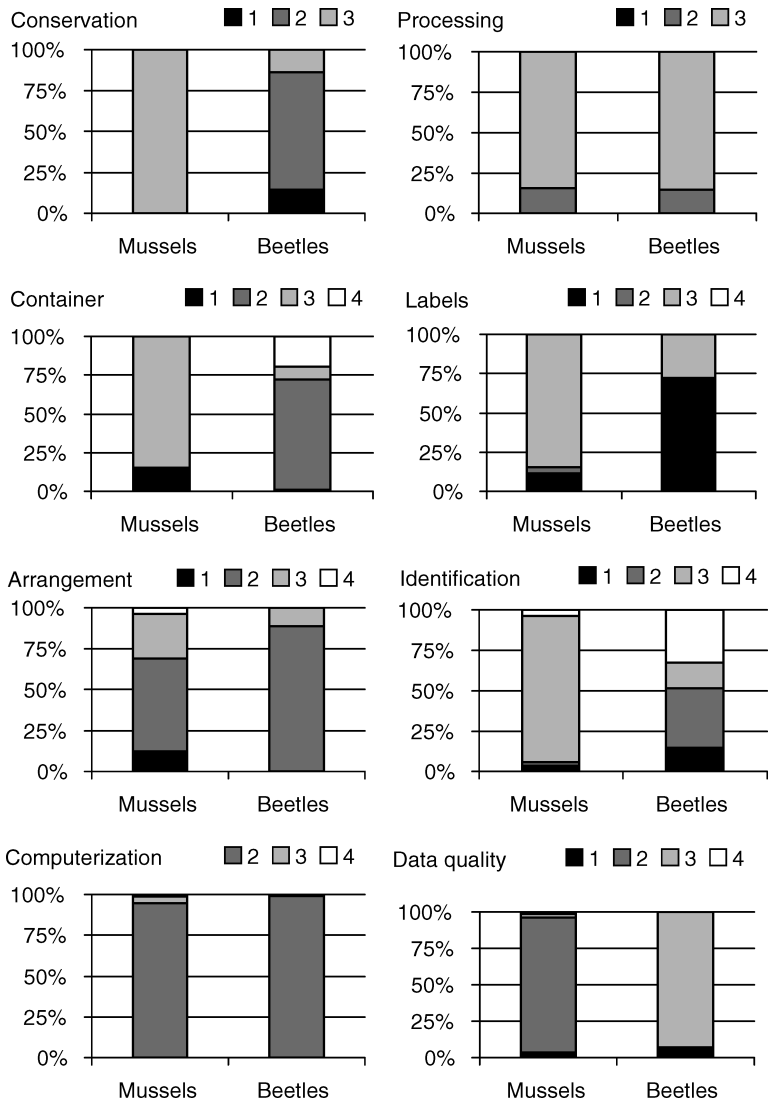

Figure 3. Proportional comparison of profiling scores for all eight profiling indicators in UI mussel and INHS ethanol-preserved beetle collections.

processing state, container condition, and identification level (Table 5, Fig. 2). For the most part, these disparities are attributable to the neglect the wet collection experiences in comparison with the more actively-used pinned collection. In an effort to address the poorer condition of the wet material, all the alcohol was replaced (improving the conservation score) and all of the old vial stoppers and wire-sided vial racks were replaced (improving the containers score). In contrast, the wet Hymenoptera scored better for data quality than the dry collection (Table 5, Fig. 2). This disparity is partly attributable to the Charles Robertson collection, a large and historically important collection of pinned bees (Marlin and LaBerge 2001), each specimen of which was assigned a single label with a number, referencing Robertson's collection logs.

In comparing the mussel and beetle collections, it is evident that the mollusks are in better overall condition than the beetles: the mollusk collection scores higher than the beetles in every category except processing state (where they are equal) and data quality (where the beetles outscore the mollusks) (Table 5). Parsing out the data more fully is especially instructive. All of the mussels are in good conservation state, whereas roughly 13% of the vial racks of beetles are problematic, and only 15% are in acceptable condition (Fig. 3). Surprisingly, the beetles and mollusks are almost identical with regard to processing state, but the beetle labels are in very poor condition, possibly due to the dark alcohol (low score on conservation status) discoloring the label paper. The specimen containers scores are a good example of the different messages received from arithmetic means as compared to profiling score distributions. Although the mean score for mollusks was slightly higher than the beetle score (Table 5), Figure 3 indicates that the mollusks have a higher proportion of containers rated as problematic, whereas the beetles have far more ideal containers (in this case, archival, plastic vial racks containing the well-curated aquatic beetles). Limited resources may best be allocated toward replacing the problematic mollusk containers first, and then working on the large number of substandard beetle containers.

Conclusion

Collection profiling has established itself as a useful tool for evaluating the health of any natural history collection. However, collection managers everywhere, for a variety of reasons, have been slow to initiate profiling of their respective collections. Perhaps the time commitment of profiling thousands of units is not seen as returning enough value. Perhaps the personal working knowledge of the collection is thought to be sufficient in making collection management decisions and prioritizing resources. With respect to the single collection manager who has relative autonomy in prioritizing projects, this hesitation towards profiling is understandable. However, with respect to museum directors, or other administrators who are called on to distribute funds or other resources to multiple collections, an honest and quantified assessment of the needs of the various collections under their directorship would be of great value. It is often easy to discount the hand-waving of collection managers who may complain of being under-funded, but it is much harder to ignore the hard data associated with collection profiling.

Likewise, without actual numbers, it is easy to ignore one collection to the benefit of another. General working knowledge of the collection indicated that the fluid-preserved Hymenoptera were in poorer condition than the pinned collection, but the stark reality of that disparity, presented quantitatively, is what spurred corrective action.

Profiling, albeit no panacea, is an important tool in reinvigorating collection management and in particular providing data to support funding requests. In today's political climate, unhealthy as it is for collections, the need for useful and direct diagnostic tools is greater than ever.

Acknowledgments

The authors wish to thank co-author Ron McGinley for his leadership on the INHS Collections Resources Committee in organizing the development of the INHS-wide profiling method here presented. Funding from NSF grant BRC-0447379 to CF is gratefully acknowledged.

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