NATURAL HISTORY MUSEUM – DATA RECORDING AND TRANSSMISION

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Abstract

Recording the information related to natural history collections, belonging to an old museum, like the Natural History Museum of Sibiu, which comprises a heritage of over a million specimens belonging to various scientific areas of study, is a permanent challenge. Retrieving the information regarding an object using the old records is either impossible or requires a lot of time and effort from the curators.

Obtaining the information linked to the specimens and its transmission can be achieved with the help of a database, which facilitates the process. The concept of a general database has been used for a long time by the internationally recognized natural history museums implementing this management tool in the collections curatorial process.

In Romania, at national level, there are regulations on how the museum, starting from the old written records, should computerize the data attached to the specimens, which theoretically should serve the bi-univocal relationship assets - information. Unfortunately the standards are the same for all museum heritage areas (art, history, natural history, etc.).

In this paper we intend to analyze the efficiency of this recording system when it is applied to natural history collections, based on case studies from our museum. The survey is completed with proposals to improve the actualization of these natural history databases.

Introduction

Natural History Collections are the heart and soul of a museum. Collections may be large or small, worldwide, regional, or local in scope. They can cover many different groups of natural history objects, or just one. Museums are the libraries where scientists find specimens to study (Allmon, 1994).

The history of collecting specimens from nature has been a long one, although just how long is uncertain. While illustrations from a mid-fourteenth century Flemish manuscript show people chasing butterflies, it is unclear as to whether the specimens were ever caught or stored. Later, however, particularly in the seventeenth and eighteenth centuries, it became fashionable to keep collections – creating a 'Cabinet of Curiosities' was a popular leisure activity. In those times, such an undertaking was mainly a gentleman's pursuit, although women, too, had their cabinets – a famous example belonged to Queen Ludovica Ulrica of Sweden, the contents of which were arranged by Carl Linnaeus, the father of taxonomy, and on which he based descriptions of many species (Scoble, 2000). The most extensive personal collections were built in the nineteenth century, a time of great exploration, and one when many European countries were colonial powers with associated personnel spread across the globe. Hence many collections were made by administrators and members of the church and armed services – largely as a leisure activity. The results of 'hobby collecting'constitute is a significant component of the holdings in many of the national, regional and local museums.

The Natural History Museum from Sibiu was founded in 1895 by the Transylvanian Society for Natural Sciences from Sibiu (*Siebenbürgischer Verein für Naturewissenschaften zu Hermannstadt*). The collections were initiated in 1849 long before the museum was open to the public, and the Society had regular scientific meeting since 1845. Its founding fathers were: Michael Johann Ackner (1782 – 1862), Michael Bielz (1787 – 1866), Ferdinand Schur (1799 – 1878), Ludwig Neugeboren (1806 – 1887), Daniel Czekelius (1806 – 1871), Michael Fuss (1816 – 1883), Karl Fuss (1817 – 1874), Gustav Adolf Kayser (1817 – 1878), Ludwig Reissenberger (1819 – 1895), Eduard Alber Bielz (1827 – 1898). Thru time many other renowned scientists joined the Society and the museum with one, general, purpose the study of the natural world and sheering the results of this research through scientific papers and collections. Today the Museum of Natural History from Sibiu shelters over one million specimens belonging to the following collections: Mineralogy, Petrography, Paleontology, Botany, Malacological, Entomology, Ornithology and Zoology (general). Each collection is unique and requires different management measures and curatorial activities.

During the nineteenth century like in other European countries in Transylvania, part of the Austrian – Hungarian Empire at that time, only the rich members of the society could afford to collect natural specimens for their curiosities cabinets. The passion of collecting natural specimens was carried out also by those who considered these sorts of activities an enjoyable way to spend free time. The members of the Transylvanian Society were amateur collectors at the beginning, their true professions (priests, doctors, jurists, pharmacists etc.) allowed them the means to pursue these extracurricular activities, and even the work they performed at the museum was voluntary. The Transylvanian Society had two main objectives the study of the regional natural environment and the environmental education of the community, these objectives were carried out through their collecting, study and dissemination activities. At the end of the nineteenth century and the first half of the twentieth century, the Natural History Museum from Sibiu represented for the local community a bridge between the local scientific community and the international renowned scientists, the Society members were known abroad throughout their correspondences, scientific research and publications, specimen exchange between them and other international collectors.

Natural History Museums and their role

Science knows no boundaries; collections are not national possessions but assets of the entire scientific world (Pettitt, 1991). The scientific mission of a Natural History Museum is set by its one profile: the study of biodiversity through research on the collection and transfer of scientific knowledge to the public, aiming to educate while spending enjoyable free time, the spread of knowledge regarding the Romanian natural heritage and that of the world, raising awareness of current issues related to the environment, species and habitats. Nowadays, biodiversity conservation is one of the important topics at international level. Over the past years, major changes occurred in the Romanian ecosystems too, imposing the necessity to reassess the ecological diversity situation and an important role in achieving this goals play the natural history museum collections. In the ICOM code of ethics for museums, Section 7, which discusses the legal framework, mentions the *International Convention regarding the trade of endangered species of flora and fauna* (Washington, 1973) and the *Convention on Biological Diversity* (Rio de Janeiro, 1992), conventions that any museum or collector must comply, stating again the importance and necessity of natural history collections. One of the initiatives started by the Secretariat of the Convention on Biological Diversity in 2006 is the Museum of Nature and Culture. The Convention on Biological Diversity's Museum of Nature and Culture serves as a great opportunity for Parties to share their cultural inheritance with the world, and to publicly showcase their country's unique biological diversity in an artistic and symbolic way. By donating artwork to the Museum that is reflective of the biological diversity unique to each country, the world benefits from the beauty of the individual artwork as well as the immediate need to protect and conserve the world's biological diversity for generations to come. These pieces donated are on permanent display as part of the Convention's Museum of Nature and Culture exhibit, and greet visitors as they enter the Secretariat.

Curators want collections that are reference tools for taxonomic, zoogeographic, and ecologic studies, rather than accumulations of specimens that are of little worth other than as curiosities (Emerson and Ross 1965). Who could have predicted in the 1960s that twenty years later researchers would routinely extract DNA from specimens preserved in ethanol. We can only guess what uses future scientists will have for museum specimens.

Plant and animal collections in museums, herbaria and research institutes across Europe represent a significant global resource for taxonomic and biodiversity research. More than half of the world's type animal, plant and fungi specimens as well as many historically important specimens are held in European collections. These collections represent a significant commercial, academic and educational resource and their loss would have a serious effect on collection-based research across Europe (Collins et al., 2005). The value of the museum heritage is enormous. Using museum labels, for example, one could extract important data. Metadata (records describing entire collections) extraction is especially important in huge and variable biodiversity collections and literature. Unlike many other sciences, in biology researchers routinely use literature and specimens going back several hundred years but finding the information resources is a major challenge. Metadata and data extracted from natural history museum specimens can be used to address some of the most important questions facing humanity in the 21st century including the largest mass extinction since the end of the age of the dinosaurs. What is the distribution of the species on Earth? How has this distribution changed over time? What environmental conditions are needed by a species to survive? (Heidorn & Wei, 2008). Also, metadata can significantly improve resource discovery by helping search engines and people to discriminate relevant from non-relevant documents during an information retrieval operation (Greenberg, 2006).

The study of natural science collections allows us to forecast the future of the planet – information that profoundly affects our lives. These are a few of the natural history collections uses and their impact:

- *Economy and trade*: Many regulatory decisions made by governments are supported by research that depends on scientific collections, including natural history collections. These decisions can have a major impact on foreign and domestic trade.
- *Changes over time*: Worldwide, museums, universities, and other institutions have been amassing collections since the 17th Century. By analyzing specimens collected at different points in time, researchers can reconstruct important historical changes. Collections offer scientists a window on the past.
- *Environmental Studies*: Collections document the condition of soil, air, and water, help track pollution, and enable us to model future environmental changes so they can be better managed. Many studies in the fields of ecology, evolution, pollution and climatic changes require museum specimens. Provided selective collecting is allowed for, museum collections are logical places for life history studies. Using existing collections for such studies often enables large amounts of data to be accumulated in a short time on such things as fecundity/mortality patterns, host-parasite relationships, estimates of breeding seasons, micro-growth increments (many organisms show growth layers when sectioned, such as the 'rings' of a tree, and these can be used to study past environmental conditions), food pests, life-cycle duration, larval growth pattern, migration (museum collections have been used to locate locust outbreak sites and to track traditional migration patterns), species that mimic other animals, and other polymorphisms, plant fecundity, flowering and fruiting dates, periods of dormancy, and correlations of plant growing sites with rainfall or altitude. Systematics collections provide a wealth of historical information on habitat composition, and on the distribution of plants and animals, that is invaluable to those predicting ecological shifts due to global climate change.
- *Nature Conservation*: The mapping of distribution patterns of birds, animals, plants and so on, essential to protect the environment, and for the adequate assessment of planning applications, also needs natural history collections; maps of rare and critical species can be reliably prepared only from museum (voucher) specimens.
- *Food and agriculture*: Scientific collections of agricultural pests and other threats to food safety and security are used routinely for border inspection, consumer protection, and control measures. Crop pests can be studied in part by examining pest-damaged material in herbaria (galls, etc); potential control organisms for weeds can be identified by studying 'habitat' details of insects as recorded on museum labels. The prickly pear invasion in Australia was successfully controlled following a study of this kind. Insect pests, and suspicious weeds and seeds, all need the collection for reliable identification. Otolith (ear-stone) collections give information on the historical age distribution of

populations of fish and whales, and the results can demonstrate whether the stocks are declining (Pettitt, 1991).
- *Public Health and Safety*: Whether they are used to track down the cause of a deadly new epidemic or to learn important lessons from an ancient one, collections are pivotal resources in the fight to save lives and to improve the health and safety of people around the world.
- *Invasive Species*: The easy movement of trade goods through ports is vital to the global economy. At the same time, invasive species that stow away with these goods can threaten our crops, ecosystems, and animal and human health. In the United States there are estimated to be over 50,000 invasive species; collectively, they cause nearly $120 billion worth of environmental damage and loss per year and can spread infectious diseases to animal and human populations (The Society for the Preservation of Natural History Collections).
- *Underpinning taxonomy*: A well referenced natural history collection is necessary for obtaining accurate identification of biological material.
- *Education value*: In lifelong learning where collections are used as learning resources to instruct, inform and inspire. The museum must publish information about itself and the collections. Museums must have as priority to published catalogues which enables users to know the extent and the nature of their collections (Stanley, 2004). Education as a crucial museum function has been recognised as long as there have been public museums.
- *New data*: Collections of objects often serve us in ways that could not have been imagined at the time when they were made. Sometimes these unanticipated uses can help solve today's most pressing scientific problems. Likewise, years, even decades from now, new analytical techniques will allow researchers to use the same specimens to answer new questions.
- *Archaeology and Ethnology*: Identification of bone, shell and insect fragments from archaeological burials and excavations, to assist the correct interpretation of the site. Ethnologists also require bits and pieces of feather, fur, skin, bone, shells and botanical material such as gourds identified in human artifacts. These identifications would be impossible without extensive reference collections.
- *Historical studies*: Collections can yield information of importance in historical studies. The collecting data attached to specimens collected during expeditions and campaigns has assisted in fixing other historical events in sequence. The history of anatomical preservation, and of taxidermy, can only be studied using museum specimens (Asma, 2001). The collecting and the collections influence the development of society and science, on local and national biodiversity history (Stanley, 2004).
- *Law enforcement*: museum reference collections can identify hair as human or non-human, can tell the age and race of an unearthed human skull, accurately identify hairs as evidence in prosecutions over badger hunting, and identify pollen grains or grass fragments for 'scene of crime' forensics, all of which can only be done with the authority of a reference collection. Collections also help customs officers keep our green and pleasant land unsullied by illegal animal and plant imports: powdered keratin from rhino horn, horn or ivory objects, or pelts and leathers - often as made up goods. Sometimes only a tuft of feather or hair, or a small piece of skin is available, and without considerable expertise backed by extensive reference collections the task of positive identification would be impossible. The public is usually quite unaware of this activity. Without it, the legislators could legislate about the control of export or import of animals and plants until they were blue in the face - but to little effect.

Natural History Collections are non-renewable resources as many specimens now existing in museums would be impossible to collect again due to destruction of sites or habitats (Winston, 2007).

As Duckworth et al. (1993) have pointed out natural history collections are cost – effective: "Virtually all explorations during the past 300 years, from discoveries on earth to forays into the solar system, have resulted in additions to the collected resource in the natural sciences." Even in cases where specimens could be recollected, the cost of the doing so each time they were needed to support a research project would be astronomical compared to the cost of maintaining them and adding to them judiciously over time. Art objects tend to have high market values, which most natural history objects at present do not, although the Moa egg broken in the 90' in a Tasmanian museum was valued at £600,000, a respectable figure even compared with current art object auction prices. If, however, one considers the cost of attempting to replace a natural history collection, then its monetary value would generally be astronomical (Pettitt, 1991).

Collections of natural science specimens are the foundation for our scientific understanding of the natural world. Among other purposes, we use collections for identifying species, teaching, maintaining verifiable records of changes in our environment, prospecting for new medicines and determining the paths of infectious diseases.

The recording and transmission of natural history data

More than a billion biological and geological specimens have been collected, preserved, and deposited in the permanent collections of museums and herbaria around the world. These specimens are the foundation of our knowledge about biological diversity, the planet formation (rocks and mineral), the past and present. Researchers in biodiversity informatics are engaged in providing digital access to the basic biodiversity data associated with specimens, as well as new software tools and services that will create novel research opportunities for ecological analysis, predictive modeling, and synthesis. Greater access to structured biodiversity information also directly benefits applied areas of conservation and resource management. Digitizing the data associated with a billion specimens is an enormous task, and much of it still lies before us. Already, however, tens of millions of specimen records have been captured in collection management systems that represent a solid foundation for comprehensive digital libraries in the museum community (Beaman et. al., 2004).

Most natural history collections contain thousands, if not hundreds of thousands, of individual pieces that require care. An individual specimen may contain hundreds of related pieces. Thus guidelines for collection management and care must take into consideration the reality of large quantities of specimens and numerous pieces per specimen. Evidence of the identification, condition, history, or scientific value of a specimen, artifact, or collection when recorded in a permanent manner enhances the value of the specimen. Each institution should develop collections policies and procedures that provide a written framework for collection management, care, and use. It is essential that each institution also provide the resources (e.g., time, money, qualified personnel, appropriate space, and facilities) needed for the long-term preservation and documentation of the collections under its responsibility, or make alternative arrangements for collection management and care with an appropriate allied institution (Society for the Preservation of Natural History Collections).

As a museum manager and curator the main question is what information should be made available considering the user community and its varied requirements. At European level the European Commission lunched in 2000 a three-year project called ENHSIN (European Natural History Specimen Information Network). Coordinated by The Natural History Museum in London, it aimed to create an interactive system facilitating access to these valuable data. Among the most important are the place and date of discovery of each specimen, as well as the exact scientific name attributed to it. Seven institutions have teamed up to work on developing this pilot network. Results of the project showed, in decreasing order of importance, the following aspects related to a natural history specimen (Fig. 1): the general collecting sits are of the almost importance, followed by the collecting data, exact collecting sits, biological information, collector (s) name (s), collecting method and the collecting time. Old natural history collections, like our collections, that were poorly funded and curated over the years, can offer to the general scientific public the general collecting site, biological information that can be obtained by examining the specimen, the collector (s) name (s) and, in some cases, the exact collecting data.

ENHSIN produced also a provisional questionnaire to assess the requirements for an integrated network of databases on natural history specimens. The questionnaires were sent in 30 countries including Romania, both at scientific and sectoral level (Table 1).

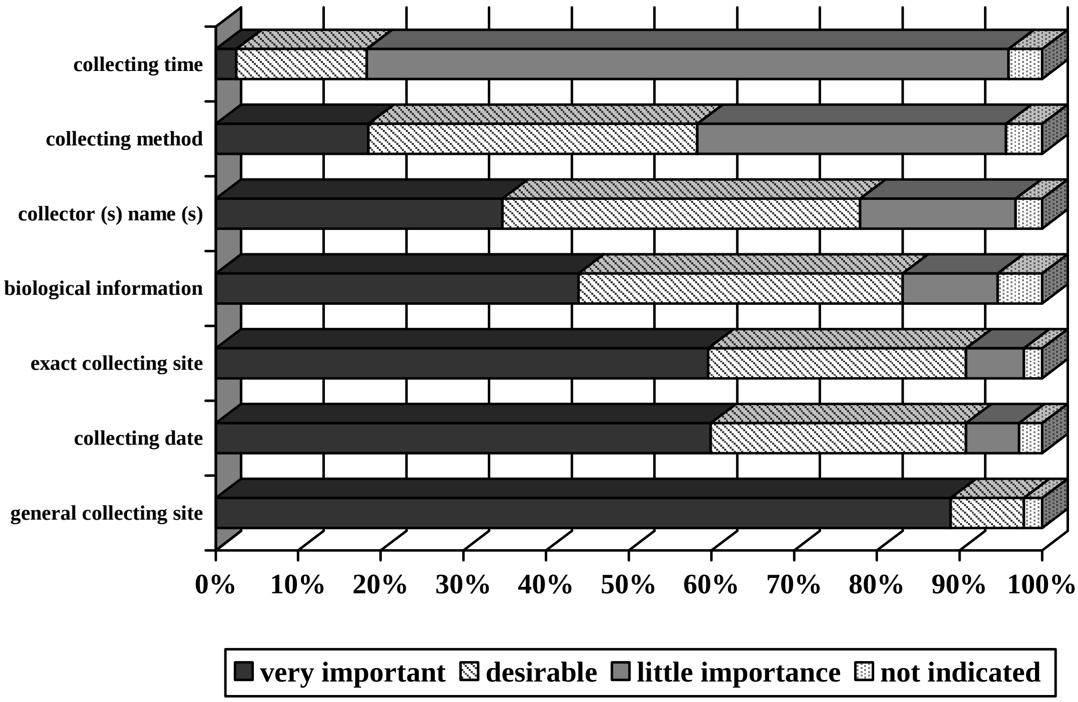

Fig. 1 Distribution of percentages of importance assigned to natural history museum specimens data considering scientific users (http://www.nhm.ac.uk/research-curation/research/projects/enhsin/index.html)

Tabel 1: Importance of data concerning a natural history specimen (Calabuig et. al., 2000)

Museum specimen information	**Percentage assigned very important (%)**	
	Scientific users	**Sectoral users**
Valid/current name	90,8	86,8
Collecting site, general	88,9	64,5
Location	87,3	67,1
Type status	65,3	22,4
Collecting date	59,9	36,8
Availability for loan	59,6	35,5
Collecting site, exact	59,6	32,9
Author of valid/current name	58,3	31,6
Name of curator/contact person	56,4	46,1
Availability for study on site	52,9	32,9
Changes of identification	52,5	31,6
Sex	42,4	48,7
Development stage	44,6	47,4

ENHSIN was the predecessor of the Biological Collection Access Service for Europe, BioCASE, EU funded project (2001 – 2004), a transnational network of biological collections of all kinds. BioCASE enables widespread unified access to distributed and heterogeneous European collection and observational databases using open-source, system-independent software and open data standards and protocols. These laid the groundwork for implementing a fully functional service unlocking the immense biological knowledge base formed by biological collections. During the project 31 countries established the network, starting with meta-information on thousands of biological collections, and followed by a unit-level data (individual collection or observation units, for example individual specimens or observation records) access network.

Regarding our museum collection the unit-level data is included on old original labels which in many cases are incomplete or hard to read, or even more disturbing some specimen's labels are missing. The museum collections from our museum were donated by the members of the Transylvanian Society for Natural Sciences from Sibiu who worked as volunteers, as we previously mentioned. The recording of the collecting data associated to the specimens was not a priority to collectors, because the number of specialists and museum staff was reduced and the Society members were collecting natural specimens belonging to different scientific areas. For example, the museum includes both a mineralogical and molluscan Bielz collection. In the museum archives are found old inventory books, written in German by the Society members, incomplete and today useless because the old inventory numbers were changed and during time were added new ones. On the other hand, the Society did not benefit from a true headquarter until the museum was opened, and until then the collections were moved from one place to another and thus, we presume that a lot of written information was lost. During the world wars, the evacuation of the collections in secure spaces contributed to the lost of information, specimen labels. In 1949, when the communists came to political power, the collections were confiscated by the state and for each one of these collections were made economic inventory books not scientific ones, with new inventory numbers for the specimens replacing the old ones. These inventory books written by accountants replaced the old scientific inventory books. They grouped the specimens according to genus or a general characteristic thus making the inventory books easier to follow from an accountant point of view but impossible to read by a scientist. An inventory book that can be of interest to a scientist should include written information for each specimen apart, data extracted from the original labels (old scientific name, collecting sites and date, the person who collected the piece) and from this information the museum curator could bring up to date these information according to today's taxonomy and toponymes. For example, the Paleontological Collection from our museum includes thousands of foraminifers specimens registered under the unique name "Miocene microfossils from Transylvania". Accountants gave inventory numbers to hundreds of pieces without taking in to consideration the scientific value of the objects and so by receiving an inventory number these specimens have today national heritage value and are protected by law. These specimens are a problem for the museum curator, as extra work, waste of space and time. These inventory books are no use from a scientific point of view, only from the economic aspect of the collection. With time the collection curators wrote in notebooks each specimen scientific names following the original labels, the collecting sits and the place where the piece can be found in the deposit. Over time, the curators and scientists published papers after studying the collections, but the results of their studies were not included in the general inventory of the collection or even worst the lists published included museum specimens without their inventory numbers, making it impossible for future generations to identify which one of the specimens was subject of those studies.

Many other natural history museums used the card index before the computerized databases, one of the major ways by which the data was catalogued, especially information that was subject to change over time and which needed to be kept up-to-date (Beccaloni et al., 2000).

Although card index archives have served the natural history community well in the past (and continue to do so often), they have many disadvantages when compared with computer databases. Cards are all too easy to misfile, misplace or lose. They become degraded with use – characters may fade and cards get torn or bent. Handwriting on cards is often illegible, and archives are difficult to copy. Adding data to existing cards or making corrections can prove a problem (e.g. because of lack of space), and maintaining consistency of data is not straightforward (e.g. if abbreviations are used for journal names). Indexes take up a large amount of physical storage space. The Museum of Natural History from Sibiu presents index cards for a part of the Malacological, Mineralogical and Paleontological Collections, having as source the original labels. Unfortunately these index cards were written by non-specialists and many of them do not include scientific correct information.

The advantages of an electronic database over the traditional index cards and hand written inventory catalog is obvious. Strum (2006, 2) considers that computer databases are excellent for searching the records of the collection. However, the curator has to make sure that the data can be accessed now and in the future. Whether a database that is stored and not used for ten or twenty years will remain accessible is uncertain because of rapid technological changes. On account of these uncertainties some collectors, even today, are continuing to maintain a paper-based catalog along with their digital one, as it is our opinion as well. Such a paper-based, in the case of our collections, can be a print out on acid free paper of the digital catalog, the material we have so far. This also allows the collection to remain useful if the digital form becomes corrupted or unreadable. In conclusion the computer – base registration system will considerably increase the accessibility of the Museum collection. It must "combine a minimum of main-hours with optimal flexibility in storage and retrieval of data, and an acceptable employment of computer time and equipment" consider Germeraad et al. (1972).

According to the Cultural Ministry Methodological Norms of museum collections evidence, curatorial and inventory processes from 2000, the inventory lists regarding museum heritage pieces (no matter the area of study) should include in an excel table the following 16 columns: 1. inventory number, 2. the date when the object entered the museum heritage, 3. the name or title and the author of the object, 4. description of the object and its photographic image number, 5. number of pieces, 6. the place, date and author of the discovery, 7. the collection to which the piece belongs to, 8. material and technique, 9. dimensions and weight, 10. conservation status, 11. how the piece entered the museum's collections (donation, acquisition, collected by a museum employee etc.), 12. entry document record, 13. the value of the piece, 14. exits where the specimen was shown, 15. verification, 16. observations.

Some of the fields used today may not be of immediate use to the curator, but could enhance the value of the collection. But considering the small number of museum staff this inventory lists are impossible to accomplish when it comes to collections of over 1.000.000 specimens and only 5 museum curator (for geology, mallacology, botany, entomology, general zoology).

An alternative to the Excel format was elaborated by the Institute for Cultural Memory. DOCPAT (DOCumentarea PATrimoniului Cultural Mobil şi Arhivelor Documentare) program for the museum collections record, carried out by the institute, distributed free to over 170 users around the country (http://www.cimec.ro/DespreCIMEC/Report-Activity.htm, accessed on 28.06.2011). In general, the database program includes an area designed for a natural history collection, but there are a few negative parts in using it. The program has restrictive limits regarding the total number of records, the number of fields per record, and even if the number of characters per field or record is not restricted when the analytical evidence paper is generated the data is not complete because it does not fit in to the empty space generated for each entry. Fields can not be added midstream and their properties such as length or type can not be changed. The scientific names of the species must be written with italic characters which can not be performed. Reports can not be printed using italic and bold typefaces, various font size and proportionally spaced fonts. It is not easy to insert letters with diacritic marks such as in Röding, Müller, the person completing the field has to write the name in a word document and then copy it in to the field. The program is not web-ready, if the data will be made available on a website on the Internet, as many scientists asked the museum staff in the past. The program is not object-oriented, object such as "Genus+Species+Author+Date" can not be created and used repeatedly, and it must be created anew each time. One of the downsizes of this program is that if the scientific name of a specie, its classification changes, the museum curator has to make the correction needed for all the entries, each one at a time, which is a very big set back.

If one of the advantages of computerizing the archives, the specimen information, were to be a saving of space, with the old inventory books being subsequently disposed of or placed into storage, the specialist coming to research the collection would not spend a lot of time searching for the desired piece, but then the original archive would be either unavailable to users or difficult to access. This could be a problem if, for example, doubt arose as to whether information in the database had been transcribed correctly from the original labels, or if the museum curator has redetermined the specie correctly, as it happened in our case. Such a limitation is overcome if digital images of the original labels are incorporated into the database, together with the minimum amount of data necessary to index the images (e.g. the scientific names of the organisms). A superior system would be to have a database with images of all the labels, plus fields containing all the information contained on them.

Computerizing shell Collections

The molluscan collections from the Natural History Museum of Sibiu (Romania) shelter about 515.084 specimens, among which 209.653 specimens are inherited from the Transylvanian Society for Natural Sciences from Sibiu. The Transylvania Society for Natural Sciences from Sibiu Malacological Collection was initiated in 1852 when L. J. Neugeboren (founding member of the Society donated 210 shells of mollusks. In the second half of the nineteenth century and in all the years that followed, members of the Transylvanian Society have focused on the expansion and deepening on the knowledge of the Malacological fauna from Transylvania and the one specific to the Carpathians. There were a large number of specimens collected. Society members who had an essential contribution in achieving the Malacological collection, preserved today in the Natural History Museum in Sibiu, were Michael Bielz (1787-1866), Edward Albert Bielz (1827-1898) and Carl Friedrich Jickeli (1850 -1925). Currently, the Transylvanian Society Malacological collection includes 209,653 pieces, of which 20,000 belong to the Jickeli collection, the majority being included in the Bielz Collection (Mesaroş, 2010). In 1967, Richard W. v. Kimakowicz donated to the museum the Kimakowicz Collection, counting 305.431 specimens, collected for more then 80 years by Moritz and Richard Winnicki von Kimakowicz, the result of the father and son passion for natural sciences, mollusks in particular.

These collections are probably the most valuable in Romania and among the most representative in Europe, in terms of age, historical and documentary value, coverage (the main material was sampled from here, but also from other continents and a large part of the world's Ocean are also represented), number of series and types of specimens.

The 515.084 specimens belong to 5 classes, 15 orders, 238 families, 710 genus and 10.300 species (Corocleanu, 1987). Most of the information has not yet been stored electronically, which impedes considerably its access and thus effective use. The task of making the specimen information available is, however, so great that it is necessary to priorities.

Once a shell collection reaches a certain size it becomes difficult to keep in order without a formal system. Specimens stray from labels and unrecorded information fades from memory (Rosenberg, 2006). Corocleanu I., molluscan Malacological curator attempted to compile the label information on index cards. The museum curator did not hand wrote index cards for each inventory number. If from one inventory number to another there was the same specie, according to the original labels, then she made one index card for all those inventory numbers. On this card she wrote the specimens scientific old name, as written on the original label, the collecting sites and in some cases the person who collected them and the date. Some observations are hand written on the back of the index cards with a pencil. This index cards were arranged in alphabetical order according to the first letter of the genus name. Unfortunately these old scientific names are today included as synonyms and to find a specimen in the collection using these index cards one must know and search for all the synonyms and then extract the index card and then locate them in the collection to see if that piece is really what the card point out to be. Even so, not all the molluscan collection benefits from index cards.

As a general observation this collections are hard to manage and study. For example Sîrbu (2010) published a list of freshwater mollusc from Romania identified in the collections of our museum. The author had some negative observations regarding the collection records:

- The collections' old written catalogues are usually of no use, because the material is not revised.
- The collecting sits are originally given (both in labels and publications) in German or Hungarian, seldom also in Romanian, thus, besides the systematical revision, the person studying the collection has to identify the present-day geographic names.
- Regarding the collections' preservation status, and additional available information, very often the series are mixed and either contains no label, or this is unreadable. Most mollusc series are placed in boxes, arranged on two rows in larger wooden boxes, which are highly unreliable especially when transport is concerned. Thus, many series contain material from other sources.
- Sometimes the labels are printed, especially with the name of the collector, while the species name is either printed, or, more often, written in ink or pencil. Even when this is the case, some information is impossible to be restored because of illisible words. However a lot of effort was invested in order to decipher the former gothic letters, when available, and to translate them in modern information, taxonomy and toponymes.
- Lots of labels contain only the old species' name, but no data regarding the sampling place, thus restoring the original data is highly incomplete and sometimes impossible.
- Future revisions, modern preservation techniques and proper storage conditions are strictly necessary in order to pass to other generations this heritage.

These observations present, unfortunately, the real image of the collections and are the result of the general lack of specialized staff, economic funds and storing space and conditions, making thus the realization of the required databases an almost impossible job for only one curator.

In general, the use of word processors (Microsoft Word) or spreadsheets (Microsoft Excel) for creating databases for shell collections is not recommended if more then a couple of hundred lots are involved (Rosenberg, 2006) as it is the case of the molluscan collections from the Natural History Museum in Sibiu. Relational databases use space more efficiently then a spreadsheet prevents duplications, enforces formats if desired, provides vocabulary control and has sophisticated querying and reporting functions.

Dimensions and weight of a specimen, measuring a shell in general to the nearest millimeter or tenth of a millimeter, recording the size and the data in a ledger is possible only if there are a few specimens of a given taxon in a collection, this method becomes impractical if there are hundreds of specimens of a given taxon as it is the case of our museum collection. The size can be used as means of identifying the type specimens.

The Material and technique section present in the general database is useless for a Malacological collection because the museum curator can not run chemical analysis on the shells to determine the specific material and the technique in which the piece came to be is a biological process.

Until today, the museum curator has made an effort and completed the required information in those fields that conquered with the curatorial aspects of a Malacological collection, bought in the case of the Excel database and of the DOCPAT database.

An example of success: after 22 years of work, a team of molluscan museum curators from the St. Fagans National History Museum, National Museum Wales curated a collection of over 700.000 specimens. The Melvill-Tomlin Collection comprises over 786. 000 shells and the collection were acquired in 1955. The collection arrived in mahogany cabinets. The new entries were hand written into large registers. In 1978 Graham Oliver (museum curator) developed a paper system for recording information and with the help of another colleague started a programme tackling curation of the Melvill-Tomlin Collection. Between 1978 and 1994, for 16 years, the two museum curators aided by volunteers curated over 64 superfamilies, establishing the present name and labeling and securing the storage container. When each superfamily was finished the written hand list was published and sent out to institutions, in this way the information was disseminated to taxonomists, who visited the collections and study them, the museum gathering new records and new data to its recording system. In 1995 the museum staff decided to accelerate the pace of documentation by inputting the basic collection information, for each specimen the inventory number, the scientific name and the collecting site. All the data was then included in to a rapid entry database using Filemaker Pro, allowing many people to enter data at the same time. Since 1997 the museum had over 20 staff members' curetting the molluscan collection. After 22 years the general inventory to the Melvill-Tomlin Collection is available, making it possible to find in the collection a specimen in a few seconds not weeks, scientists can help easier the museum curators. In the last 15 years the storage conditions of the collection were also modified. The collection was unified in a single deposit. The shells were housed in mobile storage racking with a drawer system, mowing to increase or decrease the distance between the drawers. This flexible method of storage allowed the curators to arrange the specimens as they considered more accessible to inventory the collection and thus to any researcher. This is an example of team work, because only with the help of other mallacologists, colleagues and volunteers this achievement is possible. The success of the St. Fagans National History Museum staff is a source of inspiration.

The Natural History Museum from Sibiu Malacological collections are a work in progress and will require years to come, as today there is only one employee curetting over 515.000 specimens.

Computerizing zoological Collections

The zoological collection preserved in the Natural History Museum of Sibiu, numbers more then 20.000 specimens, namely spiders, birds, mammals and a small number of amphibians, reptiles, tunicates, comb jellies and echinoderms. The high diversity of species regards that data management is a key consideration to determine the type of database that will be used.

The present software DOCPAT used for data recording and transmission has aroused some issues regarding the curatorial activities of our Zoological Collection. The software has several menus for data recording: assignment, technical data, collecting sites, description, references/observation, management, images, responsibilities, restoration and circulation.

First of all, the label format lacks flexibility. There is no clear differentiation between the measurements that have to be done. In addition, the weight label has no point what so ever, due to the fact that preserved mammals and birds specimens don't have the original weight.

There are too many collecting sites labels that are useless. For example, there is no importance what county or other administrative region the specimens were collected. The G.P.S. coordinates fields have no preformatted signs for grades, minutes or seconds, which would make an easier task for museum curators.

It's demanding to have digital access to the basic biodiversity data associated with specimens. Though, it's a harsh challenge to proper manage various classes of information linked to biological specimens, when one is dealing with more than 1 million specimens as it is the case of our Natural History Museum.

Computerizing geological Collections

The Geological Collections include specimens that belong to three scientific areas: Mineralogy (12.254 pieces), Petrography (7.005 pieces) and Paleontology (57.159 pieces).

To analyze the progress made in computerizing the Geological Collections we should make a brief foray into the collections history. Since the early days of the Transylvanian Society (1849), who founded the Museum of Natural History (past and present deposit of the collections), the members have donated, and collected geological specimens. The second decade of the nineteenth century was a period of important geological discoveries in Transylvania and of subsoil riches intensified exploitation. Also, in this period, specialists from Western Europe developed, in collaboration with the Society members, important geological studies (Ciobanu, 2003). All these have resulted in increasing, sometimes dramatically, the number collection specimens. For southern Transylvania and the Austro – Hungarian Empire, the Society and the Natural History Museum were a landmark and a model for scientific research in techniques of collecting natural specimens and starting new collections (Ciobanu 1998). In this collecting frenzy and publishing the results of the field work, the written geologic records of the specimens were a sideline activity long neglected. Geological specimens did not require so much attention - in terms of conservation, storage in comparison to other biological specimens.

During 1849 - 1945, the Society edited 95 volumes entitled "Verhandlungen und Mitteilungen des Verein für Naturwissenschaften zu Siebenbürgischen Hermannstad". In the journal section News about the Society "Vereinsnachrichten" was listed all the activities and work done with museum specimens. These records can be referred, in terms of museum specimen's inputs by bibliographic means. The only complete record is the financial assets inventory book required during the nationalization of the Society collections, records prepared by an accountant especially interested in the financial value of the specimens and the need for each to receive an inventory number. Thus, were given inventory numbers to many pieces with no original label, no bibliographical reference, damaged from a scientific and museographic point of view. Current legislation indicates elaborate procedures for eliminating a piece from the collection making the registration a difficult process.

The Mineralogy-Petrography collection hand written inventory books include detailed information because of the important work done by one of its custodians Rudolf Binder, which recorded and curated the collections between 1928 and 1958 (Ciuntu, 1998). This collection data was computerized using the Excel table database with the following headings / fields: name, place of collection, storage location.

Macroscopic measurements were made at the beginning of the twentieth century and for some mineral species the diagnosis may not be correct. But this is not an impediment because a researcher after accessing the data bank can study and modify the diagnostic specimen. The difficulties are related to the large number of fields to be filled in the Excel database and DOCPAT program and the inconsistencies between the two types of databases, in force at national level.

For example the size and dimension section, the measurement unit indicated in the Excel database for minerals is the centimeter while in the DOCPAT program is the millimeter. Also, measuring and weighing the fossils and mineral rocks requires a long time and these process may be replaced by photographies of the pieces set next to a ruler. The researcher interested in geological specimens can then complete with personal observations the database.

The description section present both in the Excel and the DOCPAT database makes the process of registering the general data difficult. A correct geological description can be made only by a specialist in that specific fossil group or in the mineralogy – petrography area.

On the other hand specimens belonging to the same systematical group, collected from the same area may have the same characteristics and the time spent on writing the description, for hundreds of times, is unnecessarily lost.

A Paleontological collection, as old as the one held at the Museum of Natural History from Sibiu, including pieces that have few or no data is almost impossible to complete the proposed computerized databases.

Computerizing Entomological collections

The Entomology Collection of the Natural History Museum of Sibiu, dated from 1827 (Pascu & Schneider 1988) is considered one of the oldest entomological collection from Romania. The collection comprises 265.777 specimens, divided according to their higher taxonomy in separate collections (Pascu & Schneider 1988).

Along the years, the specimens present in the collection, were registered in a written inventory book including the following data: the inventory number (new and the old one), the registration date of the specimen, genus and species, the sample location name, date of sample, number of specimens comprised by that inventory number, the collector's name, the name of the person who identified the species, the name of the person who redetermined the species, the way the specimen entered the collection (donation, it was bought), conservation status, observations and the number of collection display case (storage boxes).

The entomological specimens were sampled during the years 1850, 1900, 1920, 1940, 1950, 1960 and they have been registered in a written inventory book starting with 1960, after the information included on the specimen label. Not all the specimens present in the collection were registered in the written inventory book (today there are registered only 26.202 specimens out of 265.777). Regarding the inventory book, not all the entries are complete because the specimen's labels don't contain the location, date and the collector's name (the basic information when a specimen is sampled).

Beginning with 2008, the museum curator following the general instructions started to register the collection data in to the predefined Excel database. Being a standard template the museum curator added sections that are necessary for the Entomological collection. For the Location, data and collector's name section there are two columns one for the original data from the labels, with the old German or Hungarian names of the collecting sites, and one with today's toponymes. Another section added by the Entomological collections museum curator is the number of the display case that includes the specimens making it easier for the staff to find it in the deposit cabinets. Also a necessary section added is the total number of specimens included in a display case, for better evidence of the number of specimens preserved. Because the majority of the species need to be checked according to today's taxonomy, a section will be added in the electronic inventory book containing the present day scientific name and its actual systematic position.

There are also worth mentioning some aspects regarding the inventory procedure of the Entomological Collection. Regarding the transcription of the specimen labels it is sometimes hard to recognize the hand writings, because some labels were written in 1850. Further, the collecting sites names are often written in German or Hungarian and need to be translated and included in the databases both with the original name and translated, to preserve the original data. Regarding the specimen's manipulation, a special care and attention is given to the insect specimens, they are very fragile and easily can been broken that's why they must be handle with a lot of attention in order to access the information on the labels (sometimes the information on the labels has to be read with a magnifier and the pieces of paper including them have to be removed from the pins). All this actions and activities require a lot of time. To sum up, to inventory one display case, containing more than 100 specimens, it takes approximately one and a half day of work, not counting here the searching for the collecting sites toponymes and other section that must be compiled in the predetermined databases. Computerizing 265.777 specimens requires a lot of time considering that there is one person in charge with the inventory, when in many other museum there are several specialists that are implicated and contribute with the inventory of similar entomological collection or with a lower number of specimens.

An important contribution to the inventory process is received from specialists that researched our Entomological collections. Their published work mention several systematic lists of species, from the

Entomological collection, that can be used in present (some species found in their catalogues aren't recorded in the written inventory books of the Entomological collection). Another contribution is brought by the old hand written collection catalogue of the collectors, that haven't been recorded in the written inventory books.

Computerizing botanical Collections

The Botanical Collection from the Natural History Museum in Sibiu includes 186,739 pieces, divided in to 51 Herbaria maps with preserved plants specimens, the majority belonging to Michael Fuss (1816 – 1883) Herbarium and Erasmus Julius Nyárády (1881 – 1966) Herbarium. The Botanical collection also includes: the Buds and Shoots Collection, the Exotic Fruits Collection, the Wood essence plant Collection, the Seed Collection, tubs and jars with plant fragments, microscopic slides and drawings of plants. The diversity of this heritage causes many problems when it comes to computerize the information related to the collections because in many cases the predefined Excel datasheet imposed by the Cultural Ministry Methodological Norms of museum collections evidence includes unnecessary or very difficult to apply sections for each collection. On the other hand, the botanical collections are hard to manage and study due of the unreadable handwritings on the labels, the plants are not revised and the original collecting sites are given in German or Hungarian.

The most common problem of the botanical collection involves the "Number of voucher/pieces of the specimen" section. In the botanical field number of specimens means the number of whole plants, with all its morphological parts (e.g. flowers, stems, leaves, seed and fruit). The reality is actually different because in herbarium the specimens found are represented by parts of the plants or/ and whole plants pressed on a sheet of paper. In this case is very difficult to count the specimens and their remains, only a subjective assessment of the museum curator can be made. Also, some plants as algae, fungi and moss are a real problem in establishing the number of specimens. The "Dimension and weight" parameters raise real questions due to the fragility of the plants which make these very difficult to handle in order to establish the required information. For example, preserved plants mounted on paper sheets can not be weigh because it is impossible to estimate how much is the weigh of the plant and how much is the weigh of the paper. According to the DOCPAT program plant measurements are summarized to length and height of the leaf. How should a botanical curator measure a specimen from the Gall (Cecidia) Collection, from the Moss Collection that were gathered and preserved with the natural surface where it developed (stones, bark etc.), making them impossible to measure and weigh. The dimension and weight measurements for many specimens are impossible or unnecessary because these are not representative to plant identification. Besides these parameters, there are problems in completing the section "Age of the plant" at harvest which is unnecessary for many plants and "Description of the species" which takes most of the museum curator time, and the information is already included in scientific papers.

To summarize, considering that it will take an average of 30 minutes (this time is necessary to find information as current scientific name, present day name of the collecting sites, translate the label information) for the botanical museum curator to type in to the computer program the specimen information and that the collection has 186,739 specimens, in approximately 40 years the full-time employee will have registered all the pieces in the required database.

Conclusions

We consider that before we start creating databases and Excel inventory tables we should create a better storage conditions for the specimens, and after that the data included on the original labels should be recorded, the labels photographed and included in the species databases. After that each specimen should be identified according to today's taxonomy, photographed and if the case (type specimens) measured. The aim is that records of our holdings are managed through a database management system and searches of the collection may be performed online. Correct identification and organization of specimens and their associated information is critical for the use of the collections and requires experience and specialist knowledge. Associating data unambiguously with specimens will assure that the specimens will have lasting scientific value. If data slips are lost or mixed with other specimens, if notebooks are lost, or if the code, old name for associating locality data with specimens is undecipherable, then the specimens become worthless to researchers. Unfortunately, these losses happen all too often.

Natural science collection play a substantial role in: understanding biodiversity, supporting nature conservation, furthering education and serving the community. Specimens held in biological collections form a physical inventory of biodiversity. Most natural history collections contain thousands, if not hundreds of thousands, of individual pieces that require care, as it is the case of the Natural History Museum from Sibiu. An individual specimen may contain hundreds of related pieces. Thus guidelines for collection management and care must take into consideration the reality of large quantities of specimens and numerous pieces per specimen. An institution's program for managing and caring for collections exists within the context of the institution's mission and resources. Management and care of collections of natural history materials should be governed by respect for the scientific, historic, physical, cultural, and aesthetic integrity of the specimen or artifact and its associated data. Documentation should meet the highest professional standards and follow recommendations of relevant professional societies (Fitzgerald, 1988; Garrett, 1989).

Each institution should establish priorities for the management and care of the institution's collections as a whole, in addition to setting priorities for the care and treatment of individual specimens and artifacts of particular research, historical, aesthetic, or educational value. Values of individual specimens differ and resources are generally limited, resulting in the need to prioritize management and care activities.

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The financial challenges facing natural history museums have attracted significant media attention over many years [1]. In this article, we open a separate but related debateâ€"the future of the collections of biological specimens and samples contained in these museums. As described below, the value and impacts of these scientific assets are beyond question. We suggest that the time is right to ask how we should build the next generation of collections in much the same way that astronomers and astrophysicists discuss and plan for future infrastructure needs of their disciplines. Smithsonian National Museum of Natural History. Outbreak: Epidemics in a Connected World Digital Exhibit. One World, One Health. Human health is connected to animal and environmental health. As our population grows, we interact with animals and the environment in new ways that can cause disease outbreaks and epidemics. Our world is connected more than ever beforeâ€"by global travel and trade, by technology, and even by infectious diseases.Â These data inform my strategy for preventing further transmission. â€"LaQuandra Nesbitt, Director of the District of Columbiaâ€™s Department of Health. Keeping an outbreak from becoming an epidemic requires cooperation and coordination from individual communities to international partnerships. A natural history museum or museum of natural history is a scientific institution with natural history collections that include current and historical records of animals, plants, fungi, ecosystems, geology, paleontology, climatology, and more. The primary role of a natural history museum is to provide the scientific community with current and historical specimens for their research, which is to improve our understanding of the natural world. Some museums have public exhibits to share the beauty and wonder of the natural world with the public; these are referred to as 'public museums'...Â âœª Secrets of the Fossil Hall. âœª Collecting the World: Inside the Smithsonian. âœª Mammals Hall at the Los Angeles County Museum of Natural History. Transcription. References.