The Value and Valuation of Natural Science Collections

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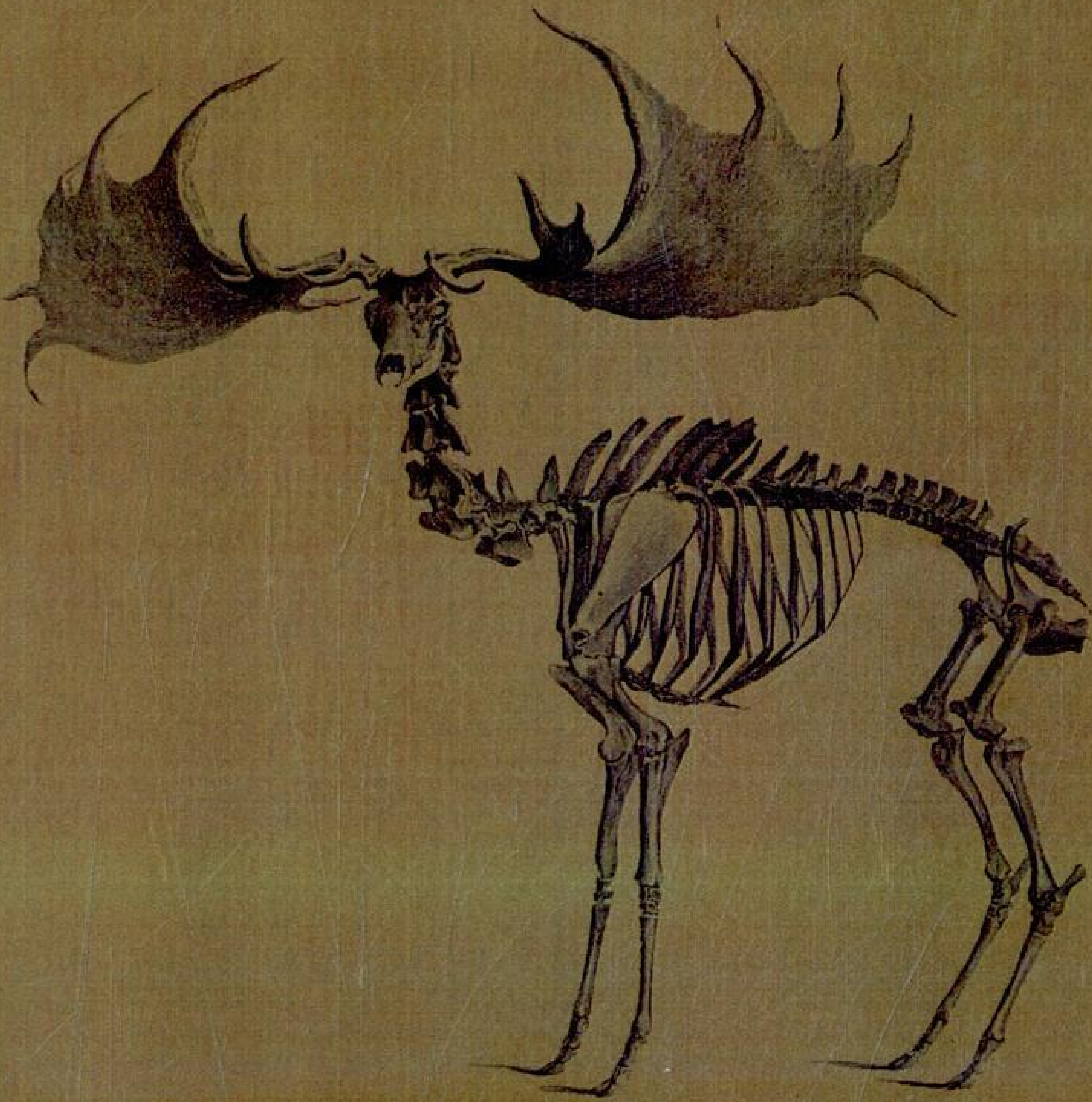

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CONTENTS

INVITED LECTURE

however, a project altogether unfit for a nation of shop keepers; but extremely fit for a nation whose government is influenced by shop keepers.'

Yet we feel ill at ease with the ethic of the grocer. It seems to run contrary to the civilizing influence of science as the pursuit of knowledge for its own sake. This philosophy is, perhaps, epitomized in Apsley Cherry-Gerrard's (1922) account of his work as a scientist with Scott's expedition to the South Pole, earlier this century:

'And I tell you, if you have the desire for knowledge and the power to give it physical expression, go out and explore... Some will tell you that you are mad, and nearly all will say, 'What is the use?' For we are a nation of shopkeepers, and no shopkeeper will look at research which does not promise him a financial return within a year. And so you will sledge nearly alone, but those with whom you sledge will not be shopkeepers: that is worth a good deal. If you march your Winter Journeys you will have your reward, so long as all you want is a penguin's egg.'

References

SMITH, A. (1776). *Wealth of Nations*. Strahan & Cadell, London.
CHERRY-GERRARD, A. (1922). *The Worst Journey in the World. Antarctic, 1910-1913* Vol.II. Constable, London.

evidence of the Ministry of Agriculture, Fisheries and Food (MAFF) stressed that the protection of the United Kingdom from pests and diseases, both imported and domestic, is a major function of the Ministry. Invertebrates, fungi, bacteria, viruses and plants which must not be imported into the UK are named in Plant Health Import legislation. It is necessary for the implementation of these laws to identify these organisms: considerable financial losses could result from erroneous naming of organisms. Similarly, the Weeds Act, which requires that certain named weed species should not be permitted to grow in the UK, relies on the accurate identification of weeds.

Accurate identification of organisms is also needed for MAFF to meet its commitments under European Community (EC) legislation and International Plant Health requirements. Mistakes in detection or identification of organisms could have severe consequences for the UK's export trade. Imports of undetected alien pests (e.g. Colorado potato beetle, South American leaf miner) and diseases (e.g. rhizomania) might threaten the UK agricultural and horticultural industries.

Pesticides Use Regulations define species of organisms against which individual pesticides are permitted to be used, the crop species on which pesticides use is permitted, or both. Again, it is necessary to identify the organisms in order to enforce these provisions. The systematics of bacteria and viruses is particularly important to MAFF in the fields of Animal Health and Welfare and Veterinary Medicine. An understanding of systematics aids in the identification of new and emerging diseases of animals and defines zoonotics by establishing exactly the species or subspecies etc. of organism which is involved. Systematics research facilitates studies of epidemics by, for example, finger-printing individual strains following typing at the species and sub-species levels. Systematics aids in disease control by helping in the production of diagnostic kits and vaccines; and facilitates studies on pathogenesis by defining virulence determinants. Studies in systematic biology may benefit the investigation of diseases that may be transmitted from animals to humans. In this context, studies on the systematics of the animal vectors of disease are particularly relevant and reference collections are correspondingly important.

The application of basic studies in systematic biology which provides the ability to identify causative agents of diseases in animals is relevant to MAFF's responsibility as Licensing Authority of veterinary immunological products. MAFF also requires the means of specifying organisms in relation to intellectual property rights in the field of biology-based innovation. Up-to-date techniques enable organisms to be identified, for example for patent descriptions relating to diagnostic kits and vaccines. For microbiological and biotechnological patents, the deposition of precisely characterized organisms is necessary under the Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure 1977.

MAFF fisheries scientists are involved with the epidemiology of disease-causing organisms in fish. Here interest centres on viruses (down to serotype), bacteria (particularly those associated with fish and shellfish diseases) and, to a lesser extent, fungi (for example in relation to crayfish plague). The application of systematic biology is also important in the study of toxin-producing unicellular algae (e.g. those that cause Paralytic Shellfish Poisoning).

The accurate identification of, and thus discrimination between, plant genotypes performs a vital function in MAFF's statutory role in carrying out Plant Breeders' Rights legislation through the Plant Variety Rights Office. This work enables new crop cultivars to be characterized, included in the UK National List and subsequently made available for sale in the UK and other parts of the EC.

MAFF has a significant interest in the *ex-situ* conservation of plant genetic resources and currently funds the Vegetable Gene Bank, the National Fruit Collection and Pea Gene Bank. Indirectly, it also funds the gene bank of Wild Species at RBG (Kew). Such gene banks represent specialized biological collections; they are important in many ways. In particular, they are designed to ensure that genetic resources are available for research (e.g. screening for resistance to diseases) or as material for the development of new crop varieties (e.g. to meet new pests and diseases, changes in demand and variations in climate). Gene banks also serve to maintain a part of the UK's agricultural heritage and to meet certain international obligations. Thus the Vegetable and Wild Species gene banks are designated as base collections under the International Board for Plant Genetic Resources. MAFF is also leading for the UK in international discussions aimed at co-ordinating the international effort devoted to the conservation of plant genetic resources and to research upon the collections.

In medicine and medical research, the Public Health Services Laboratory (PHSL) pointed out that cultures provide the links between succeed-

data could provide a foundation for creating new insights into the organisation of life on Earth. The creation of these databases will require vast resources, but their existence could save millions of dollars by eliminating redundancies in research and management activities. Is this the route we should take?

The educational role of material in collections must not be overlooked. The value of well exhibited displays of specimens from these collections is unsurpassable in its educational and inspirational impact. Modern museum displays tend to be more thematic, imposing the objectives of their designer but, in my view, sometimes thereby diminishing their flexibility in use. I believe that there is still a need for good, old-fashioned displays of adaptive radiation and systematic variety.

The importance of curation

Whatever the nature of the specimens and the manner of their preservation, there must be agreed rules to safeguard their value to science. Let me propose a few, for your consideration.

The instances quoted above strongly suggest that the process of curation must be designed on the premise that the full extent of the scientific value of a specimen was probably not perceived by its collector, and may still not necessarily be fully comprehended by the curator. To meet this objective, the ideal curation technology should conserve these unknown characters. It is probably safest to favour preservation techniques that conserve the original in a form as little altered as possible.

Botanists are therefore fortunate that the traditional procedure for preservation was by desiccation. Cryo-preservation might be superior, but the traditional dried herbarium specimen, without further treatment, is probably a near-substitute. The modern preference among plant collectors for initial fixation and storage in methanol solution does offer convenience in the field, but may prove to be less than ideal for realization of the full potential value of specimens.

Secondary treatment is probably also undesirable, in principle. It is obviously tempting to make use of chemical insecticides or fungicides to control pests, or other preparations to limit the effects of other natural processes of degradation. Recourse to such substances is often the instinctive reaction of the curator, anxious for the security of specimens under care. Are their potential effects on the quality of the specimen, and its value to science, sufficiently evaluated?

If museums do move to regimes of minimal curation for such reasons, it may become vital to devise rigorous procedures for the quarantine of new material, of borrowed specimens and of examples put on exhibition for any period of time. Stored organic tissue is a natural resource for a multitude of scavenging or saprophytic organisms and these pose a constant threat.

The managers of collections must also accept the responsibility to organize them so that all items are accessible with minumum effort. Although it may not happen, they should expect constant referral to the resource in their care. As I have mentioned, new technology in data storage and recovery will undoubtedly be of great assistance but, in the end, the proper arrangement and physical organization of the stored specimens remains an important task. They, too, must be easily and reliably recoverable!

We should, finally, not overlook the training needs of the staff involved in the curation of specimens. There has been intense debate on the role of the curator. To what extent is curation itself a career, with suitable prospects for self-development and openings for promotion? Is it necessary for a curator's motivation that he or she should participate in systematic research?

I have no doubt that the curatorial task, properly pursued, is highly professional, intellectually demanding and of itself inherently rewarding. But, I suspect, to be a good curator inevitably requires some level of inspiration that can only come from the scientific use of the specimens themselves. This question has become more pressing as museums increasingly separate curatorial staff and research teams.

Conclusion

Systematic-research centres housing collections of specimens are national and international repositories of knowledge about biodiversity. Their collections are the permanent record of our natural heritage, and contain the materials that support the research of many scientific disciplines, including those working to preserve biodiversity and monitor global change. Their collections meet the needs of applied biology, including the health sciences (parasitology, epidemiology, diagnostics), agriculture, resource management, and biotechnology. Their collections provide broad support for public and formal education programmes. Through exhibits, their collections serve a primary role in promoting public awareness of nature and biodiversity.

The data centres, libraries, and archives associated with systematics collections also

simplify museum objects as scientific evidence. In attempting to emulate scientific objectivity there is a temptation to believe that a valid measure of scientific importance has been created. It would be as wrong to claim objectivity in this method of evaluation as it would to claim it for science. The selection of variables and how they are used is totally subjective, as is the decision to call this 'scientific importance', something it certainly does not represent. Instead the method gives a tally of use in publication, but since acquisition by the museum may have been prompted by and indeed post-dated publication it is impossible to use these figures in a meaningful way to understand past use or future potential. 'Scientific importance' is such a valuable category that it would be wrong to use it in such a limited way. It would imply that most museums could refer to only a very small part of their collections as being scientifically important; the pre-1983 conodont animal would be of no scientific worth!

The allocation of scientific importance to a specimen requires a much deeper understanding of the relationship between the specimen and science. Natural science objects are kept in preference to data because we recognize the complexity and indefinable nature of the information they contain; there is always more data to extract or to be interpreted. Because of this the relationship between object and science cannot be simple. Any specimen in a public collection is capable of influencing scientific thought. So is publication really necessary for the attribution of scientific worth?

Returning to the example of articulated fossil starfish, these have been used as evidence to support a theoretical model for rapid sedimentary deposition known as obrution (Brett 1990). The attributes of the specimen in terms of form, preservation, mineralogy, etc., all contribute evidence supporting the establishment of this model. This model influences work on taphonomy, sedimentology and geochemistry in modern environments. The specimen's characteristics present evidence which does not support other depositional models; these require other material. The model is also applied at other sites and with other specimens. All this research, much of it in areas remote from the initial interests of the worker who used the museum specimen, is capable of affecting future perceptions of the importance of that specimen.

Not only do objects feed into a complex web of research and ideas, but one which is constantly changing and deeply affected by changes of fashion, technique, opportunity, personality and the destruction of language barriers. It extends far beyond the bounds of systematics; natural science collections are so often portrayed in terms which make this appear to be the only scientific use. As curators we may be unaware of this complexity; the only link between the specimen and the science may be one research paper or an unrecorded visit from a single academic. How then can we hope to get an accurate gauge of the importance of that specimen? What is certain is that simple tallies of published material will always undervalue collection importance.

The curator as connoisseur

If we cannot claim objectivity even in scientific evaluation then the role of the curator as connoisseur becomes even more critical in the assessment process. But in this we bring our own strengths and weaknesses, and despite attempts to be even-handed it is inevitable that we will collect, protect and exploit that with which we are most familiar. Collection assessments then reflect our ignorance as much as our expertise and are likely to distort perceptions of worth. While we can do little about this it should at least be used to encourage those who arrogantly believe their own assessments to be the final word to think again.

Inevitably curators must evaluate collections themselves during object curation; rarely, but ideally, they would have a team of specialists on hand who might contribute other views. Our task is made particularly difficult due to the increasing complexity of the myriad of sciences which our collections support; we cannot be expert in them all. In the distant past natural science collections were served by teams of honorary curators who, whilst lacking the training of modern staff, were quite able to maintain the limited breadth of understanding necessary to follow scientific progress. Today, collections become ever larger while staff provision continues to diminish. As a consequence we increasingly become scientific generalists without the time to develop the specialisms which might aid collection evaluation. The focus on local matters makes evaluation more manageable, but removes this evaluation from the context of mainstream science.

Echoing our experiences in systematics what we yearn for are simple and obvious characteristics which might enable fairly objective evaluation. For these purposes the most commonly grasped straw is that of associated data. It is assumed that specimens lacking data are of no value. But poorly documented specimens enabled the discovery of ammonite jaws; type and

Calculating the financial value of systematic biology collections

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Introduction

What is the financial value of a major natural history reference collection, such as that of The Natural History Museum (NHM) in London? This apparently simple question is very difficult to answer, primarily because accepted methods for quantifying the scientific, cultural, educational and other values of a collection do not exist. However, there are increasing pressures on the systematics community to attempt these calculations for a variety of reasons, including insurance of collections and public accountability (Boreham 1994; Maslen 1994a, 1994b; Evans 1997).

Despite the difficulties, we believe that there are several reasons why it is not adequate to assert that this kind of valuation is impossible without first having attempted the exercise. First, monetary values are the most widely understood units of comparison in communicating relative importance. Therefore, there is a potential benefit in providing some general quantitative basis for discussing values that have previously been stated in qualitative terms. In this respect, we consider there to be a strong parallel with those studies that attempt to assign financial values to particular components of biodiversity.

Second, if the systematics community does not attempt to provide well argued estimates, there is a danger that the value of natural history collections will simply be assumed or calculated by others with less knowledge of their worth. By participating in the debate, we as systematists are better placed to influence the outcome.

This paper describes our experience in exploring the financial value of the collections of the NHM. It is essentially a cautionary tale that identifies some important issues about valuation. Our purpose is not to produce a definitive value but rather to examine some ways in which the problem may be approached. We hope to identify where difficulties arise and to inform discussion on the question of whether the valuation of collections is a worthwhile exercise.

Valuation methods in the absence of markets

If one accepts that there is merit in stating the financial value of a natural history collection, how can it be calculated? Collection items for which there is an established market in operation, such as works of art, fossils, minerals and historical collections, do have an identifiable financial value. This figure may reflect certain features of the specimen, such as its aesthetic appeal, more than others, including its scientific value.

However, for many natural history specimens there is no market, making it more difficult to ascribe financial value. A number of approaches have been developed for estimating financial values in the absence of a market. Perhaps the closest analogy for museums can be found in the field of environmental economics, especially as applied to biodiversity. Environmental economists such as McNeely (1988) emphasize the need for applying appropriate financial values because the accelerating pace of destruction indicates that biodiversity is under-valued.

Using the NHM as an example, we have tried to develop one method of estimating the financial value of its collections that captures both the investment costs of creating the collection and the value of the future benefits that arise from its existence and use.

Investment costs of collections

The total investment cost of the collection can be broken down into three main elements:

- *Cost of Acquisition (S)* – by either collection in the field, purchase (in which case the collection will have a known price, which may or may not reflect the true cost of acquisition and preparation) or donation (where another party has made the investment);
- *Cost of Curation (C)* – including time and materials for identification, preparation, maintenance, conservation and the loan of specimens to other institutions;

biologists today, is also substantial. For example, the project to complete the taxonomy of Costa Rican Hymenoptera, a total of 20 000–40 000 species, will cost an estimated US $20 million to $40 million (I.D. Gauld pers. comm.). Calculating the cost of establishing and maintaining systematic reference collections and their associated research provides a salutary reminder that systematic research is not cheap. Nevertheless, the benefits this yields to society in supporting all other biological and geological research, agriculture, medicine, industry, and in enriching our knowledge, appreciation and enjoyment of the natural world, make this an invaluable investment.

We thank our colleagues at the NHM who provided costed examples for the collection of natural history specimens.

References

ANON 1931. *A Short History of the Collections*. British Museum (Natural History) Special Guide No. 8. British Museum, London.

——— 1994. *Systematics Agenda 2000: Charting the Biosphere*. Systematics Agenda 2000.

DE BEER, G. 1953. *Sir Hans Sloane and the British Museum*. Oxford University Press for the British Museum, Oxford.

BOREHAM, T. 1994. Valuing Heritage Assets: Is it Worth the Trouble? *Business Review Weekly*, November 14, 116–118.

BROWN, K., PEARCE, D., PERRINGS, C. & SWANSON, T. 1993. *Economics and the Conservation of Global Biological Diversity*. Global Environment Facility Working Paper No 2. World Bank, Washington.

EVANS, M. 1997. Accounting for local authorities' museum collections. *This volume*.

MASLEN, G. 1994a. Heritage audit to cost state millions. *The Sunday Age*, 20 November, 8.

——— 1994b. Absolutely priceless. *The Bulletin*, 6 December, 107.

MCNEELY, J. A. 1988. *Economics and Biological Diversity: Developing and Using Economic Incentives to Conserve Biological Resources*. IUCN, Gland.

PEARCE, D. W. 1976. *Environmental Economics*. Longmans, London.

RILEY, N. D. 1964. *The Department of Entomology of the British Museum (Natural History) 1904 - 1964. A Brief Historical Sketch*. XIIth International Congress of Entomology, London.

STEARN, W. T. 1981. *The Natural History Museum at South Kensington*. Heinemann and the British Museum (Natural History), London.

Fig. 3. Structure of expenses of a collection of 45 000 specimens.

The total expenses are about 124 000 CK per year, but the principles are the same as in a bigger collection (Fig. 3). The wages actually take about 10% more from the whole budget. Twenty times fewer specimens are preserved in Mikulov, but the costs are only ten times lower. The average cost of preservation of one plant specimen is about 2 CK, i.e. twice as much as in the bigger collection in Brno.

Conclusion

From an economical point of view large collections are more advantageous. However, small, local, regional collections are a separate issue. If they are useful, then despite the higher costs, they are to be accepted. If not, then the material would be better placed in a bigger collection.

Another way of increasing efficiency and sparing the time of personnel, as well as costs, is the use of computers. We can place the material stored in databases in deposits out of major centres, in places where storage is not so expensive. If for some reason we do not need to use the dried plants, the computerized information may well prove sufficient in some cases.

Finally, modern technologies (e.g. e-mail) enable us to use distant databases without having to involve other curatorial staff.

References

Clifford, H. T., Rogers, R. W. & Dettman, M. E. 1990. Where now for taxonomy? *Nature*, **346**, 602.

Walters, S. M. 1993. Herbaria in the 21st century: why should they survive ? *Webbia*, **48**, 673–682.

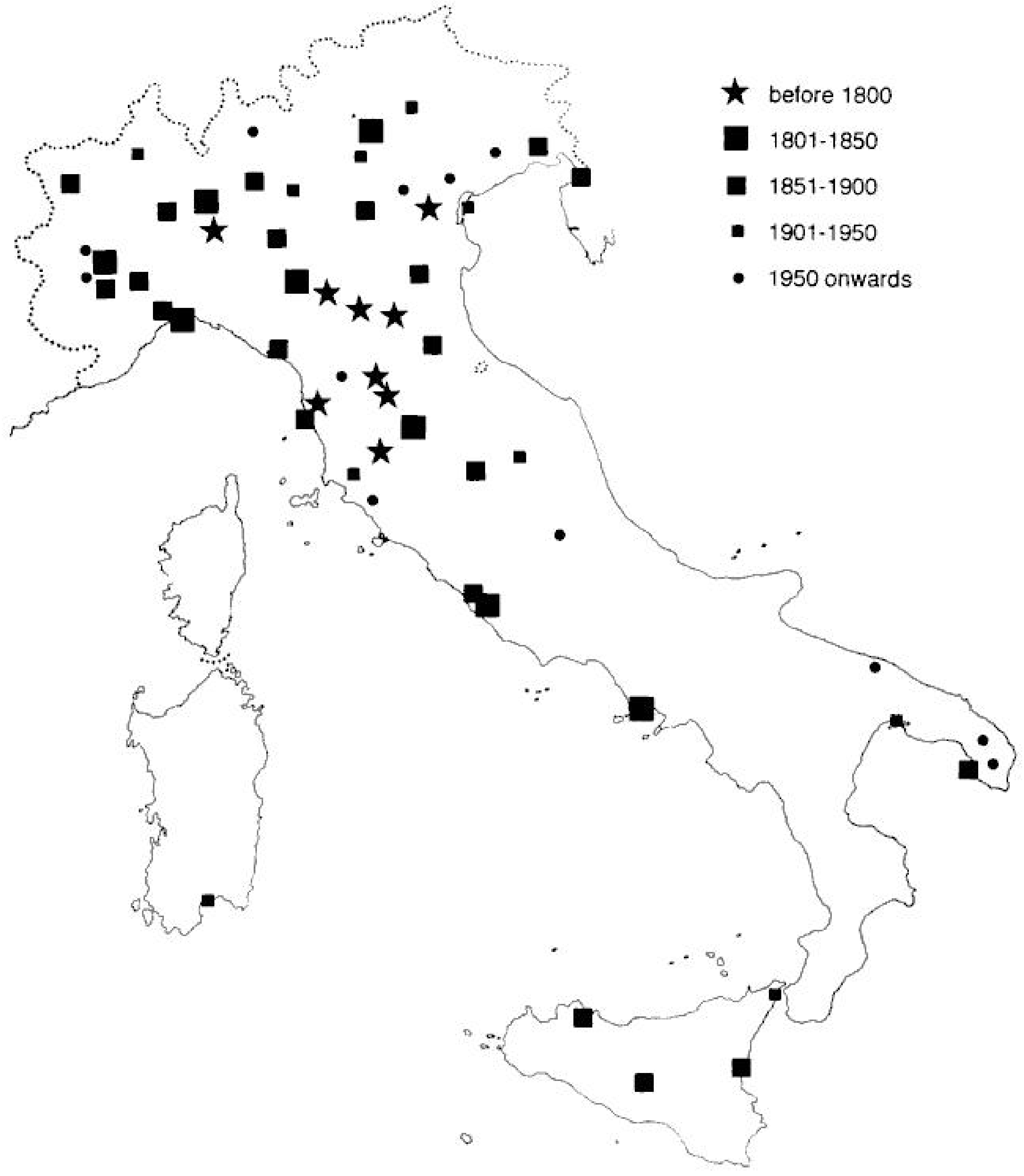

Fig. 3. Dates of foundation of the main natural science museums.

and Palermo. These collections still contain very important materials, valuable evidence of how scientific knowledge developed in our country.

Conclusions

This brief overview of Italian scientific museology leads to some interesting conclusions about the situation relative to science museums in our country. First of all, it is apparent that most of the science museums today are located in Northern Italy. This is a direct consequence of our country's political history. For many years Italy was divided into separate states each of which created its own museum. In fact the oldest museums can usually be found in the oldest capitals of the former Italian states. Therefore, the oldest and most valuable historical collections are all concentrated in these museums. Fortunately, almost all are public (owned by universities or local governments).

In addition to this heterogeneity of distribution, there is also marked heterogeneity of content. Zoological and palaeontological collections are the most prevalent (the latter are often associated with archaeological collections),

include: 'Life on the Danube bank', 'Life in the Romanian Plain', 'Life in the hilly region', 'Life in the Carpathians', 'Life in the Danube Delta', 'The tundra', 'The North-American prairie', 'The fauna of Southern oceans', 'The African Savannah' and 'The Sahara Desert'. Since 1964, 12 palaeontological and 5 anthropological microdioramas have been made. In 1967 an artificial cave was opened where visitors could see along its 11 m length, stalagmites, stalactites, curtains, towers, shelves, columns, bat colonies and the remains of *Ursus spelaeus*.

The invertebrates include several hundreds of sponges from the Adriatic Sea, Indian and Atlantic oceans. Coelenterates are represented by jellyfish and corals from almost all seas and oceans of the world, and totalling upto 1500 exhibits. Helminths total 3000 specimens. The most recent specimens are from the newly described group, Vestimentiphera, e.g. *Riftia pachyptila*. Molluscs total over 200 000 specimens and include marine, freshwater and terrestrial species, the largest being the so called 'Bielz' collection with 98 000 specimens. During the last decades additions have been made of some molluscs collected by the Oceanological Centre of Bretagne (Brest, France) from the eastern Pacific rift, at 2600–3000 m depth, in the vicinity of hydrothermal vents (e.g. *Calyptogena magnifica*, which can reach 30 cm long). Recent expeditions from the Museum to Indonesia (1991) and Brazil (1994) enriched these collections with species from the Indian Ocean and the Atlantic. Arthropods (excluding insects) are well represented by 150 000 specimens, the Crustacean collection having about 500 type specimens.

Insects are represented by collections arranged according to the most important orders: Coleopterans, with more than 100 000 specimens of 7500 species; 244 specimens belong to different categories of types. Heteropterans include 35 000 specimens of 3500 species. Lepidopterans are represented by 250 000 specimens from all over the world. Many microlepidopterans from Europe and Central Asia are in 'Caradja' Collection. In the same collection there are also macrolepidopterans (especially Papilionidae) from the following regions: Palaearctic, IndoMalayesia, Indonesia, Africa, Central and South America. This collection includes over 110 000 specimens with more than 3000 type specimens. Hymenoptera includes less than 30 000 specimens of 3000 species. A relatively new collection is that of Dipterans with Romanian, Palaearctic and exotic material, totalling about 5000 specimens, 109 of them being type specimens. Trichopterans form a good collection, totalling about 100 000 specimens. Other orders (Orthoptera, Neuroptera, Homoptera, Thysanoptera, Odonata, Malophaga) are represented by several thousands of specimens from Romania and world-wide.

Vertebrate collections are organized according to the main classes. Fishes include over 10 000 specimens of holocephalians, sturgeons and bony-fishes with 46 type specimens for 23 species.

Over 3000 herpetological specimens include the giant *Adrias japonicus*, *Megalobatrachus maximuss*, *Telmatobius culeus* and *Sphaenodon punctatus*, *Eunectes murinus*, *Python sebae*, *Dermochelis coriacea*, *Testudo gigantea elephantina* as well as specimens of every species of crocodiles.

Birds are represented by many rare or extinct genera (e.g. *Apteryx*, *Grus*, *Goura*, *Didus*, *Gypaetus*) in almost 9000 specimens. From exclusively Romanian fauna there are 320 species and subspecies.

Mammals include monotremes, marsupials and eutheria from all over the world, including *Ornythorhynchus*, *Tachyglossus*, *Uncia*, *Okapia*, *Dugong*, *Trichecus*, *Daubentonia*, *Gorilla* and many others from 5500 skins, skulls and skeletons in the museum's collections. Some other vertebrates are included in about 1300 exhibits of the collection of comparative anatomy.

All these natural history collections are a part of the planetary biodiversity, helping us to understand the physical, natural and cultural features of our planet. Each specimen is an encyclopedia of complex information regarding cell and molecular biology, chemical structure of the soil, water or air, degree of pollution, etc. Being preserved in collections of natural history enables a better understanding of phyletic relationships between species with a large range, centres of evolution, adaptation to local ecological conditions and degree of emergency protection.

References

ALCOVER, J. A. 1992. Colecciones de ciencias naturales en las Baleares. *International Symposium and First World Congress on Preservation and Conservation of Natural History Collections*, **2**, 75–82.

ANTIPA, G. R. 1918. Die Organisationsprinzipien des Naturhistorischer Museums in Bukarest. Ein Beitrag zur Museumskunde. *Bulletin Sect. Science Academy Romania*, **5**, 222–228.

BACESCU, M. 1972. L'evolution des Musees de Sciences naturales. *Cahiers d'Histoire Mondiale UNESCO*, **14**, 72–102.

HELGUERAS, A. L. 1992. Las colecciones biologicas

and dry insects, plus the problems of fires and wars, have resulted in only a small fragment of the eighteenth and early nineteenth century collections being extant. It is only from the beginning of the nineteenth century that we have satisfactory preservation of the collections.

The Zoological Institute understands its international responsibility for the National Russian Zoological Collection, but the state does not. The systematic collection of animals is kept in 11 laboratories, plus the museum. The Mammal Laboratory takes care of 100 000 specimens belonging to 1350 species including the osteological collection (nearly 25 000 exhibits). In the laboratories of Ornithology and Herpetology the collection of birds numbers 200 000 specimens of 4240 species, mainly as stuffed skins. The collection of amphibians and reptiles contains 200 000 specimens also mainly in alcohol. The large collection of fish in the laboratory of Ichthyology includes 150 000 specimens, representing 8500 species. The largest is the entomological collection with 14 million specimens of 100 000 species. Other invertebrates (including Protozoa) represent 1 million specimens belonging to 30 000 species. In total the whole collection numbers nearly 16 million samples. A sample as a unit of conservation is, in most cases, a specimen (dry or in alcohol or in formalin) or a part of a specimen (e.g. a skull) or a vessel with samples of plankton or other groups of microscopic animals.

This collection consists mainly of animals from the Palaearctic region and the World Ocean, but also of animals from the rest of the world. The collection includes hundreds of type specimens, many of rare and endangered species. We have unique exhibits of animals belonging to extinct species and subspecies. The collection of mammoths and other animals of that time (woolly rhinoceros, cave bears, ancient bisons etc.) is well known all over the world. All of this huge collection needs everyday care including control of conditions, taxonomic arrangement, exact identification etc. At present there are 46 official keepers and curators, who fulfil this work at a salary of approximately 30$ per month, less than half of the official subsidence level in Saint Petersburg. This example alone shows that the existence of Russian zoological collecting continues now only through the enthusiasm of the keepers, not by financial support.

The future

Much more money is needed for the technical maintenance of the collection. A good example concerns the use of alcohol as a preservative. The whole collection contains 200 tons of alcohol and requires 10 tons annually to compensate for evaporation and to change old solutions. At today's price of 7200$ per ton, this requires 72 000$ per year. In short the state spends nearly 100 000$ annually just to keep the collection at a minimum level of maintenance. Below this level a catastrophe will become inevitable, and destruction of specimens will begin. Moreover,financial support is necessary to prevent the danger of fire; at the present time fire fighting measures and equipment are at the same level as at the beginning of the century. The same is true of security and recently some loss through theft has occurred. In Russia there is currently no system of insurance of collections against fire or theft. We understand the position well and our great hope at the moment is mainly in God !

During the last 100 years the state spent on average 150 000$ annually just to support the collection. It is very hard to estimate expenses connected with numerous expeditions at different times and in different locations. We have made several attempts to estimate the monetary value of the collected specimens, but with little success; the main problems arise when we try to evaluate type specimens or specimens belonging to extinct species or subspecies. We consider that the value of every specimen consists of the expenses for obtaining, preparing and preserving that specimen. We are sure that careful calculation of all expenses for most of the collected specimens will show that every item is very expensive. Concerning the specimens of extinct animals it is really impossible to establish value; they are priceless.

The Russian people fully understands the very high value of their national zoological collection. Thus the opinion of the Academy of Science is now to do everything possible to preserve the national treasures. But is the opinion of the government the same? And this problem goes further than our own government; there are an increasing number of cases when rare specimens are collected by foreign institutions, especially in the remoter parts of Russia. The weakness of our laws and the greed of local leaders now present a great danger for museums. In our own experience we know that international agreements and declarations are most effective in this direction and we thus have three ways to safeguard our treasures: by improving the laws, by increasing awareness of society, and by encouraging international solidarity.

Table 1. *Continued*

Use	Organism	Reference for further information
BIOCONTROL		
Locusts & grasshoppers	*Metarhizium anisoplia*	Lomer & Prior (1992)
Weeds	*Puccinia* spp.	Julien (1992)
	Phragmidium spp.	
Plant parasitic nematodes	*Arthrobotrys* spp.	Stirling (1991)
	Dactyella spp.	
Soil-borne plant pathogens	*Trichoderma spp.*	Hornby (1990)
	Fusarium spp.	
WASTE:		
Anaerobic digestion of food		
processing wastes	*Lactobacillus casei*	Greenshields (1989)
	Acetobacterium woodii	
	Methanosarcina barkeri	
Composting organic wastes		
Town wastes	*Chaetomium* spp.	Hawker & Linton (1971)
Agricultural wastes	*Zoogela ramigera*	
Detoxification		
Recovery of heavy metals from		
aqueous effluents		
Uranium	*Chlorella regularis*	Greenshields (1989)
	Aspergillus niger	
Gold	*Chlorella vulgaris*	
Copper	*Penicillium spinulosum*	
	Trichoderma viride	

such as those between trees and mycorrhizas or legumes and rhizobia are essential for healthy growth. The establishment of such plants would require the associated microorganisms. Further, the very nature of those microorganisms that can be cultured renders them particularly suitable for *ex situ* conservation, and this will rarely affect their number in nature; i.e. they can be used in a sustainable manner. However, the numbers currently held fall well short of representing the genetic resource of those known to nature.

This begs the following questions:

- are there sufficient collections to preserve adequate representatives of microorganisms?
- are those that exist duplicating effort?
- what could be done to rationalize existing collections?
- what should be done to co-ordinate the activities of collections world-wide?

Microbial resource collections retain representatives of biodiversity to supply to users. In theory, all microorganisms have something to offer with regard to morphological or biochemical properties and there can be vast differences between properties of strains of one species. Therefore the task of providing adequate coverage of microorganisms is an enormous one. The estimated number of fungi in nature is 1.5 million (Hawksworth 1991), the majority of which are yet to be discovered, and *c.* 11 500 species of fungi (0.77%) were held in collections in 1990.

There are, on average, 41 strains for each name listed in the WDCM. Following compensation for teleomorph/anamorph connections, spelling variations and synonyms there is an average of 71 strains per species currently held. An example of the variation in a species is seen in the holdings of the Fungal Genetics Stock Centre where in excess of 3000 strains of genetically marked *Neurospora crassa* are kept. A conservative estimate to give modest representation for a species could be as high as 50, based on morphological and physiological variation within a species; this would mean 75 million strains would have to be maintained by collections.

Each of the 246 fungal collections listed in the WDCM would need to hold 304 878 strains to achieve this target. This is an unrealistic challenge for existing collections, particularly with the current lack of co-ordination which has

Table 2. *The ten largest microbial collections listed at the World Data Center and their holdings (Sugawara et al. 1993)*

Collection	Country	Number of strains	Organisms held
Agricultural Research Service Culture Collection (NRRL)	USA	78010	Algae, bacteria, fungi
American Type Culture Collection (ATCC)	USA	53615	Algae, bacteria, fungi, protozoa, cell lines, hybridomas, viruses, vectors, plasmids, phage
Centraalbureau voor Schimmelcultures (CBS)	Netherlands	41300	Fungi, plasmids
University of Goteborg, (CCUG)	Sweden	28100	Bacteria, fungi
International Mycological Institute (IMI)	UK*	20000	Fungi, bacteria
Mycotheque de l'Universite Catholique de Louvain (MUCL)	Belgium	20000	Fungi
Institute for Fermentation Oska (IFO)	Japan	13443	Bacteria, fungi, cell lines, viruses
Canadian Collection of Fungus Cultures (CCFC)	Canada	10000	Fungi
Fermentation Research Institute (FRI)	Japan	9800	Bacteria, fungi
The Upjohn Culture Collection, [UC(UPJOHN)]	USA	9390	Algae, bacteria, fungi, protozoa, plasmids, hybridomas

*International, based in the UK but owned by IMI on behalf of the 37 Member countries of CAB INTERNATIONAL.

Growth in Europe (BRIDGE) Programme (until 1994) and is an integrated catalogue project, incorporating a European network of microbial collection data banks. The objective is to improve awareness of strains available and facilitate ordering. There are eleven national nodes which can be contacted directly (Table 3) and the whole database is available on-line through Deutsches Institut für Medizinische Dokumentation und Information (DIMDI), Welßhasstraße 27, D-5000 Köln 41, Germany, Tel: 49 221 47241, Fax: 49 221 411429.

The first phase of the MINE project under the CEC Biotechnology Action Programme was completed at the end of 1989, all fungal and bacterial data have been integrated into one centralized European database, with common data formats (Gams *et al.* 1988; Stalpers *et al.* 1990) which went on-line in 1993 under the CEC BRIDGE programme on the database host DIMDI. Further details can be found in the booklet *European Laboratory Without Walls: In the field of MINE, The Microbial Information Network Europe* (Aguilar 1990).

Reorganization of collections

Rationalization of collections can begin nationally. In the UK the Office of Science and Technology commissioned a review of microbial resource collections (OST 1994). The UK collections were considered to have been under-resourced. The review team suggested a reduction of the eleven collections to three main centres with one contact point. They also recommended the reduction of the nine funding bodies to one and wished to keep the main advantage of the existing situation where there is a wealth of expertise. The latter would be attained by keeping seven of the eight collections as satellite collections of the three main centres, relocating only one in its entirety. This was envisaged as resulting in a more efficient use of equipment and resources and co-ordination of marketing. The extent to which these proposals can be implemented will ultimately depend both on the resources that can be made available and the policies of the owners of the collections themselves.

Co-ordination of collection activities world-wide

There are national and international organizations established to encourage the collaboration between collections. National Federations exist in Australia, Canada, China, Czechslovakia, Japan, Korea, New Zealand, Turkey, UK and USA (Kirsop & DaSilva 1988). These carry out useful work in their own right co-ordinating training, producing publications and representing microbial resource collections in societies, unions and in governmental surveys and discussions. The European Culture Collection Organization (ECCO) offers a forum for discussion of topics relevant to collections and brings

The social history value of natural history collections

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Introduction

Natural history specimens and the collections they form are directly and inseparably connected with individual persons and their individual lives. This paper attempts to show that natural history information is an important source of social history information and should be considered as an important part of the overall value of natural history collections.

The author writes as a natural history curator in a provincial UK museums service which covers the major aspects of human and natural history. Both the local dimension and the links between the natural and man-made world are very important; the wider context is the one most of our customers and users recognize; it reflects how they make inquiries. Their interests in social history move seamlessly into ethnology and the natural sciences. Looking at the wider context of natural history collections is therefore, second nature; appreciating all values of natural history collections is also second nature where they are competing for attention with other collections and their relevance is under constant scrutiny.

In addition, the author has had the benefit of being involved with a local Collections Research Unit (CRU) and FENSCORE (see below), whose accumulated data greatly facilitate using specimen and collection data for social history purposes.

Social history can be viewed as an all-embracing term that covers anything done by humankind. In this paper the social history of natural history is the history of individuals, groups and societies as evidenced by biological and geological specimens and collections. Social history value is one of six values that can be assigned to natural history collections, the other five being: scientific value, time-capsule value, inventory value, monetary value and ethnic value. These are discussed in more detail in Appendix 1, and Pettitt's paper gives a very useful summary of the uses of natural science collections and the prejudice against them in some quarters (Pettitt 1991).

It is possible, of course, that a single specimen or collection may have two or more of these values at the same time.

Social history content of collections

Social history value comes from data which are *either* directly associated with the specimen, such as the locality, date etc, or with wider associations with the people, places and times connected with them, or else associated with a collection, for example its cabinets, or its sale or other transfer.

The great strength of natural history material is that, even at its most basic level of provenance, individual items are so clearly attached to individual persons, places and dates. A collection is like a series of diary dates with a three-dimensional piece of the living world attached. People–time–places are what human history is all about. Whether they are great naturalists or little-known local naturalists, it is fascinating to link real people to real specimens and objects and places. The people may have relatives and friends to show an interest in their work. Past times retain a fascination for many. Even in the UK the places are often still there, either as an extant feature, such as a wood, or as an imprint (for example the line of an urban road following the edge of a wood now long-gone).

For easy reference, the social history significance of the various data that can be attached to **individual specimens** is listed in a separate section below. The many areas of interest that can be linked to **persons** involved in natural history collections are also discussed in a separate section, as is the significance of the various data that can be attached to **collections** themselves. There is not enough room for these sections to be exhaustive but curators and researchers will no doubt be able to think of their own examples and probably add new categories of social interest.

An increasing interest

From the experience at Nottingham Museums, and from anecdotal evidence from natural history colleagues elsewhere, there has been an

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Fig. 3. H. Fisher, *c.* 1900.

Fig. 4. Boxes used for storage in the Harry Fisher Collection.

Valuing the resource

If natural science collections have a social history value through their links to people and places etc, then perhaps they can by analogy achieve the same monetary value. Like natural history items social history objects are often of low intrinsic resale value but high in local relevance. The insurance value aimed at the replacement cost of a social item has been recently estimated as part of a general valuation exercise at Nottingham (Nottingham Museums Insurance Revaluation Project 1995 – internal document). That figure, £35 per item, is of the same order as the replacement cost of field collecting natural history specimens. Monetary value is of course of interest in setting replacement costs. The real day-to-day value of the resource is in its usefulness to the many types of users; in most case this will be an intellectual value given by the user. Occasionally it will be a commercial value based on some other equivalent such as a standard market rate for buying access to photographic/ theatrical props. The value of the **potential** use also needs to be considered – this is the value of the collection being there for future users. There is no obvious way this can be quantified.

Size of the resource

Through the work of the CRU' and FENSCORE an estimate of the size of the national database of natural science collections information in the UK can now be made. Based on the 75% of the UK so far surveyed it is likely that there are some 80–100 million specimens in some 20000 collections, **outside** the Natural History Museum in London. Including the latter gives an overall figure of about 150–170 million specimens in the UK. Even allowing for a percentage of specimens that have little or no individual provenance this is a substantial dataset. For example, the accumulated UK Census data from the nineteenth century is of the same order of magnitude in terms of items, although the social significance of that will be greater.

The significance of the resource

How important is this resource? Most natural historians will need little convincing of the social significance of natural history collections. It is important not to overestimate the value. Natural history collections are unlikely to replace other social history resources but they may prove to be a useful addition. The question of significance can be looked at both qualitatively and quantitatively.

Qualitatively the value of social history data from natural history varies greatly. If the civil war in Afghanistan in the 1980s were to be studied the data from the natural science collections collected there during that period would not compare to the mass of data available from newspapers etc. Indeed the normal 'news'

voyages for example will set some pulses racing as much as the mention of Darwin, Banks or Wallace.

Habitat information is predominanly of scientific interest but looked at on the wider front its absence from many of the pre-1970 specimens reflects the late appreciation of this aspect of site recording.

The collecting process and the conservation process is perhaps of most interest to those studying the history of science. Changes in the status of using alcohol, phenoxytol, brandy and other preservatives over the years says something about fashions and science; the return in recent years to ground glass stoppers for spirit collections over plastic caps might be interpreted in one way by an economist – a latter day William Morris might regard it as an example of the superiority of the craft product.

Specimen trade and dealer details have obvious uses in building up the extent and value of trade in items that by 1900 included most of the remotest places in all continents except Antarctica. The sorts of trials and tribulations suffered by Nottinghamshire collector Mansfield Parkyns in the 1840's in trying to get his collections back from Ethiopia make us appreciate the determination of earlier scientific inquiry to defeat the rats, the thieves, the decay and the ship-wrecks (Parkyns 1853).

Specimen exchange details are an indication of the activity of naturalists, as well an indication of the postal contact between scientists sharing information and resources, at varying times throughout history, and how the most was made of the communication system of the day. Natural science collections have been traditionally added to by exchanging between naturalists, especially amongst plant collectors and herbaria owners.

Label information can be useful in linking specimens together when the actual written data are insufficient to do this; handwriting comparison is regularly used to associate specimens collected by a previously unidentified worker with those where a signature or name is present. Printed labels can perform a similar function.

Person data attached to the field-collecting, collection-building and determining activities obviously allow numerous connections to be made with the wider social world and these will be considered in the next section.

Finally, individual specimens take on additional value when they have been used as the subject of an **illustration**, especially if figured in a publication. To give a local UK example, the mounted bird collection of the Foljambe family in Nottinghamshire has additional value as some of them were reputed to be the subjects used by John Gould, the famous British wildlife illustrator. Natural science illustration and art is a study in itself, and the recent investigations by the Musee d'Histoire Naturelle in Paris should prove valuable in making this natural science resource more widely known and available.

Social history aspects of persons

Person information is attached to specimens in at least one of three ways, by being a field collector, a collection builder or a determiner. Person names lead us into that persons life and experience and then into the lives of all the people connected to them. This provides an incredibly rich area of study. This can be summarized under the following headings:

- sex
- name, surname and family relationships
- name, forenames, intrinsic interest
- pastimes and hobbies
- addresses
- profession – changes
  - – collecting opportunities
  - – place of work
- publications
- qualifications
- status
- biography – traditional
  - – series of times and places
  - – collecting areas, holiday areas
- lists of specimens / records
- acquired collections, collection histories
- companions
- societies
- fashions
- links with other cultures

Personal details can be useful in scientific purposes as well as the wider social reasons. The association of two previously unconnected collections might depend on recognizing common data such as a profession, a birth date or a co-workers name attached to specimens.

Sex of the persons associated with specimens has some interest; for example looking at some 6000 collectors in part of the UK (Walley, 1993) the proportion of men to women is approximately 20 to 1. This was calculated over a period

Criteria for establishing the scientific value of natural science collections

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Introduction

Natural science collections consist of objects which have a complex variety of properties, and any comprehensive valuation of an object or collection must take all of these into account. It is not difficult to identify object properties which have traditionally been used to ascribe value to natural science collections; cultural value, heritage and historic value, economic value, market value, entertainment and aesthetic value, and scientific value are all familiar concepts in the realm of natural science collections (e.g. Williams 1987, pp. 1–4). Somewhat more intractable is the problem of how to determine values in each of these areas for an object, either in absolute or relative terms. This is mainly because some aspects of valuation are subjective and context sensitive, depending upon the purpose of the valuation and the perspective of the valuer.

The aim of this paper is to examine just one of these attributes, that of scientific value. The reason for concentrating on scientific value is not because it is inherently more important than other attributes (it certainly is not), but because the underlying philosophy of science is one of objectivity, and so, for this attribute at least, it should be possible to construct an objective set of criteria to establish value. Determining value in such a mechanistic way is not an option when considering, for example, the cultural, aesthetic, or historical value of material. It is theoretically possible to calculate the economic value of a collection by an analysis of its wealth generation potential, but in most cases this is completely impractical because of the difficulty and cost involved in obtaining sufficient data for a meaningful analysis. This leaves financial value as the value parameter most easily assessed, either by reference to the marketplace, or in terms of replacement cost of material. It is hardly surprising then that financial value is the preferred parameter for expressing the value of collections in many quarters. It has an air of objectivity which is lacking in other value parameters, is universally understood, and is a form of 'common currency' into which almost anything can be translated for the purpose of measurement or comparison. However, financial values as applied to natural science collections almost invariably fail to take into account any of the other value parameters, except where they may contribute to the market valuation (e.g. Rolfe *et al.* 1988), and must be regarded as an extremely poor guide to the overall value of material.

In order to arrive at criteria for the scientific valuation of natural science specimens and collections, it is first necessary to examine the nature of the relationship between the scientific process and material evidence. Much of the ground covered in this paper will be familiar to readers with a research background, and to some of those with responsibility for the care of natural science collections. Others may have a less complete understanding of the concept of scientific value, its origin, and implications for collections care and management, and it is hoped that they will find the discussion below particularly useful.

The nature of scientific value

In its broadest definition, scientific value is the value placed on material by the scientific community. Thus an object regarded as having great scientific value may have no value at all outside the context of science. The value of such an object to society at large is a function of both the value with which the scientific community invests it **and** the value which society places on science itself. This is the critical benchmark to be applied to objects or collections when assessing their scientific value.

In practice there are two broad categories of material which are regarded as having value in the natural sciences:

1. Material which is integrated into the fabric of science
   = *scientifically important material*
2. Material which facilitates scientific work
   = *material of value to science*

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Category 2B: reference material. A major function of some natural history collections is to serve as working reference collections for the identification of specimens, and to provide comparative material for taxonomic and other studies. Often these will be held by what may be regarded as single function institutions, e.g. agricultural or fisheries bodies etc. The value of such collections to science can only really be judged by the frequency of usage, and this will depend upon both the comprehensiveness of the collection in the institution's sphere of interest, and upon the quality of data associated with the collection. This category may also apply to parts of collections, for example, most museum collections contain elements which, in terms of their scientific value, may be regarded primarily as reference material.

Category 2C: potential for scientific importance. In the discussion above it has been stated that just because material has potential for being scientifically important, that does not make it **scientifically important**. However, such material may be of great **value to science** because its preservation might permit studies which would not otherwise be possible. This is an important factor in, for example, acquisition policies.

This potential is one of the more difficult and subjective qualities of natural history material that a curator may have to assess. There are clear-cut cases, such as when material is novel, and would almost certainly yield useful data in the short term if it were studied. There are also less obvious cases where material is unique in some aspect (e.g. from a locality which is no longer collectable) and may prove to be important at some point in the future, but for which there is no obvious importance at present. Finally, there are those cases in which only a crystal ball could possibly hint at the future uses of material currently held in collections, and thus the potential value of that material.

Obviously every specimen held in every natural history collection world-wide could be said to have potential for some unspecified purpose at some unspecified time in the future. However, there are two sides to the potential equation. Against the potential for some future benefit to science as a result of preserving material, we must balance the potential damage to science that preserving material can cause by acting as a drain on finite resources. If material is to be of value to science, therefore, there must be a perceivable benefit which could be realized within a definite time period, such that the resource cost of preservation is reasonable when measured against the anticipated benefit.

A further consideration which should be taken into account is the resource investment which has already been made in the material. Clearly there is a case for preserving material when a substantial resource cost has already been incurred, and in comparison with this the preservation cost is low. There is also a good case for preserving material which would be very costly, or indeed impossible, to recollect in the future.

All of the above cases are context sensitive and subjective, most particularly in the way that perceived benefits of preserving material will change through time, and as the resource base of science varies. It is, however, incumbent upon those responsible for collections of natural history material to ensure that, as far as possible, if they are preserving material on the grounds that it is potentially important to science, then it does not become an unreasonable drain on the resources of science, and do everything in their power to realize the perceived potential.

Quantifying the scientific value of collections

In addition to simply classifying various parts of a natural history collection in terms of their scientific importance, it is useful to quantify the value of material if possible. Quantification facilitates comparisons both within and between collections, and is necessary if we are to fully understand how our collections are made up and the scientific significance of the various parts. This information is essential for the effective management of natural history collections.

The most practical method of quantification which can be applied to all categories, and used as a universal measure of comparison, is simply to count numbers of specimens in each category. This method is currently used, and conveys some useful information (e.g. Nudds 1994). However, numbers of specimens are not necessarily the best guide to the scientific value of material in all the categories listed above, and more appropriate measures could be used for particular categories.

Scientifically important material (category 1)

Category 1A: subject material. The quality of value to science in this category is certainly not the number of specimens, but rather the number of concepts, or validly reached conclusions, that the material supports. For example, it is of no consequence to science if the type series of a species consists of one or one hundred speci-

gardens, supplying and investigating plants for use in medicine: the Royal Botanic Garden, Edinburgh, is one such, founded in 1670 (Fletcher & Brown 1970). Whatever their origins, however, the principal purposes of botanic gardens today are to furnish material for systematic research and to display plant diversity, for education and amenity.

Around the time Pisa and Padua re-invented systematic collections of living plants, collections of dead plants also began to be established. According to Arber (1986), Luca Ghini (?1490–1556) at Bologna 'seems to have been the sole initiator, in the renaissance period, of the art of herbarium making, which was then disseminated over Europe by his pupils', although the earliest extant herbarium is that of Gherardo Cibo, who began to collect *c.* 1532. The first institutional herbaria were founded in the latter half of the sixteenth century, the earliest being at Kassel in 1569 (Holmgren *et al.* 1990). As with botanic gardens, early herbaria were often associated with medicine, the collections being used during the preparation of printed herbals.

For over 450 years, governments, universities and private individuals have thought it worthwhile to make collections of plants. As a result, there are now well over 270 million herbarium specimens, in more than 2600 herbaria, and the number is increasing at a rate of around 3.5 million per year (Holmgren *et al.* 1990). Given that the total number of plant species is decreasing (since extinction is currently removing species at a much higher rate than they are being replaced through evolution: Systematics Agenda 2000 1994), and that the world has been scoured for specimens, dead or alive, for over 400 years, it would be surprising if questions did not arise from time to time, such as: haven't we collected enough and do we need to keep what we already have? As Davis & Heywood (1963) asked, in a textbook on flowering plant taxonomy: 'can governments be expected to go on expanding their herbaria indefinitely?' But these questions are in fact a distraction. Assembling and maintaining botanical collections are cheap, compared with most other scientific activities (and insignificant in relation to particle physics or molecular biology), while the benefits are demonstrable and great.

A personal perspective on accountability and accounting in systematics resesearch and collections management

The intellectual challenge of putting figures to the costs and benefits of botanical collections provides minor satisfaction, but is it necessary? It is certainly healthy for scientists to be reminded how much their activities cost and that they should have long-term goals, set short-term targets, work hard, be efficient, and publish. But current norms of public sector management go far beyond this. In the UK (and, I suspect, elsewhere), a generation of politicians and civil servants has brought words like **accountability** and **audit** to prominence. The people whose taxes pay for herbaria and botanic gardens have been encouraged to exert their right to bring public servants to account, to insist that they are told **how** 'their' money is spent, that it is being spent **wisely** and that it represents the **essential minimum** of spending. In order to improve efficiency and performance, there must be clearly defined objectives, and targets and criteria against which performance can be measured (HM Treasury 1992). These principles and practices are obviously good, as is the idea, embodied in the UK Citizen's Charter, that the public sector should aim to give a high quality service to the citizenry.

The central issues are: what is wise and what is essential? These questions are always difficult, but particularly so in relation to basic scientific research, where discovery cannot be planned and the significance of observations may not appear for many years. No-one has discovered a rational way to plan spending on basic scientific research, because there isn't one: it's a gamble, where the outcome and odds are unknown, but where benefits sometimes accrue. So, since no-one can determine in advance what is wise and essential, we hide our inadequacies by concentrating instead on things we think we can do well, which is to use auditing and accounting procedures to show how money is spent and that it is indeed a minimum. Unfortunately, many values cannot easily be turned into valuations.

At the Manchester conference and at a subsequent meeting in Leiden (*Systematics Agenda 2000 – the challenge for Europe: the action plan*, 14–17 May 1995), most participants were confident that systematics research, together with the natural science collections that underpin it, are vital, but that they are underfunded and in decline. Cotterill (1995) expresses a similar view. The response of many governments will probably not be dissimilar to the UK Government's (1993) view that: 'Whilst the Government is committed to supporting systematic biology, it has to consider its claims alongside other important branches of science and other claims on public funds' – the cake-server's dilemma. Those managing biological collections, believing in the value of what they do, work to persuade their sponsors that they

mismatch between the nature of incoming exchange material and the desiderata of an institute before the increased unit cost was worthwhile. The remedy for unsatisfactory exchange is not to abandon it, but to specify clearly and often what each institute is studying and seeking.

Alternatively, consider an institute that does act 'selfishly': an expedition collects 3000 specimens but no duplicates at all (Table 2, column D). The acquisition cost (£28.40) is still well above that in the basic model (£24.90). Though the institute might benefit from having amassed a collection fully in accordance with its acquisitions policy, the cost is not only an extra £3.50 per specimen but a reputation for 'rape and pillage' that will probably prevent further collection. Furthermore, it is unlikely that the expedition could gather and properly document 3000 different, informative specimens. It is much easier to collect three sets of 1000 specimens than one set of 3000. The distribution of species within and between different plant communities means that a significant proportion of an expedition is spent in searching and travel, which are, in themselves, non-productive. Thus, collecting in a particular locality quickly begins to obey the law of diminishing returns. And, regardless of whether the expedition collects many duplicates of a few plants or few duplicates of many plants, there are severe limits to the number of plants that can be collected per day, set by the logistics of specimen processing, transport, and so on.

Staffing. Since salary costs dominate the cost of acquiring herbarium specimens, it is desirable to use the least expensive staff for each activity, providing this does not adversely affect the quality of the collections and their processing. The staffing assumed in my basic model may seem generous. Remember, however, that the hypothetical, model expedition was not an unfocused collecting trip, but a deliberate attempt to collect material relevant to institutional research programmes. For this, a fairly high level of expertise is essential. It might be thought that costs could be reduced during the expedition by substituting technicians, to take over tasks that require no specialist knowledge, such as pressing specimens. This may sometimes be worthwhile, but often it will not, since processing material for the herbarium (and cleaning seed) can usually be done in the evening and early morning, when plant collecting is impossible.

In other words, it is very difficult to reduce the acquisition costs to £20 or less, unless specimens are collected near the herbarium and identified quickly by eye by a very junior member of staff – in which case, they probably aren't worth collecting. Specimens can be made as expensive as one cares to be inefficient, but clearly there will be some cases where acquisition will inevitably be costly, as a result of very difficult terrain, extreme isolation, or other special factors (irritant or spiny plants, tall trees, etc). Here, the price could be forced upwards, to £50 or more.

Bryophytes

Again using our Himalayan/SW China experience, it is possible to work out an approximate cost for the collection of bryophyte specimens and their incorporation into the herbarium. Bryophytes take up less space on an expedition than vascular plants, it is easier to collect duplicates, and exchange is often more efficient, since it takes place between people who generally know each other's interests and expertise very well.

Assume that a senior scientist on a Himalayan/SW China expedition collects four sets of 1500 specimens. The local herbarium has no bryologist and does not request a set of specimens; three sets are therefore available for exchange, bringing 6000 specimens in total. Identification is slower than for vascular plants (average 1 hour for each specimen) and requires the expertise of the senior scientist. Mounting is easier, since all that is generally needed is to stick paper capsules onto herbarium sheets. Although individual specimens are small, they are fairly bulky, so that the number of specimens per herbarium cabinet and the herbarium building cost are not much different than for vascular plants. On this basis, the acquisition cost of bryophytes is approximately £12.60 per specimen (Table 3). The number of duplicates is again critical. The extra difficulty of naming bryophytes, as opposed to vascular plants, coupled with a higher rate of collection in the field, means that the dominant cost element is identification. With vascular plants, as we have seen, it is extremely difficult to reduce the effective cost of the first phase of acquisition, namely collection. However, since the 'weakest link' in the acquisition of bryophytes is not collection but identification, it may often be best to maintain a high collection rate on the expedition, but to identify specimens only to genus, allowing them to be incorporated cheaply into the herbarium until they are required for study.

the cost of collecting seed or other living material can be estimated by subtracting the cost of collecting the 2400 herbarium specimens acquired by the expedition, from the total expenditure on salaries and direct costs. On this basis, if each living accession brings an average of 2.5 other accessions in exchange, the unit collection cost is £4.50. Identification is 'free', since this is included in the cost of the voucher specimens destined for the herbarium.

But the most expensive aspect of living plants is their cultivation. The Royal Botanic Garden Edinburgh currently maintains around 40 000 accessions of living plants, at a cost of around £2.5 million per annum (no ground rent is paid, since the Garden is on land owned by the State), which implies that each accession, on average, costs over £60 **every year**. In a botanic garden, many of the plants are on display, and are therefore managed in ways that would make no sense in a commercial nursery. But costs are inevitably high in a botanical collection, as opposed to a nursery or parks department, since each species has its own peculiarities and cultivation techniques often have to be worked out through trial and error. Botanic gardens, after all, are where most plants are brought into cultivation for the first time.

The benefits of botanical collections

Botanical collections bring many benefits, which are more than commensurate with the investment that has been made in acquiring and maintaining them. Let us first list the uses to which they are put.

The uses of herbarium specimens

Research into plant systematics. If we are to discover, catalogue and understand the million or more species of plants, algae and fungi that share this world with us, and gain insights into their relationships and evolution, herbaria are essential: 'For practical reasons, the classification of the world's flora is primarily based on herbarium material and the literature associated with it. Despite its limitations, a herbarium has certain advantages over living collections. It is usually only in the herbarium that we can compare all the related species of a genus in the same place, in the same state and at the same time' (Davis & Heywood 1963).

After they have been used for taxonomic research, herbarium specimens acquire significance as the essential material for checks and replication: taxonomic research must be open to test.

Identification. Almost all aspects of biology, from conservation to breeding and the search for new drugs and plant products, require the identification of biological material. Where good aids to identification exist, such as field guides or floras, they will be used before recourse to the herbarium. But even so, the identification of plants is ultimately dependent on the use of botanical collections. For many parts of the world and many plant groups, there are no published aids to identification and matching with herbarium specimens is the only sure way to accuracy.

Definition. The proper application of the names of species and other taxa is determined by types, which for many groups of plants are herbarium specimens. Definition is also the prime purpose of another group of herbarium specimens: the voucher specimens deposited to support identifications made during ecological, molecular genetic or other studies.

Biogeography and temporal changes in populations and distributions. A herbarium specimen documents the existence of a particular plant at a particular place and time.

Environmental monitoring. Changes in distribution demonstrated by herbarium material can be used to monitor environmental change. For example, van Dam & Mertens (1993) used diatoms on specimens of aquatic macrophytes held in the Rijksherbarium, Leiden, to detect deterioration in water quality over the last 50 years.

Ethnobotany. There is no necessary link between herbarium specimens and ethnobotany, only the accidental one that information about the uses of plants is sometimes recorded on herbarium labels; see Chaudhuri *et al.* (1977) and Altschul (1968).

History of exploration. Herbarium sheets are records not only of plants collected, but also of their collectors: they are sociological documents.

Professional education and training. The importance of herbarium specimens in taxonomic training is obvious, given the uses listed above.

The uses of living collections

Properly documented living collections have all the uses mentioned above, plus others:

Public education, amenity and display. One of the

Gleason, K. L. 1994. *Porticus Pompeiana*: a new perspective on the first public park of ancient Rome. *Journal of Garden History*, **14**, 13–27.

Harvey, J. 1981. *Medieval gardens*. B.T. Batsford, London.

Heywood, C. A., Heywood, V. H. & Wyse Jackson, P. 1990. *International directory of botanical gardens V*. Koeltz Scientific Books, Koenigstein.

Hibberd, D. J. 1980. Eustigmatophytes. *In:* Cox, E. R. (ed.) *Phytoflagellates*. Elsevier, New York, 319–334.

HM Treasury 1992. *Executive agencies: a guide to setting targets and measuring performance*. Her Majesty's Stationery Office, London.

Holland, P. 1634. *The historie of the world. Commonly called, the natural historie of C. Plinius Secundus. Translated into English by Philemon Holland*. 2 vols. Adam Fslip, London.

Holmgren, P. K., Holmgren, N. H. & Barnett, L. C. 1990. *Index Herbariorum. Part I: the herbaria of the world*. New York Botanical Garden.

Hooker, W. J. 1842*a*. Botanical information: Brazilian plants. *London Journal of Botany*, **1**, 295–298.

——— 1842*b*. Botanical information: Sale of Mr. Lambert's herbarium. *London Journal of Botany*, **1**, 394–396.

Jashemski, W. F. 1992. The gardens of Pompeii, Herculaneum and the villas destroyed by Vesuvius. *Journal of Garden History*, **12**, 102–125.

Jellicoe, Sir G., Jellicoe, S., Goode, P. & Lancaster, M. 1986. *The Oxford companion to gardens*. Oxford University Press.

Long, D. G., McBeath, R. J. D., McKean, D. R. & Rae, D. A. H. 1992. *Report of the 1991 Makalu Expedition*. Internal Report, Royal Botanic Garden, Edinburgh.

———, ———, Noltie, H. J. & Watson, M. F. 1993. *Report of the RBG Edinburgh Expedition to Sikkim and Darjeeling 1992*. Internal Report, Royal Botanic Garden, Edinburgh.

McBeath, R. J. D., Long, D. G. & Paterson, D. 1991. *Report of the 1990 Chungtien-Lijiang-Dali Expedition*. Internal report, Royal Botanic Garden, Edinburgh.

National Council for the Conservation of Plants Gardens 1994. *The National Plant Collections Directory 1994*. NCCPG, Wisley, Surrey, UK.Natural Environment Research Council 1992. *Evolution and biodiversity – the new taxonomy*. The report of a committee chaired by Professor J.R. Krebs FRS. NERC.

Nielsen, E. S. & West, J. G. 1994. Biodiversity research and biological collections: transfer of information. *In:* Forey, P. L. Humphries, C. J. Vane-Wright, R. I. (eds) *Systematics and conservation evaluation* (Systematics Association Special Volume **50**). Clarendon Press, Oxford, 101–121.

Noltie, H. J., Long, D. G., McBeath, R. J. D., Watson, M. F., Aldén, B. & Alexander, J. C. M. 1994. *Report of the Kunming, Edinburgh, Göteborg (KEG) Expedition to NW Yunnan 1993*. Internal Report, Royal Botanic Garden, Edinburgh.

Office of Science and Technology 1994. *Review of UK microbial culture collections*. Her Majesty's Stationery Office, London.

Oxford Dictionary of Quotations, (2nd edn) 1953. Oxford University Press, London.

Pearce, D. & Moran, D. 1994. *The economic value of biodiversity*. Earthscan, London.

Pisa, F. G. 1991. Pisa Botanic Garden celebrates its 400th anniversary. *Botanic Gardens Conservation News*, **1**, 34–36.

Pringsheim, E. G. 1946 *Pure cultures of algae: their preparation and maintenance*. Cambridge University Press.

Radice, B. 1963. *The letters of the Younger Pliny*. A translation. Penguin Books.

Rolfe, W. D. I., Milner, A. C. & Hay, F. G. 1988. The price of fossils. *Special Papers in Palaeontology*, **40**, 139–171.

Ruskin, J. 1908. *The crown of wild olive. Four lectures on industry and war*. G. Allen, London.

Schlösser, W. G. 1994. SAG Sammlung von Algenkulturen at the University of Göttingen. Catalogue of strains. *Botanica Acta*, **107**, 113–186.

Sellar, W. C. & Yeatman, R. J. 1930. *1066 And All That*. Methuen.

Small, E. 1993. The economic value of plant systematics in Canadian agriculture. *Canadian Journal of Botany*, **71**, 1537–1551.

Smith, W. W. 1932. George Forrest 1873–1932. Obituary notice. *Transactions of the Botancial Society of Edinburgh*, **31**, 239–243.

Systematics Agenda 2000 1994. *Systematics Agenda 2000: Charting the Biosphere. Technical Report*. New York.

Terwen-Dionisius, E. M. 1994. Date and design of the botanical garden in Padua. *Journal of Garden History*, **14**, 213–235.

The Staff of the Royal Botanic Garden Edinburgh 1924. Plantae Chinenses Forrestianae. Catalogue of the plants (excluding *Rhododendron*) collected by George Forrest during his fifth exploration of Yunnan and Eastern Tibet in the years 1921–1922. *Notes RBG Edinburgh*, **14**, 75–393.

——— 1929–30. Plantae Chinenses Forrestianae. Catalogue of the plants collected by George Forrest during his fourth exploration of Yunnan and Eastern Tibet in the years 1917–1919. *Notes RBG Edinburgh*, **14**, 75–393.

Thompson, A. J., Rhodes, J. C. & Pettman, I. 1988. *Culture Collection of Algae and Protozoa: catalogue of strains*. (5th edn). CCAP, Ambleside, Cumbria, UK.

Tutin, T. G., Heywood, V. H., Burges, N. A., Valentine, D. H., Walters, S. M. & Webb, D. A. (eds) 1964. *Flora Europaea. Vol. 1. Lycopodiaceae to Platanaceae*. Cambridge University Press.

UK Government 1993. *Systematic biology research: Government response to the First Report of the House of Lords Select Committee on Science and Technology, 1991–92 Session*. Her Majesty's Stationery Office, London.

Van Dam, H. & Mertens, A. 1993. Diatoms on herbarium macrophytes as indicators for water quality. *Hydrobiologia*, **269/270**, 437–445.

(of which there are 42) occupy a special position, particulary interesting from the point of view of geology. There are for example classic geological profiles, characteristic magmatic, volcanic, sedimentary and tectonic structures, typical eroded, weathered and accumulation landforms, sites of occurrence of unique minerals and fossils, and vestiges of ancient mining etc. Of great significance for inanimate nature protection are also the numerous 'landscape reserves' which are distinguished by high scientific educational and scenic value.

3. *Inanimate nature monuments.* Outside the nature reserve network, single earth science conservation objects are protected by law as inanimate nature monuments (presently approximately 1750 in number). These are geological exposures, caves and karst hollows, tors and rock walls, erratic boulders, water objects (e.g. springs, waterfalls), dunes, osars and remains of ancient mining.
4. *Documentary sites.* The Nature Conservation Act of 1991 introduced a new category of inanimate nature conservation known as Documentary Sites. This category of legal protection corresponds to the earth science Sites of Special Scientific Interest (SSSIs) applied in Britain (Nature Conservancy Council 1990).

In-depth reviews of the most important legally protected areas and objects of inanimate nature in Poland (Jakubowski 1971; Alexandrowicz *et al.* 1975) and the results of the first attempt of evaluation of objects of inanimate nature in all the protected areas (Alexandrowicz *et al.* 1992) detail all of the above categories.

Mobile monuments of inanimate nature

The rising emphasis on earth science conservation is giving new significance and urgency to the role of museums. Undoubtedly successful protection of inanimate nature depends also on activity from natural history museums. Particularly important from a museum viewpoint is the safe-guarding of mobile geological monuments in various kinds of protected areas and sites. We can distinguish the following main categories of mobile monuments of inanimate nature.

1. *Collections of specimens from sites protected by law on international, regional and local scale.* These are one of the most important categories of collections in every geological museum. Recommendations for safe-guarding such objects is found in updated lists of legally protected sites as well as in the first List of World Heritage Geological Sites Inventory Cowie 1990. A good basis for establishing museum inanimate monuments would be the construction of a unified network of SSSIs, as introduced in Britain, or their equivalents in other countries, and also international initiatives in this field (e.g. European Working Group on Earth Science Conservation).
2. *Collections of rare or unique geological specimens from classical localities now exhausted.* Many valuable sites can no longer be collected from and their corresponding museum collections may be the only clues to the geology of these areas. Geological specimens often become important historical documents as particular environments on Earth are changed or lost. This is especially important nowadays, as we modify the Earth with increasing vigour.
3. *Historical collections of eminent scientists.* These collections represent the cultural and scientific heritage of natural science and science history. Earth science continually moves on and new uses are discovered for old material. Museums are still motivated by a quest to decipher the natural world recorded in the existence of the object.

Apart from scientific values, mobile monuments of inanimate nature play an important role in museum educational activity, especially the problem of nature conservation. They provide excellent material for educational exhibits. Geological specimens are particularly useful here. Display collections of minerals, rocks and fossils are 'the real thing', for visitors, in other words they are 'natural' nature objects, different from other natural history museum specimens of the recent living world which are only dead objects torn from their natural environment. Possibilities of stimulating the imagination through direct contact with real nature is an essential factor for the popularization of both natural sciences and the fundamental problems of nature conservation as a basis for preservation of our natural environment (Jakubowski 1983*b*, 1995).

Conclusion

The concept of establishing a close connection between a museum's functions and the protection of monuments of inanimate nature has a

incomplete and provisional; the site archive will always be capable of further study. This means that it should be as complete as possible, since it stands as a voucher for the original site. On rich sites, such as central London, the quantities of material in the site archive can be very large indeed. Twenty years of excavation in London have filled 3000 square metres of stores, resulting from the investment of £40 million in recording, research and publication.

The nature of archaeological practice thus makes the decision of whether material recovered in an excavation should or should not be preserved a very crucial one. It has to take account of the usefulness of the original site observations and the quality of their recording, the extent to which objects can be conserved, and the resource implications of continuing care. These decisions can be made in the field, in the study and, ultimately, at the point when the archive becomes an inalienable part of the museum. To decide that parts of a site archive are not needed is difficult because of the assumption that even fully published material can be re-studied and because many sites have had so little post-excavation analysis and publication that it would not be possible to begin to decide what might be discarded.

But are archaeological collections formed as a result of 'scientific' excavation capable of being re-interpreted as English Heritage claim? If not, we cannot justify the retention of vast quantities of material from site archives.

Although comparatively little work has been done on the detailed re-interpretation of data from archaeological excavations there is enough to suggest that worthwhile things can be done. A recent example is a re-examination of Pitt-Rivers' work in the nineteenth century on Cranborne Chase in Dorset in the context of new field work and research in the area (Barrett *et al.* 1991a,b). What was clear from this is that Pitt-Rivers' site archive was considered by the authors to be more use than his publications, a notion which challenges much traditional archaeological practice emphasizing publication as the primary record.

There is thus an archaeological need for repositories for site archives and research records based on them; museums normally fill this role. The Museum of London has become a repository for a comprehensive range of archaeological source materials relating to London, derived from many years of field work.

But although there is a theoretical archaeological need, will there in fact be people to use this repository? We can identify several stakeholders in the Museum of London's archaeological collections, but in total they form a relatively small proportion of all those whom the museum seeks to serve. I would include the following amongst those who have a direct interest in their survival:

- the freehold owners of excavated sites; unless clearly donated to the museum they may own the objects recovered; they may also own the paper and computer records of the site and the intellectual property created by the field work and research, depending on the terms of the agreement for the archaeological work to take place (these issues are discussed in The Society of Museum Archaeologists (SMA 1995);
- charitable foundations and government agencies who have grant-aided archaeological projects;
- the people who have excavated, researched and published the site; the world of archaeological scholarship generally; as we have seen, the collections and records will be the basis for future work, the subject matter, methodology and techniques of which cannot be anticipated.

The general public has a rather different interest. Their needs from the archaeological collections are mediated by the staff of the museum. Exhibition, publication and educational programmes are designed to explain people, places and things. They need the knowledge and understanding derived from the archaeological process for at least part of their content. The ideas will usually be communicated through objects – but this certainly does not require collections as extensive as the archaeological discipline needs. Indeed, since an archaeological repository used almost exclusively by researchers does not need an interpretative apparatus for the general public, it hardly needs to be in a museum at all. There is certainly a considerable cost in maintaining a repository. In the Museum of London, processing the incoming archaeological archive from excavations and the continuing costs of managing this and earlier material probably totals £750 000 per annum. It is growing at about 100 square metres each year, a process driven not by the museum but by the pace of redevelopment and the requirements of archaeology. This rising cost has to be found within a total budget which is unlikely to increase in the foreseeable future. In other words the growing needs of the archaeological discipline could affect all other functions that contribute to the museum's overall purpose, and it is to that we should now turn.

KEYNOTE ADDRESS

The cultural impact of natural science collections

CHARLES PETTITT

Manchester Museum

Introduction

Natural history collections have a major role to play in many aspects of life today; they can and do contribute significantly towards defeating disease, combating environmental pollution, understanding the 'greenhouse effect', and to other scientific studies vital to human society and to life on planet Earth (Pettitt 1991). Oldfield (1985) estimated that by the end of the twentieth century between a half and one million species would become extinct. For some groups and parts of the world, museum collections will soon represent the only record of biodiversity.

Ultimately the true worth of natural history collections will be judged by their demonstrated use to society (Pettitt 1989). This value to society is enormous, but is poorly understood by the public and by politicians (Howie 1986; Ingrouille 1989; McAllister 1991). Too often people say of large collections, 'but what good are they if we can't see them?'; these people fail to understand the value that large research collections have as objective data banks with an irreplaceable historical dimension. The gradual loss of interest in the world of nature by the scientific community and the public during the first part of this century has progressively downgraded the resources devoted to natural history in museums. We must ask ourselves why society considers spending several million pounds for a painting is a public benefit, while a few thousand pounds to maintain a natural history collection is seen as a drain on the public purse (Edwards 1985). This paper gives examples of a number of ways in which the expertise of natural history curators is called upon in public life.

Although several other papers in this volume address the value of natural history collections to scientific research, it is worth reiterating the essential underpinning of research that they represent. Natural history collections are an irreplaceable database of information on species diversity and habitat changes. Hounsome (1984) points out that the basis of all science is that observations by one worker can be verified by others. With taxonomic, distributional and ecological observations, verification is usually only possible if the relevant specimens have been deposited in an accessible and suitable museum collection. He indicated the difficulties in verification that arise for sensitive groups, such as birds, where it is illegal or unethical to collect 'voucher' material.

Current level of use

McAlpine (1986) examined 1350 papers in 12 natural history journals and found 12.7% used collections and no less than 44.4% **made** collections in the course of the work. For taxonomic or systematic studies authors either consulted collections, made collections, or did both in 90.4% of the papers. However, Cato (1988) analysed the contents of ten similar journals for 1985–1986, and found only 24 articles related to natural history collections (119 pages in 15 510 = 0.8%). In six museum journals he found there were 34 articles (302 pages in 3166 = 9.5%) on natural history. Steve Garland (1990 *in litt.*) checked three major entomological journals for 1989 and 1990, and found that, ignoring small notes, of 251 papers, 105 (42%) used collections in some way in arriving at their results.

Non-biologists and administrators often fail to appreciate the necessity for obtaining accurate identification of biological material, or the difficulties of so doing without access to good reference collections. The strange fact is that, even as the demand for assistance with identifications threatens to submerge those able to provide the service, research funders still regard taxonomic work with a jaundiced eye (Brinkhurst 1985).

Environmental studies

Many studies in the fields of ecology, evolution, pollution and climatic changes require museum specimens. Provided selective collecting is al-

in a medical research programme (Genoways *et al.* 1976). A hospital found 'abnormal larvae' of the parasitic worm, *Ascaris lumbricoides*, in some pathological tissue; museum identification proved these to be the normal young from a harmless roundworm, which was then traced to the tank supplying the water to wash the specimens (BMNH 1956). Near-Eastern hamster specimens were used in a medical study on toxoplasmosis. In America, mammal collections have yielded information on Chaga's disease and haemorrhagic fever (Genoways *et al.* 1976). The control of other diseases such as bilharzia, bubonic plague, malaria and river blindness, all depend for cost-effective treatment on very precise identification of the animals transmitting the disease, using reference collections. For example, the ticks, *Ixodes reduvius* and *I. hexagonus*, are superficially similar, but the former carries bovine piroplasmosis (red-water fever), the latter is harmless. With the easily confused mite species, *Trombicula akamushi* and *T. autumnalis*, the former transmits 'rural typhus' or 'japanese river disease', the latter does not. The incorrect identification of the very similar looking freshwater snails of the genus *Bulinus*, only some of which carry bilharzia, can lead to futile and costly attempts at eradication (BMNH 1956). Museum identification is often needed to determine if the fungus causing skin lesions is ringworm, rather than psoriasis, impetigo or secondary syphilis. If ringworm it is then also important to distinguish between the various species of *Microsporum* that cause ringworm; some, from animal sources (*M. canis*, *M. gypseum*) are easily cured or may even disappear spontaneously, but other species, such as *M. audouini*, need X-ray therapy. Psychiatrists regularly use specimens of birds, bees, butterflies, small mammals and so on from museums for the treatment of phobias; by controlled gradual increased exposure to the specimens, patients learn to control their irrational fear of the living animals (Logsdail 1987; David Erwin 1990, pers. comm.; Calder 1991). Human skulls in museums have been used for studying the history of 'trepanning' (Martin 1989). Museum animal skulls have been used extensively in a standard work on variation and diseases in animal teeth (Colyer 1936), currently under revision.

Half the world's medicinal products are not synthesized, but obtained directly from plants. Only a small fraction of plants have been screened for pharmaceutically useful compounds, and even fewer invertebrates, even though several species have yielded potent anticancer drugs (Oldfield 1985). With the accelerating extinction of species, material in museums will increase in importance for this work.

Local authorities

Health. Another success story for natural history collections: environmental health officers with their mangled, cooked or partially digested animal remains, a snail in a can of peas, a slug in raspberry jam (author's experience), fish teeth in bread (BMNH 1956), or the cat bones in a tandoori curry (Mike Hounsome 1990, pers. comm.), all need careful identification plus expert opinion upon where the 'foreign body' entered the process, often with legal proceedings pending; usually such identifications can only be done using reference collections. These officers also rely heavily on their local museums for help identifying infestations.

Planning. Environmental impact statements made in response to local planning applications need the backing of voucher collections else they are likely to prove worthless at a public enquiry (John Mathias 1991, pers. comm.). The defence of SSSIs and other sites of biological interest depends upon ecological information verified by voucher material (Ely 1994). In the US, national legislation now requires the evaluation of environmental consequences whenever major governmental projects are undertaken. This has resulted in heavy demands being placed on natural history museums for access to records and specimens that document environmental processes (Malaro 1991). Growing public concern could well result soon in similar European national and EEC legislation, increasing still more the importance of well documented **local** collections.

Weights and measures. Museums have identified Canadian salmon being sold as European salmon, and mock halibut sold as halibut, to assist inspectors in prosecutions.

Law enforcement

Police. 'Aiding the police in their enquiries', museum reference collections can tell the age and race of an unearthed human skull, accurately identify hairs as evidence in prosecutions over badger hunting (Bowler 1991), and identify biological materials for 'scene of crime' forensics, all of which can only be done with the authority of a reference collection. Examples include the museum identification of feather fragments helping to convict a wife-murderer who also killed her pet chicken (Alan Knox

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ELY, W. 1994. *Natural History Museums and Biological Recording*. *In:* STANSFIELD, G., MATHIAS, J. & REID, G. (eds) *Manual of Natural History Curatorship*. London, HMSO, 167–190.

FITZPATRICK, J. W. 1985. The Role of Scientific Collections in Ecological Morphology *In:* MILLER, E. H. (ed.) *Museum Collections: Their Roles and Future in Biological Research*. British Columbia Province Museum Occasional Paper **25**, 195–208.

GATES, P. 1990. Why Spring may never be the same again. *The Independent on Sunday*, **25 Feb.**, 12–13.

GAVAGHAN, H. 1987. On the wings of European technology. *New Scientist*, **2 April**, 38–42.

GENOWAYS, H. H., CHOATE, J. R., PEMBLETON, E. F., GREENBAUM, I. F. & BICKHAM, J. W. 1976. Systematists, Other Users and Uses of North American Collections of Recent Mammals. *Museology*, **3**, Texas Tech. University, Lubbock, Texas.

HANCOCK, E. G. & MORGAN, P. J. 1980. A survey of zoological and botanical material in museums and other institutions of Great Britain. *Biology Curators Group, Report No. 1*.

HAYHOW, S. J. 1989. *Natural History Enquiries: An evaluation of the service offered by museums*. MSc thesis, University of Leicester, Dept. of Museum Studies, Leicester.

HERON, F. A. F. 1989. *Re-appraisal of the Johnstone collection of diseased, tumourous and abnormal fish from 1904–1926*. MSc thesis, Universiy of Liverpool.

HOUNSOME, M. V. 1984. *Research: natural science collections. In:* THOMPSON, J. M. A. (ed.) *Manual of Curatorship A guide to Museum Practice*. Butterworths, London, 150–155.

HOUSE OF LORDS (1992). *Select Committee on Science and Technology. Systematic Biology Research: written evidence received up to 21st May 1991*. HL Paper 41, 202 pp. HMSO, London.

HOWIE, F. M. P. 1986. Conserving natural history collections: some present problems and strategies for the future. *In:* WADDINGTON, J. E. & RUDKIN, D. M. (eds.) *Proceedings of the 1985 Workshop on care and maintenance of Natural History Collections*, Royal Ontario Museum, Toronto, 1–6.

INGROUILLE, M. 1989. The decline and fall of British Taxonomy. *New Scientist*, **7 Jan.**, 64.

KLASS, E. E., OHLENDORF, H. M. & HEATH, R. G. 1979. Avian eggshell thickness: variability and sampling. *In:* BANKS, R. C. (ed.) *Museum Studies and Wildlife Management*. Selected Papers. Smithsonian Institution Press *for* National Museum of Natural History, Washington, 253–261.

KUIPER, J. G., OKLAND, K. A., KNUDSEN, J., KOLI, L., PROSHWITE, T. V. & VALOVIRTA, I. 1989. Geographic Distribution of the small mussels (Sphaeriidae) in North Europe (Denmark, Faroes, Finland, Iceland, Norway and Sweden. *Ann. Zool. Fennici*, **26**, 73–101.

LEE, W. L. 1979. The San Francisco Bay Project: A new approach to using Systematics. *In:* BANKS, R. C. (ed.) *Museum Studies and Wildlife Management*. Smithsonian Institution Press *for* National Museum of Natural History, Washington, 249–252.

——, BELL, B. M. & SUTTON, J. F. 1982. *Guidelines for acquisition and management of biological specimens*. Association of Systematics Collections, Kansas.

LOGSDAIL, S. J. 1987. 'Taxidermy mounts of birds of prey for phobic treatment'. Letter to Gordon Reid, Horniman Museum, 30.7.87.

MALARO, M. 1991. Moving People towards Change. *MDA Information*, **14** (2–4), 18–23.

MARTIN, A. W. 1989. *in litt.* to Gordon Reid, Horniman Museum, Feb. 1989.

MCALLISTER, D. E. 1991. Biodiversity of Natural Science Museum Clienteles: The splendid diversity of modern museum functions. *Proceedings of the Society for the Preservation of Natural History Collections 6th Annual Meeting* (*abstr.*), 29

MCALPINE, D. F. 1986 Curators and Natural History Collections: Have we become islands in science? *In:* WADDINGTON, J. E. & RUDKIN, D. M. (eds.) *Proceedings of the 1985 Workshop on care and maintenance of Natural History Collections*, Royal Ontario Museum, Toronto, 7–14.

MILLER, E. H. 1985. Museum Collections and the Study of Animal Social Behaviour. *In:* MILLER, E. H. (ed.) *Museum Collections: Their Roles and Future in Biological Research*. British Columbia Province Museum Occasional Paper, **25**, 139–162

NORRIS, A. 1988. Vanishing herds – large mammals in museum collections? *Biology Curators Group Newsletter* **4(8)**: 148-149.

OGILVIE, R. T. 1985. Botanical Collections in Museums. *In:* MILLER, E. H. (ed.) *Museum Collections: Their Roles and Future in Biological Research*. British Columbia Province Museum Occasional Paper **25**, 18–22

OLDFIELD, M. L. 1985. *The value of conserving genetic resources*. US Dept of Interior, Washington D.C.

OUELLET, H. 1985. Museum collections: perspectives. *In:* MILLER, E. H. (ed.) *Museum Collections: Their Roles and Future in Biological Research*. British Columbia Province Museum Occasional Paper **25**, 215–218.

PAINE, C. (ed.) 1992. *Standards in the Museum Care of Biological Collections*. Museums and Galleries Commission, London.

PEAKE, J. F. 1986. Zoological Collections of the British Museum (Natural History). *In:* MORGAN, P. J. (ed.) *A National Plan for Systematics Collections?* National Museum of Wales, Cardiff, 34–39.

PERRING, F. H. 1977. The role of natural history collections in preparing distribution maps. *Museum Journal*, **77 (3)**, 133.

PETTITT, C. W. 1971. *Studies on the Polymorphism, Distribution and Laboratory Culture of Littorina saxatilis (Olivi)*. MSc thesis, University of Manchester, Zoology Department, Manchester.

—— 1977. An Investigation of Variation in Shell form in *Discula (Hystricella) turricula* (Lowe, 1931) (Pulmonata: Helicacea) *Journal of Conchology, London*, **29**, 147–150.

—— 1986. Collections Research in the United Kingdom. *In:* LIGHT, R. B., ROBERTS, D. A. &

A comparison of methodologies used for valuation of the fish collection at the Canadian Museum of Nature

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Introduction

The issue of collections valuation is one that has vexed museums for years. The scientific community readily recognizes that scientific collections contain a wealth of information and offer unlimited potential for a variety of uses including future research and study (Table 1). Traditionally, however, there has been a reluctance to assign any value to such collections. As recently as 1992, the Canadian Museum of Nature's (CMN) Annual Report referred to the valuation of its collections as impractical and uneconomical. The unique nature of the collections was considered a barrier to any valuation and the museum, like many others, avoided the issue by phrases such as 'No Commercial Value' or 'Scientific Value Only'. For accounting purposes the collections were valued at $1000 in the museum's financial statements.

The financial situation for public agencies such as the museum is changing rapidly: shrinking budgets require strict controls and, in some cases, substantiation for continued support. If any aspect of future funding is contingent upon agencies showing value, it is imperative that reasonable values be assigned to scientific collections. This became abundantly clear when the CMN tried to obtain permission to construct a new building to consolidate its staff and collections holdings. Government authorities who, in the past, could not understand why they should authorize an expenditure in the order of $30 000 000 to preserve collections with a declared asset value of $1000 changed their perspective for the same collections with an estimated replacement cost in excess of $1 billion.

The museum recognized, however, that this estimate could put them at risk. Even though a reasonable estimate of the cost of collecting, preparing and identifying specimens to replace the existing collection could be made, it implied a value that could not be realized on the commercial market. Clearly this was not a comfortable position. What was really needed was a measure of the value of the collections to the Canadian economy. To do this the CMN, with support from Environment Canada's Environmental Innovation Program, and in association with Agriculture Canada and Forestry Canada, contracted with P.G. Whiting and Associates to investigate and develop a methodology to establish the socio-economic value of scientific collections. This paper will discuss the work done for the CMN Fish Collection, comparing the replacement cost methodology developed by CMN Collection Division staff with the socio-economic value methodologies investigated by P.G. Whiting and Associates.

Table 1. *Typology of values derived from scientific collections*

Use/Value category	Types of value
Education/knowledge	
1. Display	• public awareness • increased interest and curiosity • increased education • cultural benefits
2. Research	• increased knowledge • new technologies • resource management and administration techniques • legislation/regulation of species
3. Teaching	• increased knowledge • new science students
4. Identification	• increased knowledge • remediation activities required • commercial production protection • legal/legislative requirements • international trade effects
Material resource	
5. Genetic material	• increased knowledge • new varieties
6. Posterity, future use insurance	• future options maintained • potential future benefits • measure change over time
7. Loan	• shared knowledge/resource • income potential • improved stature of institution
8. Sale	• income • shared knowledge/resource

Table 2. *Summary of costs to replace the Canadian Museum of Nature Fish Collection in 1995 dollars based on estimated numbers of specimens and costs for local, distant and remote collecting trips*

	Local trip	Distant trip	Remote trip
Duration of trip (days)	1	14	28
Cost of trip ($)	1400	25 000	69 000
Number of specimens collected/trip	186	2340	3200
Number of specimens in CMN collection	68 500	556 000	231 000
Number of trips required to replace collection	368	238	72
Cost to re-collect CMN collection ($)	515 000	5 950 000	4 968 000
Total collecting cost ($)		11 433 000	
Preparation and identification (105 000 lots @ $80/lot) ($)		8 400 000	
Total replacement cost ($)		19 833 000	

Replacement cost

The replacement cost or value of certain types of collections such as minerals, fossils, and mammal pelts can be estimated from commercial sources such as catalogues, insurance appraisals, and market value set by recent sales. However, for most scientific collections there is no real commercial or market value and other methods must be used to estimate their value. In practical terms, the cost or investment of resources to collect, prepare, register, and identify a collection can be calculated to a reasonable degree of accuracy to produce a defensible replacement cost.

The methodology adopted was relatively simple. Although specimens come from all over the world, it was observed that all of the museum's collections could be characterized as having come from three types of collecting localities: local; distant but accessible; and remote and not easily accessible. The cost of these generalized trips and expected yield of specimens could be estimated from past experience to provide a reasonable estimate of the cost of collecting the specimens. The basic field party unit of one researcher and one assistant used for the calculations was a reasonable assumption because costs and specimen yield tend to be multiples of this basic unit.

The 'Local Trip' was characterized as one day in the field with a half-day preparation time and transportation by museum vehicle. This trip would cost about $1400 including salaries and administrative overheads and yield an average of about 186 specimens. The museum has about 68 500 fish specimens from local sites which using this formula would have cost about $515 000 to collect, prepare, and identify.

The 'Distant Trip' was characterized as 14 days in the field with 2 days travel, and 13 days of preparation and clean up. This again would be to an accessible location where normal commercial or road transportation is available. It was estimated that a trip of this type would yield about 2340 specimens and would cost about $25 000. The museum has about 556 000 fish specimens from distant localities which it estimates would cost $5 950 000.

The 'Remote Trip' was characterized as to a location where specialized transport was required such as the Arctic. This trip included 28 days in the field with 4 days travel and 19 days preparation and clean up. This trip would cost about $69 000 and would yield about 3200 specimens. The CMN has about 231 000 fish specimens from remote locations which would have cost $4 968 000.

The total cost for collecting the CMN fish collection is therefore estimated at about $11.4 million (Table 2). Although the collection has about 855 000 specimens, it is comprised of only about 105 000 lots. It is estimated that it costs $80 per lot to prepare and identify specimens after they are returned to the museum. This would add another $8.4 million bringing the replacement cost of the collection to a total of $19.8 million. The cost of ongoing care was not factored in as it is not a replacement cost consideration.

Socio-economic value

Following a descriptive analysis and review of various possible valuation methodologies, it was considered that the 'Past Expenditures' and the 'Benefits' methods would be most appropriate for scientific collections. These methodologies are concise, non-duplicative (no double/multiple counting of benefits), logical, and replicable.

Table 3. *Summary of CMN Fish Collection costs for the years 1991/92 to 1994/95*

Year	Collections ($)	Research ($)	Overhead ($)	Housing ($)	Total ($)
1991/92	161 364	134 790	73 440	180 000	549 594
1992/93	161 410	244 605	99 865	180 000	685 880
1993/94	99 486	177 396	65 298	180 000	522 180
1994/95	82 972	187 278	95 391	180 000	545 641

Table 4. *Summary of CMN Fish Collection costs from 1991/92 to 1994/95 in constant (1986) dollars*

Year	Collections ($)	Research ($)	Overhead ($)	Housing ($)	Total ($)
1991/92	126 759	105 884	57 690	141 398	431 731
1992/93	124 449	188 593	76 997	138 782	528 821
1993/94	75 254	134 188	49 393	136 157	394 992
1994/95*	N.A.	N.A.	N.A.	N.A.	N.A.

* index not yet available for 1994

Past expenditures method

The past expenditures method is based on the premise that the dollar amounts spent on a collection's acquisition, maintenance or display are more indicative of its carrying cost value than its total value. It is essential to identify all costs associated with a collection including capital and non-capital items, and it was anticipated that the actual past expenditures would be available in public expenditure account records. While it may appear to be a straightforward exercise to document past expenditures, a number of factors complicate the situation:

- availability and access to historical cost records;
- collections being moved between departments or agencies;
- the amalgamation and/or disaggregation of collections over time;
- changing accounting systems over time;
- incorporating (or accounting for) overhead administrative costs;
- actual spending indicates what is affordable, not necessarily what is desirable;
- percentage of the collection donated.

Notwithstanding these difficulties, the specifics of past costs were portrayed as accurately as possible.

Two valuation approaches were used; current dollars and constant (1986) dollars. By using these two approaches, the effects of inflation would be identified. In addition, a capitalized value (imputed total value) for the collections was calculated based on past annual expenditures. Using an appropriate 'social discount rate' allowed a capitalized value to be calculated providing a reasonable base estimate of the value implicitly placed on the collections by the museum.

It was recognized that expenditures have been made over a long period of time to maintain, develop and research the collection, but that the collection contained more value than is reflected in the annual expenditure figures. The approach used views the on-going annual nature of these expenditures as an amount supporting a value of something larger than these annual expenditures. By creating a capitalized value based on these on-going expenditures, a closer indication of the collections' real value is derived.

A summary of the Fish Collection costs that were identified for the last four years is presented in Table 3. Collections and Research costs reflect the sum of salary, benefits, capital costs and a percentage of the total divisional operations and maintenance and overhead budgets pro-rated on a per capita basis. The Museum Overhead Costs assigned to the Fish Collection = (Total Administrative Budget/Total Number of Staff) × Number of Research and Collections Staff working in the Fish Collection. Housing costs were based on rental rates of $\$125/m^2$ for office space and $\$90/m^2$ for warehouse space. While these figures represent the carrying costs associated with the collection, they do not include all of the costs associated with its acquisition. Unfortunately at this point it is impossible to determine the actual acquisition cost figures and to factor them into the equation, but it is estimated that approximately

made to determine the various links between actual users of the collections and others who used their results through various levels, thereby identifying the ultimate benefits generated by the collections.

The scientists associated with the Fish Collection provided a list of the users of the collection over the previous twelve months (1993). Summarized in Table 6, it shows the different types of uses that are regularly made of the collection by outside agencies. These requests and uses are over and above the ongoing research activities of the scientists themselves. In addition, the survey of collection users showed that the use of the collection is usually only part of a research project or other on-going programme. In most cases, scientific and other users of the collection see the collection as a valuable resource supporting their specific research, teaching and other interests.

The primary users of the collection are the direct users. The benefits which they and/or their organizations derived from the collection are not distinct in economic terms, but are clear in scientific terms: the desired assistance or information was obtained from the collection. The indirect users of the collections (those who benefit from the results of the direct users' work) appear to be legion. To a lesser or greater degree they include: hunters, bird watchers, fisheries managers, fishermen, native fishermen, and the fisheries, wildlife and other fauna resources toward which the scientific endeavour is directed. Direct collection users did not use the collection with the specific expectation that someone or some other institution was waiting for the results and would pick up the research results and work with them further. Rather, beneficiaries of their work were identified in the general and holistic sense noted above.

Table 6. *CMN Fish collection uses and users requests reported between April 1, 1993 and March 31, 1994*

Classification	No. of observations
1 Information or advice (to anyone: public, other scientists, etc)	52
2. Contribution to another research effort/activity	24
3. Press or journalistic requests/enquiries	17
4. Review of manuscripts/papers	22
5. Miscellaneous other uses/requests/activities	17
Total	132

The actual linkages between collection use and the ultimate beneficiaries of that use did not emerge as a clear or straight connecting line. Such linkages may best be determined through an appraisal of the overall nature of scientific research and the information distribution systems it includes. There is no precise way of knowing which researcher or research institution will pick up on the results of the work by the direct collection user and carry the research forward. It is doubtful that survey respondents can accurately identify or confirm these linkages. Indeed, the linkages to indirect users of information generated by direct users are impossible to determine with any degree of certainty. The benefits derived by the ultimate beneficiaries (who appear to be Canadians, specific sub-groups, and society in general) seem to relate to a better environment, either through managed natural resources or increased awareness of natural systems.

A hierarchy of benefits proposed for scientific collections has an intangible element to a collections value and a tangible or quantifiable element. The tangible could be viewed as follows:

Primary benefits
- Direct: • benefits to the collection user
- Indirect: • benefits to others as a result of the direct collection user's benefits

Secondary benefits
- Direct: • expenditures of the collection user
- Indirect: • expenditures of others related to their use of the original collection user's results

The monetary primary benefits identified by users from the use of the collection was minimal, indicating that the respondents had difficulty personalizing the benefits; benefits to the individual and benefits to the organization were not well separated, and inadequately described. Neither could the indirect primary benefits be adequately determined by the survey, primarily because indirect users could not be identified explicitly.

Similarly, the identified secondary benefits associated with the small expenditures of direct users were inconsequential as were the secondary benefits associated with indirect users. Other beneficial outcomes from direct and/or indirect use of the collection are not discernible from the method adopted for this study. The limited survey mechanism employed did not permit adequate or quantitative assessment of the actual costs incurred and the additional non-monetary primary benefits. It is possible that personal interviews of the survey respondents could yield more definitive results which reflect the personal and/or organizational benefits derived from the use of the Fish Collection.

There appears to be an inherent weakness in the benefits methodology itself. Secondary benefits, as measured by the expenditures of collection users were very small and yet significant benefits are clearly being received by users of the collections. This leads to the inescapable conclusion that some other means of determining and measuring these benefits in a more thorough manner needs to developed. Clearly, the low level of benefits documented does not adequately reflect the full benefits being received by collection users.

Discussion

The fishery is an important element of the Canadian economy and is composed of both a commercial fishery and a recreational fishery. According to recent reports the base value of the commercial fishery is $1.5 billion annually excluding processing, transportation, refrigeration, distribution, wholesaling, retailing and other aspects integral to the success of a commercial fishery. Added to this, the sport fishery generates $5.9 billion annually, including expenditures for boats, gear and benefits received from the recreational experience. The total from the fisheries therefore totals over $7.4 billion annually. What percentage of this figure should be attributed to the collections?

A factor which tends to be overlooked in an analysis of the type undertaken so far, is the distribution of benefits and costs associated with the collections. Canada's scientific collections are used not only by Canadians, but by researchers from around the world. Likewise, Canadians use the collections housed and maintained by other countries. It is this reciprocal open-access policy which allows Canadian researchers to use these foreign collections and vice versa. The benefits derived from our collections, therefore, do not all remain in Canada; some benefits are exported. Similarly, Canadian use of foreign collections represents an import of benefits to Canada. While no definitive studies of relative Canadian/foreign use of collections has been undertaken, it is thought that Canadians import greater benefits from foreign collections than foreigners export from Canadian collections. In other words, by maintaining and allowing foreign researcher access to our Canadian collections, Canada is a net beneficiary. If Canada was to reduce such access or collections, Canadian access to foreign collections may become more expensive and the balance of 'trade' may change.

Replacement cost method

The replacement cost of the Fish Collection is estimated at $19.8 million in 1995 dollars. This cost is only a basic value for the replacement of the collection and does not include any premium for extraordinary scientific value such as types or historic specimens. This methodology does not give a measure of the value of the collection to the Canadian economy.

Past expenditures method

The estimated value of the collection based on past expenditures is $14.4 million in 1994 dollars. One significant reason why this value is lower than the estimated replacement cost is that no figures could be included for the donated material. If the CMN had had to pay for the collection of this material, expenditures would have been considerably higher and the capitalized value of the collection would have increased proportionally. Also the methodology only measures what the museum can afford to spend and not what it considers to be the optimal investment for the collection. Like the replacement cost method, the past expenditures method does not capture all the value generated by the collection.

Benefits method

Theoretically this method should provide the best estimate of the socio-economic value of a collection. Unlike the other methods, there is no problem with inflated costs due to excessive duplication which may not add any real socio-economic value to the collection. Unfortunately, museums do not normally keep the records necessary to do this type of analysis. Also even though museum workers understand how their research and collections information is used they can give few concrete examples of value generated by their work. Extensive research would be required to develop an accurate picture, but considering that the fisheries is worth about $7.4 billion annually to the Canadian economy an annual expenditure of about $550 000 is a small investment (less than 0.01%) as insurance to help secure the future of this economic sector.

In summary, quantitative values based on cost methodologies were capable of being derived; further methodological work needs to be done before quantitative results can be obtained using benefits methodology. While costs approaches do not provide a rational basis for future expenditures, benefits approaches do.

In terms of future research efforts, more emphasis should be placed on benefits approaches.

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Appendix – literature consulted during valuation survey

ALLMON, W. D. 1994. The Value of Natural History Collections. *Curator*, **37** (2), 83–89.

CANADIAN MUSEUM OF NATURE, 1991. *Annual report 1990–1991*. Canadian Museum of Nature, Ottawa, Canada.

DAINTON, LORD 1991. *Enquiry into systematic biology research* House of Lords Select Committee on Science and Technology, Session 1991–2, 1st Report.

DEPARTMENT OF FISHERIES AND OCEANS 1993. *DFO Factbook*. Ottawa.

——— 1994*a*. *Canadian Fisheries Landings. Volume 15(4)*. Government of Canada, Ottawa.

——— 1994*b*. *Canadian Fisheries Statistical Highlights*. Government of Canada, Ottawa.

FEDERAL BIOSYSTEMATICS GROUP. 1995. *Systematics: An Impending Crisis*. Canadian Museum of Nature, Ottawa, Canada.

LORD, B. *et al.* 1989. *The Cost of Collecting, Collection Management in UK Museums, A report commissioned by the office of Arts and Libraries*. HMSO, London.

MARRIAGE, P. 1992. *Proceedings of the Workshop on Systematics (University of Ottawa 16–17 June 1992)*. Research Branch, Agriculture Canada.

SHEPHERD, K. 1994. *Cost Value Evaluation of CMN's Collections*. Canadian Museum of Nature (internal report).

STATISTICS CANADA 1994. *The Consumer Price Index. Catalogue No. 62-001. August, 1994.*

WARD, N. D., 1991. *Valuation of Natural History and Other 'Non-Art' Objects Charitable Deduction Purposes. ALI-ABA Course of Study. Legal Problems of Museum Administration*. American Law Institute.

WHITING, P. G. & ASSOCIATES 1985*a*. *Economic Impacts of Heritage Institutions on the Canadian Economy. Part I Analysis of Methods*. Canadian Museums Association.

——— 1985*b*. *Economic Impact of the Arts (Culture) in Canada. Methods and Bibliography*. Canada Department of Communications.

——— 1995. *The Social and Economic Value of Scientific Collections*. Report submitted to the Federal Biosystematics Group. Pp 67.

H = HIGH M = MODERATE L = LOW N/A = NOT APPLICABLE

Collection Groups	Burgess 21,000+	Ont. 14,000+	Micro. 200,000+	Gen. Ref. 23,000+	Types 8,000+
COLLECTION COMPARABILITY (SIGNIFICANCE)					
Ontario/Regional	H	H	H	H	H
Canadian	H	H	H	H	H
International	H	M	H	M	M
Baseline/Archival (incl. Type Specimens)	H	H	H	L	H
RESEARCH & EDUCATION POTENTIAL					
Research					
Academic/Professional	H	H	H	L	H
General/Interpretive	H	H	M	M	L
Education					
University teaching	H	H	H	H	N/A
ROM Programmes	H	H	M	H	N/A
Special interest groups	H	H	L	H	N/A
PUBLICATION POTENTIAL					
Specialist/Professional	H	H	H	M	H
Popular publications	H	H	M	M	L
EXHIBITION POTENTIAL					
Professional interest	H	H	M	M	N/A
Public interest	H	H	L	M	N/A
Special interest	H	H	L	M	N/A
Visual Appeal	M	H	L	H	N/A
POTENTIAL COLLECTION ENHANCEMENT					
SOURCES					
Research	H	H	H	L	H
Purchase	N/A	H	L	M	N/A
Donation	L	H	M	M	M

Fig. 1. ROM collections evaluation for the Department of Invertebrate Palaeontology. The subcollections are abbreviated as follows: Burgess = Burgess Shale and other lagerstatten; Ontario = Ontario and contiguous provinces and states; Micro = Micropalaeontology; Gen Ref. = General Reference Collection; Types = Type and figured specimens.

sessed for its significance under a number of criteria. For each criterion the collection was rated high (H), moderate (M), low (L), or not applicable (N/A).

For illustration, the assessment of the Invertebrate Palaeontology Department is provided. The collections were subdivided conceptually into five subcollections: the Burgess Shale and other lagerstätten (about 20 000 Burgess Shale specimens and about 700 other fossils catalogued from classic localities such as Bundenbach and Solnhofen in Germany, the Mazon Creek and Bear Gulch faunas from the USA); fossils of Ontario, including those from contiguous provinces and states numbering about 14 000 specimens or lots; the Micropalaeontology Collection, dominated by several hundred thousand conodonts from the Carboniferous of

North America, with representation from other microfossil groups; the General Reference Collection, an eclectic collection of fossils representing most groups from around the world and from Precambrian to sub-Recent time; and the Type and Figured specimens numbering over 8000. The criteria for assessing the collections are given below.

Collection significance

Ontario/regional. The collection (whether or not of Ontario objects) is judged for its significance at a provincial or regional level by comparing it to all other such collections within the province or region.

Canadian. The collection (whether or not of Canadian objects) is judged for its significance by comparing it to all other such collections within Canada.

International. The collection is judged for its significance by comparing it to all other such collections in the world.

Baseline/archival and types. The collection is judged for the degree that it either contains type specimens or artefacts of taxonomic significance to the discipline, or it is judged for the degree that it represents spatially and temporally controlled and non-duplicable baseline data obtained in such a manner as the curators' peers would agree to be of disciplinary significance.

Within this section:

- 'HIGH' means that the collection is recognized by the discipline to be among the very best such collections at that comparative level (for example, the best in Ontario; among the top two or three in Canada; one of the ten strongest such collections in the world).
- 'MODERATE' means that the collection's value for the discipline will be recognized by the curators' peers but that it will not be judged to be one of the major such collections at that comparative level.
- 'LOW' means that the curators' peers will not judge the particular collection to be especially strong or important for the discipline at that comparative level.

Research potential

Academic/professional research. The collection is judged for the degree to which it will support the type of academic or scholarly research which the curator's academic peers acknowledge as advancing knowledge through contributions of an original nature. Within this section:

- 'HIGH' means that the collection is recognized by the discipline to have a high potential for supporting original research, being among the major collections in which such original research could be undertaken.
- 'MODERATE' means that the collection's potential for supporting original research is recognized by the curators' peers but that it would not be judged to be one of the major collections in which to conduct original research.
- 'LOW' means that the collection is not judged by the curators' peers to be especially strong or important for supporting original research in that discipline.

General/interpretative research. The collection is judged for the degree to which it will support the type of secondary scholarly research which results in interpretative exhibitions, popular syntheses of disciplinary topics and similar contributions to general understanding. Within this section:

- 'HIGH' means that the collection is judged to be among the best such collections for supporting innovative or highly appealing presentations or for illustrating interpretations of interest at a level accessible to general public.
- 'MODERATE' means that the collection's potential for supporting such general or interpretive research is recognized by the curators' peers but that it would not be judged to be one of the better collections on which to base such general research.
- 'LOW' means that the collection is not judged by the curators' peers to have much potential for the conduct of such general or synthetic research in that discipline.

Education potential

University teaching. The collection is judged for its significance in clarifying significant disciplinary themes and concepts; for illustrating critical specimens or artefacts or types and classes of such objects; or for structuring training programmes or research opportunities, at a university level.

ROM programmes. The collection is judged for its significance in using important specimens,

ROM 2000 AND THE COLLECTIONS					
Collection Groups	Burgess	Ont.	Micro.	Gen. Ref.	Types
RELEVANCE	H	H	H	H	H
ACCESS	H	H	H	H	M
EXCELLENCE	H	H	H	M	H

Fig. 2. Summary of collections evaluations with respect to the aims of ROM in the year 2000. Subcollection abbreviations are the same as for Fig. 1.

The above categories all rate existing collections as they stand. The matrices also rate the potential for collection enhancement. Different types of collections tend to be acquired in different ways. The Burgess Shale, occurring as it does in a highly regulated locality, can only be acquired through permitted collection as part of an approved research programme. Similarly, the Type Collections are enhanced through the results of in-house research and by donation as the ROM is increasingly recognized as a repository for type and figured material. The Ontario collection grows almost equally through research, donation and purchase of specimens of research or display value.

The collections evaluation matrix can be summarized to show the value of the collections with respect to the aims of the ROM in the year 2000 (Fig. 2). 'Relevance' is the process of obtaining information about materials being studied, and fostering an understanding and appreciation that can be meaningful in everyday life. Most of our research activities are covered in this category. 'Access' means the availability of the collections to all aspects of communication. Available to the public via displays, popular publications, and special events; to researchers from other institutions via academic publications, and study visits or loans; to special interest groups such as collectors and artists. 'Excellence' refers to the overall value of the collections to enable the ROM to excel at whatever it does.

The collections matrices provide a quick graphic indication of collections' strengths within the museum. It must be stressed that the matrices cannot stand alone, but must be accompanied by the longer narrative evaluations, which clarify and, in places, justify the ratings. The process of evaluating the collections at the Royal Ontario Museum has not been easy. Initially there was a great deal of opposition to the idea of any kind of evaluation. This was due in large part to fears that collections that did not rate as Excellent would be abandoned and, more threatening still, that the curators that worked on these collections might be made redundant. However, as two-thirds of the museum's operating expenses are devoted to maintaining the Curatorial Division, it became clear that it would be necessary to justify the continued expenditure of resources by demonstrating the value of the collections.

The evaluations will be used initially to help determine staffing needs. A significant number of senior curators are scheduled to retire in the next few years. The Curatorial Division will have to fight hard to maintain those positions. Collections of research excellence are a strong justification for hiring a research curator. The evaluations may also influence priorities in exhibit development. With limited funding available for building new galleries, areas for which there already exist collections of display excellence will be considered before gallery concepts that require acquisition of new material. The demonstrated value of the collections will help justify the expenditure of resources, both financial and human, for their continued development and maintenance.

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A Dutch exercise in the valuation of natural history collections

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Introduction

Funding the conservation of our cultural and natural heritage requires a selective approach. We cannot, and should not, preserve everything. Museums, archives, and other types of organized collections of specimens and data, spring up the world over, and The Netherlands are no exception; it is said that after the UK we are second when it comes to museum density. Increasing demands are being made on the resources of the Dutch central government, as on all governments. As a result,some years ago the General Audit Office, the organization advising Dutch Parliament on the efficient spending of the tax payer's money, concluded that a general evaluation of the state of the national collections was needed to halt and remove the growing backlog. Beyond this evaluation a consequent rescue plan and revised cultural heritage political strategy would also be needed. Parliament agreed to allocate funding for this, and the Delta Plan (Ministry of Welfare, Health and Cultural Affairs, 1992) for the Conservation of the Cultural Heritage was launched in 1990: the name incidentally is derived from the Delta Plan that led to the extensive hydraulic engineering works needed to prevent the southwestern river delta area of Holland from flooding again after the 1953 disaster; prevention was indeed one of the primary objectives of the operation.

One fundamental problem was how to set the priorities in this rescue operation? What should be the criteria for the selection of the collections and individual objects on which to spend money? How should one distinguish between the current normal work load and genuine backlogs and neglect in conservation and registration ? Curators can be, and usually should be, ardent collectors, but whatever they bring in cannot without further qualification be considered as a backlog once the material acquired remains preserved, but untouched due to a lack of funding. Sometimes collecting and curation reaches irresponsible levels, and then the title of McGinley's (1992) paper is appropriate: 'Where's the management in collections management?' These problems were raised at the start of the Delta Plan operation. To establish the requirements of the state museums and archives (including their libraries) each had to produce an inventory of its collections in some detail. Among the information to be provided was: names of collection units, number of included specimens, classification on assumed museum value, state of conservation, state of registration, estimated time schedule and funding needed to remove backlogs in conservation and registration. The question of the buildings in which collections are stored was a separate issue.

A classification of collections of all sorts based on a widely, more or less intuitively accepted valuation system, would be a crucial element in any Delta Plan action: the allocation of funds would depend largely on a rapid analysis of the actual importance of each collection.

Setting priorities: the A–D valuation system

The application of this valuation system to natural history collections is the main subject of this paper. I shall briefly explain what the general system looked like, and how its simplicity and the possibility to refine it for particular disciplines led to a broad acceptance, also in natural history circles. Soon after the introduction of the refined system, though, certain flaws became apparent. The question of geographical scale in handling reference values was a more serious one which is addressed later in this paper.

For the Dutch Parliament, the question was what to preserve and where to draw the line in subsidising the plan. Debate in Parliament was quite lively, and covered Rembrandt, pottery fragments, and even fig wasps! The debate was relevant for other reasons as well: the politicians were about to decide whether or not, and which, state-sponsored cultural heritage institutions would become privatized, and how financial support for these would then be organized. It would be wrong to send them off with enormous backlogs. By July 1 1995 all the state museums in The Netherlands will have become chartered trusts: they will manage the state-owned collections on the basis of multi-annual agreements with the national government's cultural heritage unit. As a sideline, one bonus of the Delta Plan operation has been that reductions of staff and material budgets have not taken place for almost a decade.

To set the priorities for grant allocation right, a general system of categories of importance was imposed upon us by the government agency conducting the Delta Plan operation. Category A included the objects (collections and individual specimens) of extremely high value, being irreplaceable or having a very high reference value. Examples range from classic paintings in art galleries to holotype specimens in natural history collections. Category B included objects of value, definitely requiring preservation on a number of possible criteria. Category C included objects of indeterminate value, being in some way relevant to the collection. This may be material that might acquire value (and move to category B or A) after proper study. Category D included material not worthy to be kept in the collection, i.e. material that should be removed or completely disposed of. This A to D system was applied to all state-owned collections in 1991, and the resulting scores were subsequently considered when deciding on grant allocation. Appendix 1 gives the criteria on which natural history objects, sometimes entire collections, were assessed for the A to D categories; most of them are straightforward and need no further explanation. The list is not exhaustive or final, but simply an account of the major criteria currently applied.

One general criterion (No.1) applies to categories A to C. Category A then is defined by one or more additional criteria (Nos 2–4), such as the nomenclatural reference criterion (No. 4). Category B is defined by a number of important, but less heavy, usually regional or local criteria. Criterion No. 5 needs specification in terms of geographical scale and will be addressed later.

Problems encountered

What were, and to some extent still are, the problems arising from the application of the system ? The fact that the system of criteria was readily absorbed by the natural history community not only had to do with straightforwardness, but also with the fact that certain flaws rendered, without much debate, collections eligible for Delta Plan grants. These flaws concerned the initial omission of geographical scale in some of the criteria and the question of time series. Another problem has been the fact that with natural history collections one usually has to deal with quantitative estimates of value based on samples or entire collections. An unforeseen complication appeared to be the view of our financial masters that unstudied acquisitions do not have cultural heritage value at all. Looming behind this view is, what I have called, the futurological dilemma, the limited predictability of future developments. I will briefly go into these more or less interrelated complications, because I think managers responsible for collection policies, will encounter them sooner or later.

Spatiotemporal scales and administrative levels of funding

While type specimens constitute global standards (criterion 4), voucher specimens documenting the local occurrence of species represent the other end of the scale (criterion 5). To illustrate the problem of scale, in The Netherlands provincial water authorities are monitoring aquatic organisms, some of them building huge sample collections of invertebrates and cryptogamic plants intended to document the changing distribution patterns of these organisms in their region. Sooner or later they run into budgetary problems with all their good intentions. We have seen several instances where regional or local museums are considered to be suitable dumping grounds for such collections. The question is then: who is going to finance what ? Are claims to national funds justified to subsidize such regional or local collection projects ? My point is that one must be aware that criteria involving a definition of reference values must include an indication of geographical scale. If the valuation system is used for grant allocation this scale should correspond to a consistent level of administrative organization, i.e. to a local, regional, national or even to an international authority.

All this does not mean that local collections cannot be, or cannot become, of tremendous national or even global importance. In the age of biodiversity erosion, collections from regions of high local diversity (particularly those with many narrow endemics), or from continuous sampling programmes, may prove to be crucial in studies of environmental change. Clearly, the time dimension has analogous repercussions: what to preserve in view of considerable differences in the speed of evolutionary and environmental change ?

The value of unstudied acquisitions

When our museum set out to analyse and classify the collections on the basis of the A to

D system, hardly anything came under category C, thus deviating enormously from the situation in other disciplines. Our unstudied, provisionally sorted material had largely been classified under B. This included light trap and Malaise trap samples from the rain forests in the Far East, containing tens of thousands of insect specimens and thousands of species, the majority probably undescribed. These samples may therefore be many times more important from a scientific point of view than were our neatly arranged, well-worked holdings of Dutch material. In the Delta Plan operation, where the conservation issue was pre-eminent, all the unworked material would come under C, and I had to strike a deal with our cultural heritage unit about a formula by which the material should be distributed over the categories B and C in our final report. The scientists, as one might expect, considered any unstudied material a serious backlog. I tended to qualify most of the provisionally sorted, accessible, and at most superficially studied material as regular work load. Backlogs are, in my view, jobs that should, for instance on external requests, have been carried out before a set time limit. You may understand that some explanation was required after the audit office inspectors came to visit the museum and had talked to some of the curators. I explicitly had to declare, in front of my staff, what were to be considered backlogs and what was to be qualified as current work load on the basis of our multi-annual general agreement with the government cultural heritage unit, who is our primary sponsor.

Long-term unpredictability of values

This is indeed the futurological dilemma that affects every collection manager when it comes to decision making, particularly in selective acquisition, conservation and disposal. It is the agony of choice, as some of our colleagues from The Natural History Museum called it when they discussed methods for making decisions in biodiversity conservation. Everything keeps changing, as we all know. How then to judge reference values ? How and when to sample? How will technology have evolved in a decade or a century from now ? Had it not been for museum collections we might not have known about evolutionary change at all, and much less about environmental change over, for instance, the past century. Examples where collections have played unexpected roles range from changes of egg-shell thickness in birds due to pesticide accumulation to the classic cases of camouflage and the evolution of industrial melanism in moths. Will we be able, by means of DNA technology, to re-create the Quagga from our museum specimens, the 'Jurassic Park phenomenon' becoming reality? Preserving history for the future continues to be an exciting challenge. We are not sure what we shall need to know and what technically will be feasible in the years ahead. This means that our view of reference and other values, including those accepted in the present A to D system, will change. In spite of this long-term unpredictability, one thing seems scientifically certain: if change in nature, in the widest sense, needs to be reflected in collections, a carefully considered continuous acquisition scheme has to be devised, taking into account evolutionary and ecological concepts. As for extant collections, in selection procedures like the grand clean-up advocated during the Delta Plan operation, the cautionary principle should be applied as much to these as to the conservation of living communities of plants and animals.

Statistics and the A to D valuation system

Some art galleries are justifiably proud of having a computerized, fully documented catalogue system rapidly spawning data and even pictures of every object in their collections. When I asked the director of one of the famous art galleries in Holland how many items he was talking about, he replied, 'as many as 600'. We all know that even in a medium-sized natural history museum we may easily be talking millions, and these cannot be individually recorded. For the Leiden Museum it was estimated that to register specimens by species name and basic label data would require more than 500 man-years. Therefore, we have to sample and make estimates by extrapolating as accurately as possible if we are to get the job done within a reasonable period of time. For new acquisitions and selection operations the sample could be larger though, and in exceptional cases every specimen could be analysed. Sampling requires an acceptable degree of accuracy and for the application of some criteria, particularly in the B category, considerable curatorial and scientific experience is necessary. In our initial Delta Plan report to the cultural heritage unit we produced a table of percentages coming under the A to D categories for around 130 collection units, ranging from mammals to minerals. This was at a precision of 1 to 10%, dependent on the size and nature of the unit. A large insect collection with a long history is harder to sample than a young collection of minerals, to mention some extremes.

Even if estimates have, for practical purposes, to be rough, the heuristic value of the exercise is considerable, because it instills the notion of selection and manageable curation. Not all the specimens placed on the museum's doorstep should be welcomed, and what is in the collections already might not be as valuable as was thought.

Recapitulation

Several lessons can be learnt from our Delta Plan exercise in the valuation of natural history collections:

1. A valuation system based on direct, intuitively accepted criteria, like the Delta Plan valuation system described in this paper, can be an extremely useful management tool.
2. The application of criteria involving reference values needs to be customised, particularly according to consistent spatio-temporal levels, in order to place the responsibility for collection management in the correct administrative domain.
3. Unpredictable future needs of society and similarly unpredictable technological developments warrant the application of the cautionary principle as much to preserved biodiversity as for living systems.
4. Scientifically sound considerations should determine acquisition and conservation strategies of natural history museums and similar organisations.
5. The heuristic value of applying an intuitively acceptable set of valuation criteria to natural history collections, whatever its drawbacks, has proved to be considerable to managing staff, curators and technicians alike.

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References

McGinley, R. J. 1992. Where's the management in collections management? Planning for improved care, greater use, and growth of collections. *International Symposium and First World Congress on Preservation and Conservation of Natural History Collections, Vol 3*, Madrid, 309–343.

Ministry of Welfare, Health & Cultural Affairs 1992. Plan for the Preservation of Cultural Heritage. *Fact Sheet C-11-E*, 1–10.

Appendix 1

Valuation categories and criteria

	criteria:	
Category A	1	plus at least one out of 2–4
Category B	1	plus at least one out of 5–12
Category C	1	only
Category D	13	only

General A–C criterion:

1. Object fits the objectives and scope of the institution (minimum criterion).

Category A criteria:

2. Object is absolutely irreplaceable, or extremely rare, or extinct *in situ* (rarity criterion).
3. Object is, within the relevant discipline or collection scope, of global symbolic or cultural significance (symbol criterion).
4. Object is a nomenclatural type or has otherwise global reference value (nomenclatural reference criterion).

Category B criteria:

5. Object documents spatiotemporal occurrence of a species, a rock type, or another phenomenon of nature, or has similar value (distributional criterion).
6. Object has demonstrable presentation value: it is informative, educative, attractive, spectacular, aesthetic, etc. (presentation criterion).
7. Object is carrier of published scientific information (including illustrations) that needs to remain verifiable (verification criterion).
8. Object is potential carrier of new scientific information of whatever kind (research criterion).
9. Object documents the history of the relevant discipline (historical criterion).
10. Object is associated with one or more other objects coming under A or B, and derives its value from this combination (ensemble criterion).
11. Object has been accepted, awaiting further analysis as to its presumed value (anticipation criterion).
12. Object has been given in custody, is no property of the institution, but satisfies criteria 1–11 (transit criterion).

Category D criterion:

13. Object has nothing to do with the objectives and scope of the institution – to be removed, to be disposed of (disposal criterion).

A scientific/historical/educational heritage for whom: the value of geological collections in a small museum

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The meaning of value

Much has already been said about the inequalities in funding and status between the arts and sciences in museums. Whilst everyone knows that paintings are worth a lot of money, art also possesses an individuality, rarity and prestige value which happens to increase with age, and thus it is not difficult to see why its acquisition, whether in the form of local or non-local, modern or old objects, is looked upon as a cultural investment. Artefacts in general belong to this cultural treasure-house concept of museums. To some extent, as museum scientists, we are our own worst enemies in respect of the collections that we wish to protect. Do we inadvertently help to devalue natural science collections on account of the way we view them? For example, a far less blinkered approach is adopted in assessing the public value of 'art' than of 'science' in museums. It is interesting to notice that the use of the term 'art' has the effect of throwing a protective ring around all those objects or products of artistic endeavour which exist within collections, whilst the use of the term 'science' is generally rather more discriminatory in its way of apportioning value and status, a fact which can end up being detrimental to the preservation of accumulated collections. One must be careful in this respect; if an object is not considered to be of 'scientific' value (a statement which despite all the theories and formulae in the world is just as subjective as many of the classifications of 'good art'), does that then mean that it is of little interest to science, that it is an inferior grade of material, or quite simply, 'not science' To add to these problems museum scientists (or the keepers of scientific collections) are rather uneasy, and generally quite ambiguous in their use of the terms 'value' and 'valuable', and perhaps even more hesitant over decisions of valuation. For example, our scientist might happily refer to all those specimens considered to be of scientific value as 'priceless', yet be equally as happy in relegating material that is not to some sort of 'educational' status, a use which necessitates, for example, specimens being interchangeable and potentially disposable (and therefore again having a value 'without price' but for a quite different reason altogether).

This partitioning of collections into generic groups of objects of high or low status is a common phenomenon encountered within the local museum. Status can impart an almost magical quality to a collection, a mantra that is faithfully followed, but barely understood. I remember once engaging in a protracted discussion with a Keeper of Natural History over the value of his geological collection. I was trying to convince him that the collection was historically valuable. However, we simply could not see eye to eye; he was quite unable to accept the concept of a geological collection having any major value other than to science itself. This was a little unfortunate because the collections concerned had no scientific value.

Novel and sometimes more appropriate ways of looking at and weighing up the value of objects can help significantly in raising the status of our natural history collections, both in the eyes of the general public as well as those of the governing and funding bodies of our museums. Whilst many of the records, as indeed some of the objects, are of scientific importance, one should primarily be emphasizing the importance of their historical and cultural heritage; in other words their link with the environment, locality and people. Examples of the novel use of collections in display might include the themes of taxidermy as craftsmanship, the re-creation of a natural historian's study in period context, artistic displays of minerals on the theme of colour, and the uses of fossils and minerals in medicine, superstition and folklore.

Discovering and assessing the value of collections

Having worked closely with local museums for eight years as a peripatetic geological curator within southeast England, I have witnessed collections of almost every type of quality, relevance and state of repair. The poor condition as well as high value of geological collections in the non-national museum sector in the UK should produce few surprises here. This situation has previously been reported on within various commissioned reports (Doughty 1981) as well as within the museum press (Knell & Taylor 1991). Furthermore, a number of peripatetic curator schemes have outlined the situation as it exists within the regions (Knell *et al.* 1987) which, whilst marginally improved upon within recent years, is still a cause for concern (Timberlake 1989).

The approach to dealing with such problems, however, can vary considerably between curators. In my experience I have rarely, if ever, come across a museum collection which I have not felt justified curation or conservation, and just as rare is the collection that cannot be put to some relevant use in the service of the museum.

Firstly, the carrying out of a full and proper assessment of a collection's value to a museum requires a fair degree of skill, impartiality and breadth of general knowledge of geological material. Indeed, the latter is a great deal more important than knowledge in any particular specialism. Specialist reports, such as some I have seen provided by national museum staff, often fall foul of a pre-occupation with assessing a collection on the basis of its scientific merit alone. In effect, this is often an assessment of the collection's value to the national museum, rather than its worth to the local one. In many cases this definition of worth or value is very different.

It is perhaps worthwhile at this point to take a closer look at the assessment process; to understand that there is no set formula which can be employed, no magic calculation by which specimens can be assessed by someone who is not an expert. (For example, there are serious shortcomings to the expectation that the roles of assessment and curation can effectively be absorbed or taken on board by new appointments of collection managers and curator/conservators.) The complexity of the issue, and indeed some of the most searching questions which need to be asked, are best demonstrated through taking a close look in turn at the varied examples of specimens and collections within their contrasting museum contexts.

Certain Victorian fossil specimens, particularly those of reptiles and fish, possess an obvious financial value, regardless of the detail of their scientific data (Rolfe *et al.* 1988). To some extent this value is the most subjective of all; for example, the price at which these would sell (if auctioned) is often quite different to that of their valuation. Nevertheless, the discernible financial value of those fossils and minerals now difficult to collect on account of filled-in quarries or inaccessible mines, mechanical working, or else protective legislation, is almost a quantifiable asset when one studies the prices now being fetched within auction houses in Britain and abroad. It is no surprise that the best collections of such 'sought after' material are still to be found within museums and to this day good Victorian specimens (though often from broken-up collections) still fill boxes in store within even the smallest of local museums. In one way this is a godsend, in terms of there being a rich resource for potential display, but in another it is a worry. Little attention was paid to the security of such material in the past, collections remained without inventories, visitors were allowed unimpeded access, and as a consequence some collections have been left with a legacy of missing specimens (Timberlake 1989).

Specimens showing skilled nineteenth century preparation including those from some of the classic collecting sites which have typically produced good examples of soft-bodied preservation in fossils or else well-preserved fish remains, such as Solenhofen in Bavaria and Monte Bolca near Verona, Italy (fossil fish), are good examples of just what might be found in the small local museum. Such specimens are not at all relevant according to most current collecting policies, yet many of these are nevertheless superb examples, and are part of the cultural treasure of the museum and community concerned. Perhaps it would be better to treat all these as if they were objects of natural art, or else unique artefacts, for clearly they do not belong to any sort of systematic collection within the local museum, and would never be referred to as such. Their practical value and use to the museum must be in terms of aesthetic display, although undoubtedly these also have a further (though unquantifiable) value, such as being part of a material archive of the museum itself, an archive which relates both to past collectors and collections.

In fact, there is a very real need to try and approach every collection afresh, without too many preconceived ideas about what exactly is or is not important to the particular museum concerned. For example, consider a small local museum that has recently been donated a small collection of common, local, but fragmentary ammonites of known provenance (Fig. 1). At first sight, these specimens would appear to score low on the scale of status, in particular when compared to the previous example of Victorian fish. The ammonites would not appear to be rare, they have no financial value and above all show no evidence of skilled prepara-

scientific importance? More to the point, this was being improperly used at the time it was examined. The cabinets were left unlocked within a classroom and the specimens were open to unsupervised student handling at all times. Partly as a result of this, the value of the collection had been considerably depleted, both through theft as well as through deterioration in the condition of specimens.

Collections as complete examples of fine contemporary curating practice are similarly valuable, both in historical terms, and also aesthetically as an example of quality museum material. Although such collections may not actually have a 'scientific value', they are nevertheless rare outside the larger museums and national collections. I would say that they had an intrinsic 'period value', much as in the same way that we would regard period or antique furniture (indeed the cabinets housing the collections very often are valuable antiques in themselves). Sometimes the specimens, as originally arranged within the drawers, are 'objects of curatorial craftsmanship'. Some could be displayed in their entirety within a period setting. The J.C.Taylor mineral collection at Rochester Museum, Kent, forms one example of this category.

The assessment of historically important collections is an interesting task. Located within one of the least-known, most inaccessible and uncurated collections in southeast England is to be found a cabinet which contains some of the first scientific specimens ever collected from the Antarctic continent; natural history and geological items collected on Ernest Shackleton's fated 1911 expedition. The collection, though little known, is of immense importance. It is historically valuable because of its association with Shackleton the explorer, as well as being of great value to the history of science. On account of its present situation it would perhaps be appropriate to transfer this to a relevant museum such as the Scott-Polar Research Institute in Cambridge, but not, I would suggest, to a systematically based (national) museum collection.

Some specimens are of historical interest merely on account of their association with important personages, even though they may be of mediocre quality and of little intrinsic value on their own. Illustrated is an example of cut amber within a collection donated to Queen Victoria and the royal children at the Swiss Cottage Museum, Osborne House, Isle of Wight. This particular association has added great value to these objects. This acquired value is reflected in the additional resources, in terms of both curatorial and conservation expense, which have since been expended on their preservation and display. However, since these could never be exchanged or transferred, they do not really possess a financial value as such.

Certain collections would appear to be of 'curiosity value' only. For example, they were probably not collected by, or even associated with, any named collector, and may have little accompanying data. Nevertheless, in certain situations these can turn out to be amongst the most valuable, important, or interesting collections in the whole museum. One such example encountered during my time in southeast England was a small, old display case of minerals and shells found in store within a small Hertfordshire museum. This was labelled as having been collected by the 'village gold prospector'; a rather strange attribution for Hertfordshire! The prospector was in fact the village baker who went to seek his fortune in the gold diggings of the Macquaire River, New South Wales, Australia during the 1850s. With various conservation problems inherent, the curator had removed the case from display several years before. It was at the time considered to be of less value than a collection of local fossils which had been put on display in its stead. However, the collection did contain some extraordinarily large nuggets of gold, yet its value as a social history item was even greater still. Most of all, it was of value and interest as a working collection made by an ordinary person; of relevance to the life and history and characters of the village, yet also important as a tangible link to the issue of emigration during the last century. Nevertheless, resources had not originally been found for the conservation of this collection, perhaps on account of its original perception as an object(s) of 'non-local natural history', which of course did not possess importance as regards collector or rarity. Without employing some degree of lateral thinking, many of our museum objects are thus liable to be relegated within the collection hierarchy to lumps of meaningless junk. Which of course, is just the situation that many boxes of fossils and minerals presently find themselves in. Fortunately, in the above example, the gold prospector's case has finally been rescued from the fate of ignominy and decay; it has been conserved and curated, and even more importantly, some really positive thoughts paid to its future role. It is, once again, a 'valuable' collection.

A collection is not necessarily just the sum of its component specimens, labels and catalogue(s), furniture, and historical association. Sometimes its importance can also be defined

as this is as an important entity, and as valuable to the museum concerned, as any modern published research collection.

Fig. 5. The archival value of old museum registers, Saffron Walden Museum, Essex.

The curation, conservation, and in particular the improved presentation of a collection has a significant effect on raising the value of the collection. An example of good presentation is shown in Fig. 6. The stored fossils here, which have been cleaned, labelled and recently re-identified, have then been arranged within stratigraphic/taxonomic order in plastazote lined and inlaid drawers. Good curation, storage and presentation is an art-form, as well as a technical and academic skill. Nevertheless, a collection in the context of a local museum in the end is as valuable as the museum considers it to be. In purely financial terms the market price in almost all commodities is affected by appearance and attention to presentation detail. We may not like it, but we are often having to evaluate collections for their replacement value. In fact, the criteria for pricing specimens and collections is not so different from those we would use for pricing an antique or used car. If one can assist, even in only a small way, volunteer-led museums in the process of taking control and looking after what they have, of generating a sense of pride and feeling of self-worth in the work that they do, then the value/status/'public perception of worth' cycle of improvement will be self-perpetuating. Pride is value, and is care; and in real terms that means money, not in terms of disposal, but rather in attracting funds.

The production of a modern display also bears some relationship to the value of a collection. A new geological gallery within a small local museum will have a knock-on effect beyond the public appreciation of what is actually in it. This is just one of a range of subjective criteria that will help to raise the real value of the collection, specimen by specimen. In most cases the production of a gallery will gradually encourage the trustees or local authority to spend more on the conservation and curation, or indeed anything else which will ultimately help to raise the financial worth or status of the collection. This doesn't happen overnight, but on the other hand, I am sure that this link between using the collection and being able to attract funds is not new. Fossil, rock and mineral roadshows are not just the prerogative of the large museum; they can be done anywhere and on any scale.

Fig. 6. Good storage improves long-term value. Fossils from a rescued collection within a plastazote foam-line drawer.

What, you may ask, has this got to do with the value of specimens? The point is that every time you examine a specimen brought in by a small child it is worth remembering that the most important and valuable specimen that you are ever likely to have handled in your life was the very first one that you ever collected, for example, the one that you may well have taken to an 'expert' in the museum for identification or the one that may well have set you upon a career in geology or in museums. Apparently, little things such as this do alter our lives. This is just the sort of object-related experience that can never be objectively valued or quantified.

Finally, I must inject a note of caution concerning some forms of supposed help provided to small museums and their neglected collections, for example, the process of removing specimens of 'better value' as well as the process of 'grading' carried out on many of these by so-called specialists. 'Specialists' may be well-intentioned, but often they will be found to have little sympathy for the normal and mundane. In some circumstances this has led to untold and unforgivable damage. Specimens removed 'for their own protection' have themselves become lost, whilst that left within the museum is mixed up and removed from context following hurried and sometimes brutal visitations. Some collection rescues really have been worthwhile, but not all by any means. Above all one must try to steer away from professional arrogance on this issue and this applies as much to the Keeper of Natural History within local museums as it does to the specialist from the national(s).

The cost of the professional

This is a subject which deserves a much greater level of discussion, debate and recognition within the museum profession. The relationship between the value and status of a specimen or collection and the professional work time and skill that has been put into it in terms of conservation and curation, is a relationship that is at best misunderstood and at worst poorly appreciated or even barely recognized by directors of museums, trustees and auditors, and of course the general public itself. It is partly because of this that we find ourselves so easily forced into believing, and therefore relying on, rather unreal expectations or estimates of how much it costs to 'restore' effectively and thereafter to maintain a previously neglected and unused collection. Perhaps none of us really want to know this; we are all rather frightened of the consequences of such a revelation. The situation as it pertains to the restoration of the geological collection in the small museum is a case in point.

Rescuing and restoring a neglected geological collection requires a great deal of skill and knowledge. Whether or not all this skill and knowledge can be supplied by one person or by two (a curator and a conservator), very much depends upon the experience of the person concerned and the nature of the collection. In the example of the small museum this help will have to be brought in from outside; this will mean employing a freelance curator/ conservator or else 'buying in' the time of a professional already employed within a larger museum service. The latter option of course, may be rather more difficult to achieve. Other less expensive options, such as long-term volunteer commitment, the hiring of students etc., simply do not work so effectively in the majority of cases. Increasingly, it is being expected of museums that they demand high standards in the quality of work carried out (Paine 1992, 1993). Without having the necessary expertise in-house to judge, they simply won't know for certain whether or not they are achieving this, and indeed, whether or not volunteers etc. are providing accurate, quality work to a satisfactory standard. Professional specialists with a reputation and training behind them should, however, have the background and experience to deliver. Once again the sticking point for the museum world concerns people's actual perception of value, cost and affordability. Here, therefore, lies the dilemma.

The cost of professional help to curate fully, conserve and document a collection may well be more than double that of a previous valuation of its (financial) worth. This is particularly the case with geological collections, which except for certain types of specimens, are still considered to have a low market price. In most cases therefore, one cannot use a financial argument for justifying expenditure. The problem is compounded by an almost archetypal presumption prevalent in the minds of curators, i.e. that apart from the valuable space that they take up, geological collections are cheap to maintain. Such collections have only been 'cheap' to maintain in the past because no money has been spent on them! Conservation, storage and curation costs included, geological collections should really be put on a par with archaeology in terms of one-off projects and yearly budgeting requirements. I would be hesitant at the moment to come up with a figure for the annual cost of maintaining x number of specimens within the average geological collection. What I am rather more adamant about, however, are the costs which museums should expect to be meeting (and budgeting for) in contracting-in specialist help. A realistic rate for such specialist services should be in the region of £20.00 per hour. Assuming a fair degree of basic conservation work to be involved, the costs of restoring a neglected collection (up to and including its documentation) should be in the region of £4000 per thousand specimens. This is very much a ball-park figure; it may be more or less, but nevertheless it should still help to form a useful guide. We must assume that the costs of restoring a collection in this way should be considered as part of the equation which determines its value. In fact, to be able justify this expenditure, there first has to be a universal acceptance that a collection which has been so restored, is going to be considerably more valuable as a result (financially, scientifically, educationally etc.). If one had to put a replacement cost against each specimen one would be thinking therefore of doubling this figure as a base-line minimum, in other words at least £8.00 per catalogued and restored specimen (of course many items such as rare or good quality minerals or fossils such as fish etc. are liable to be worth considerably more on account of their higher original value). Collections which are well looked after and properly maintained within the museum environment should in theory gain in value (in all senses of the word) much faster than those outside of it. This should form the basis of a good argument for supporting museums and in particular for supporting additional funding and staffing as regards their collection management role irrespective of whether an obvious end use has yet been allotted for the objects within their keeping. However we look at it, we have been guilty of underestimating and ill-appreciating the value of our collections.

Conclusion

There is no doubt that value and valuation is a difficult subject. As far as small museum collections are concerned, I do not believe that objective formulae and equations for any such assessment really work. Art curators, I am sure, would not dream of providing formulae as a means of assessing the value of a painting, a ceramic or a tapestry and I very much doubt whether this is commonly applied to archaeology, ethnography or any other discipline. Equally one can no more compare the value of a historically important or interesting specimen to that of an educationally or scientifically interesting one within some grand unified hierarchy of collection(s); just as I hope one would not attempt to compare items from different disciplines, such as a painting and a group of shells, one against the other. It is a lot easier and surely more sensible in terms of positive safeguarding of our existing collection heritage, to try to assess the accruement in value of a specimen through conservation or curation work having been done on it since it first came into the museum's possession. This process of assessment would add an additional 'collection management value' to the individual specimen or collection concerned, as well as adding a value to the input and future viability of professional conservation and specialist curation help which might be available to small museums. This sort of service remains absolutely essential if geological and natural history collections within small museums are to continue to be rescued, restored and properly maintained hereafter.

Many of the papers published in this volume give me cause for concern regarding what I would consider a tunnel-vision view of what value is all about, in particular so far as it concerns natural history and geological collections. For example, the view from the national museums seems far too parochial in this quarter. One must not forget that many millions of specimens lie outside this realm, and a good many of those that do see a great deal more use during their effective museum lives. Yet resources remain unfairly divided. One peripatetic curator trying to serve the needs of many geographically disparate museums with well-over half a million geological specimens simply does not make sense!

There is an urgent need for a much broader based approach to this whole issue of how we ourselves attempt to value and care for our collections. Until this is sorted out we will get little sympathy from those whose help we are most concerned to enlist. I have often thought, 'if only a natural history curator could be something else, just for one day, then maybe we would all be able to return to our jobs the next morning with a completely fresh outlook on the matter'. Too much to hope for perhaps? Well, until we can see our collections through other people's eyes as well as our own, we will never solve the riddle of how to best argue their case in the face of a shifting world. For the thousands of geological and natural history collections lying within small museums their survival depends upon us arguing the case for their proper value and evaluation. More importantly, we need to understand that the only real safeguard for any threatened collection is to involve all of it within an active rota of use.

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References

DOUGHTY, P. S. 1981. The state and status of geology in U.K. museums. *Miscellaneous Papers of the Geological Society of London*, **13**.

FENTON, A. 1990. *On your bike: thirteen years of travelling curators*. The Carnegie United Kingdom Trust, Dunfermline.

JERAM, A. J. 1995. Criteria for establishing the scientific value of natural science collections. *The Biology Curator*, **3**, 10–11.

——— & ——— 1991. Museums on the rocks. *Museums Journal*, **91**, 23–26.

———, ——— & RODEN, R. 1987. Geology and the area museum services: a discussion paper. *Unpublished report by the Area Museum Service for South-East England (SEMS).*

PAINE, C. 1992. *Standards in the museum care of biological collections.* The Museums and Galleries Commission (London).

——— 1993. *Standards in the museum care of geological collections.* The Museums and Galleries Commission (London).

ROLFE, W. D. I., Milner, A. C., & Hey, F. G. 1988. The price of fossils. *Special Papers in Palaeontology*, **40**, 139–172.

TIMBERLAKE, S. A. 1989. British Gas geological collections consultancy: the interim report of the travelling geology curator. Unpublished report by the Area Museum Service for South-East England (SEMS).

Slaying the sacred cow

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Introduction

I wish to make it clear that the opinions given in this paper are my own. They do not reflect the policies of the National Museums of Scotland [NMS], which has clearly defined acquisition and disposal policies.

In an introductory paragraph about the Manchester conference published in *Coprolite* the following statement was made: 'It is often said that natural science collections are undervalued (in all senses of the word) when compared with humanities based collections, particularly those of fine art objects. Is this true?' Unfortunately I consider that it is, at least partially, and that we have only ourselves to blame. I believe that if we wish to be treated on the same footing as the humanities we must become even more rigorous in our collection policies and disciplines.

Back to basics

Collecting and storing objects is not only a human characteristic, it is also carried out by other animals as diverse as crustaceans and birds. By humans, however, it can be taken to extremes and has been described as 'the passionate pastime' (Johnston & Beddow 1986). Collectors begin their obsession as small children with objects such as marbles, transfers and sea-shells, easily collected, usually worthless but greatly treasured. They progress to items that require more effort and expenditure, the realm of stamps and model railways. Some collectors maintain their childhood hobby into adult life, their collection becoming bigger, better, and often more specialized. As they become more knowledgeable the collection will become better organized, the objects more carefully chosen. Stamps may become those of a particular country; the model railway, steam trains of India.

Collectors cherish their specimens, acquire specialist knowledge about them, repair, catalogue and display them. They compete with others for the best material. As their knowledge increases, they strive to improve the quality and presentation of their collection. Poor quality stamps will be sold, exchanged or simply discarded. The ultimate goal is that of items in 'mint' condition. With very few exceptions no collector wishes to be known as a collector of anything and everything. To attain standing among peers, a continual process of improvement must be carried out. Collectors will display and store their collections in a way that enhances presentation and ensures safety. Few people amass objects indiscriminately. However, such collections do exist, often stored in indifferent conditions, un-catalogued and uncared for. They may contain a few 'gems' among mountains of rubbish.

The museum curator is also a collector, but with a limited freedom of choice. A museum is a collection of collectors, managed by administrators, who may sometimes give the impression of being interested in quantity, not necessarily quality. Some may even question the necessity of having collections, not realizing that a museum without collections is no longer a museum. However, attempts to improve the relationships between curators and administrators are recommended and well worth curatorial effort.

Consider the role of museums; do they have a clearly established collecting policy, is it cohesive within the establishment or are there differences between departments? When Rolfe (1979) published his 'Acquisition Policy in Palaeontology', only two museums out of 23 had formal policies. Now no museum with major collections is without one. The policies are in place, curators are aware of them. However, there are still problems, some being a hangover from the period when policies were not published and curators were perhaps less discriminating. There are also nuances between the policies of individual museums and even between the departments of larger museums. Mainly for historical reasons the departments of the NMS have differing policies although there are common criteria. Do our policies in the National Museums complement those of the local authority museums or do we sometimes compete, perhaps unwittingly, for objects? An additional factor is that almost all museums have their collecting policies skewed by financial constraints.

Perception of permanence

The donation of a collection may be based on the owners' perception of how well their treasures will be cared for in the long term. A recent major acquisition to our collections in Edinburgh came about mainly because during visits to the museum the collector had seen material bearing numbers from the last century. He therefore felt that his material would have a long-term future in the NMS. The deciding factor was that an institution with which the collector had been involved was withdrawing from the field of palaeontological curation. He therefore felt that the likelihood of adequate display or even storage was poor and that there was a threat to the future of the collection. This fortuitous swing of circumstances brought a valuable scientific and display collection to the NMS. However, such collections are often, as here, the result of long association between the relevant curator and the collector.

Volume is not necessarily value

Occasionally collections donated to a museum can bring less joy. A few years ago the collection of a geologist was willed to his local museum. It seemed a magnificent gift. The collection was large, amounting to dozens of boxes. NMS were called in to help by the local museum curator, a non-geologist. When examined, its nature became clear, showing all too well the evidence of a collector who had simply visited sites and taken all available material. No attempt had been made to select good material and discard bad. Even worse the specimens were almost all without locality or indeed any form of attached labelling. Working through this collection was depressing for two reasons, the first being that apparently at certain locations all readily available surface material had been removed. This would make such sites less useful for future collecting or teaching purposes. The second point was that despite the large volume of material, little was of any display or reference value. This collector was a classic example of the 'collect everything, keep everything' type. Despite our efforts we were unable to save more than a few specimens of value to the local museum.

Inherited problems

Geological collection problems in the NMS mainly concern donations of material collected earlier this century and donated in the 1960s and early 1970s. We now realize this was the golden period for museums. Major efforts to register and classify such material were made at this time. However, as often happens with such collections, there was a residue left until later. Later of course never came and meanwhile other collections arrived and demanded attention. Under such circumstance it is easier to deal with small collections or purchases than to tackle some horrendous backlog of dubious quality, supported by unreadable field notes. Sometimes you become too close to the subject and it requires an outside voice to say 'discard the lot' or perhaps to come up with a less drastic solution that you have not recognized. It is easy to become absorbed in the minutiae of decisions that surround the treatment of familiar collections. Sometimes, to understand the nature of the problem it is necessary to go outside one's specialist field and consider possible solutions in less familiar ground.

An external focus

To do this, let us consider a museum that collects a distinct group of man-made objects, the 'National' Cycle Museum in Lincoln. It could be expected that the cycle museum would attempt to obtain a model of every cycle produced in Britain, to explain changes in production or design and complement the 'National' collection. Indeed this museum's objective is to collect cycles and cycling artefacts to preserve the history of cycling for future generations. Given that there is in existence a 'National' Cycle Museum, there can be less reason for the technology department of a State or Regional Authority museum also trying to obtain a model of every cycle type. They could only reasonably justify a smaller collection, showing certain machines that illustrate major technological changes, or those with local geographical links. If a major display of cycles was required then a travelling collection from the 'National' Cycle Museum would be the logical source. Many curators would say that this is a sensible approach. However, if a curator were offered a collection of 20 bicycles would he say, 'Yes we will take it but, really only two machines fit in with our policy. The remaining 18 more properly belong in the 'National' Cycle own brand of cheap garden spades. Most are basic, roughly finished items, no better and little different from similar spades made for the last 50 years. Would anyone really want to collect every variation of such an object? I think not. However, the introduction of the quality stainless steel spade is an innovation in gardening circles and not just a sign of technical progress. Because of its price, it is also an important indicator of economic and social factors. When you think of collecting in such mundane terms, it can be seen that the present sacred cow, the collect everything, keep everything ethos is truly nonsense.

In the Old Red Sandstone rocks of Scotland fossil plants are relatively common. Apart from a few localities such as Rhynie they tend to be poorly preserved compressions. Some sites yield associated remains such as myriapods and fragments of scorpion cuticle. However, most such plants are just what they first seem to be; fragments often not identifiable to generic or even family level. So how many specimens do you need whose label reads 'plant stem indet.'? Not really all that many, if detailed examination fails to reveal any diagnostic character. Hence, from any particular locality only a few of the best specimens are required.

Mineral curators are concerned that rare species are represented in their collections and that rare mineral associations and historic material from early collections is recognized although some specimens may be rather poor. They also appreciate that there may be elements within their collections that may have little display value and are without key information. In such instances disposal, either by exchange or sale, would not be precluded. Recently, NMS mineralogists received a large internal transfer of minerals and ores, collected last century, from the department of Science, Technology and Working Life. Among often good specimens, were a few low-grade ores which fall outside our acquisitions policy. This type of material, is of little scientific or monetary value. It might, however, be suitable for open display that would allow visitors to become familiar with ores by touching the specimens.

Although these are simplistic examples, I believe there are few large collections that would not benefit from careful curatorial pruning as part of a policy of upgrading and rationalization. In my experience this is best done when cataloguing a group or collection. The benefits of such a process would be considerable; savings in valuable storage space, more accessible collections, improved curator morale.

Computers to the rescue?

By using modern information storage facilities it is possible to keep data about items even if they are not physically retained in an institution. Such information can be made available for research or displayed by using computers. This is already true for those who have computer skills and hardware. With the appropriate equipment it is already possible to access the internet and retrieve and export digitized images. The NMS is pioneering the use of a computer graphics system called MOSAICS for specimens displayed in the new Museum of Scotland. Photography, scale models and microscope slides are other possible techniques. These methods of storing and accessing facts can provide a wealth of useful information without having to retain every available specimen. Often this will satisfy the general inquirer if not the researcher. Presently, all these techniques are expensive and only suitable for use in connection with rare or valuable objects. However, in the future, costs of computer technology may fall dramatically.

If curators of Natural Science collections wish them to be valued in the same manner as Humanities collections then we have to put our house in better order, decide workable interconnecting collecting policies and keep to them. Perhaps under these circumstances governments could be encouraged to give the increased funding and staff we will require to sort out some of our inherited problems.

I find it fascinating that some of my colleagues can see the truth of my arguments when applied to specializations other than their own. Perhaps more revealing is that I should use examples outside my own field to illustrate the points I am trying to make.

Conclusions

Many geological curators have problem collections, mainly inherited from the period before acquisition policies were published. However, despite this being a great frustration it should not be exaggerated. Short term, three to five year, programmes, could be set up to tackle these problems, perhaps on a similar basis to the travelling curator schemes which have been so successful in identifying them. For the future we need to organize regional curatorial groups to define clearly our collecting strategies and areas of interest on a regional basis. It is important that the National Museums take a key part in formulating such programmes, but do so in a way that recognizes curators in the regional and local museums as equal partners.

References

HOWIE, F. M. P. 1985. Conserving natural history collections: some present problems and strategies for the future. *In:* WADDINGTON, J. & RUDKIN, D. M. (eds) *Proceedings of the 1985 Workshop on Care and Maintenance of Natural History Collections*, Royal Ontario Museum Life Sciences Miscellaneous Publications. 1–6.

JOHNSTON, S. & BEDDOW, T. 1986. *Collecting: The Passionate Pastime*. Viking.

ROLFE, W. D. I. 1979. Acquisition policy in palaeontology. *Special Papers in Palaeontology*, **22**, 27–35.

Targeting the user short term - who pays for long-term storage and maintenance?

PETER MORGAN

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Introduction

The purpose of this particular meeting is familiar to me and I remember the Biology Curators' Group (BCG) in its early days in 1977 when it was a young organiztion, hosting a conference in Liverpool on the value of local natural history collections. That has led to many surveys in Britain, to many reports, and indeed has enabled museums, especially the small ones, to receive money for storage, peripatetic curators etc. So we are here, twenty years on, discussing the value of collections not even on a UK scale, but on a European and a world-wide scale. The data we have now are far better than we had in 1977.

In the survey which was undertaken by the BCG in conjunction with others, a survey of all collections in the UK was undertaken. One thousand questionnaires with a 93% response, the book for those who haven't seen, is 600 pages long. But the key point is that in Britain there are 232 museums with natural history collections with no curator whatsoever and there are 68 museums who actually have curators able to interpret and use the material. That ratio is very high, but at least we have that information now on a British scale, and there are moves afoot to try and obtain it on a European scale as well. So with this extra information, and with collections being accepted as essential to a museum, we have Paul Perro saying in 1982 that 'collections are the *raison d'etre* of museums', a truism that nobody would dispute. We have the International Council of Museums (ICOM) code of ethics that states that museum collections are of paramount importance and museum obligation to preserve them is one of the paramount resources requiring budgets and staff. But we are here today looking at detailed methodology of how we justify retaining those collections and spending money on staff to use them. So we are getting very much into a goldfish bowl mentality of looking and justifying how we utilize our collections. At the same time, we have to then compete with other budgetary provisions in museums, and at the same time look to the scientific and other communities to help us deal with the biodiversity crisis to find money to do surveys and then to store the collections so that material can be repeatedly tested and searched afterwards. So we are very much in a 'response under pressure' situation at the present moment. David Mann (this volume) summed up admirably the UK Government's approach to museums and I will not repeat it.

Primary performance targets

I work for a multi-disciplinary national museum which has ten branches. It has a museum of folk life, departments of zoology, botany, geology, an art department, it has buildings and folk-life and oral dialects, amongst the different departments. It has recently been named the 'National Museums and Galleries of Wales', with a new logo and a fair amount of money spent on providing that. It is all part of a programme to satisfy our primary performance target. The primary performance target of the National Museum of Wales is clear and it is the same as happens with the other national museums. It is the easiest one to measure, i.e. the number of paying visitors across the front door that actually come to see the public galleries. It is not the 3 million specimens behind the scenes in zoology which are used internationally for training, for publication etc. And what happens when your target figures don't match those that you predicted ? You have a budget shortfall, and in order to make up that budget shortfall you have three choices: you put more money into display on the galleries so that you have fresh attractions; you then increase your marketing budget or staff in order to market the new displays; and you increase the education/interpretation side in order to make certain that the visitors have a strong educational base.

And linked to this primary pressure, especially over the last ten years, is the concept that not only are museums all about education, but that the key word now is fun. So what we have is educational fun palaces, and everybody must come and pay to see them. But the corollary of this if you do not reach your targets is quite clear, and has been and can be seen in the staffing levels of museums in this country. And that is that the cuts and the shortfall in budget falls upon the highly labour intensive collections and research divisions, and nearly every museum in the UK has lost curators and researchers through either redundancy, early retirement or other factors and we are going through that situation at the moment. University museums have their own pressures, pressures of teaching etc. I think you will find that you are replacing one pressure with another should you transfer your funding agency, but it won't actually stop.

However, I should look on the bright side, because after Potapov & Zaitzev's paper (this volume) about St Petersburg (and I know the situation is the same in most of Eastern Europe and in Russia), one can only be grateful for small mercies, and in adversity we have to adapt, as one-well known museum director said some years ago, 'adapt or die'. Well systematists don't really retire until they die, but we must find them room in museums where they can continue to work on their particular collections.

Long term versus short term

I refer briefly, to illustrate some points about long term and short term, to Cardiff. The museum had a £27 million redevelopment scheme, the majority of which went on the galleries, but also involved restorage. The gallery money for display was no problem: £3 million over three years for new displays of geology, the history of the Earth in Wales and the natural history environments of Wales. But the plan in 1980 to restore the collections at a cost of £1/2 million has not yet been completed. We are three-quarters of the way there, and looking on the positive side, 1/2 million has been spent on making the collections accessible. The galleries will attract a quarter of a million visitors a year for the next twenty years. I hope our storage will maintain the collections for a great deal longer, and therefore is highly cost effective in use.

In discussions we talk about priorities and, very sadly for me as a vertebrate zoologist, a choice had to be made. Various old strong rooms in Cardiff, which contained 200 mounted animals, were refurbished with compacted storage, and can now house one million insects with an associated library and collections' resources. This facility has been used by the university to train people from 35 countries in systematics with a diploma and qualification as well. The same use of space, critically determined and costed, has occurred in the spirit collections and the molluscan collections, and the key feature of this is that the material for the first time is accessible not only for our staff, but for other people to use. It also allows us to assess whether the material is worth keeping and to go through it critically, to conserve it and document it and make it available. The advantage is that people can see that it is worth working on and that gives one a chance to reshuffle and get the right staff employed.

So, whereas we had three curators in 1978, those of you that have read the BCG report on the Cardiff Museum in 1980, will know that we now have ten curators (three entomologists, four vertebrate zoologists and two vertebrate zoologists) with fifteen other people working on the collections. So we can show, hopefully, progress in that particular field, and show the long-term benefits. What we also have to do now is use very strong performance indicators to prove that what we are doing on a day-to-day and year-to-year basis is critical. And that we have built in to the actual work of every research curator, and we have used, across the board in all disciplines, art as well as sciences and folklife, the Smithsonian INSET levels of 1–6, adjusted to take account of collection and conservation storage, and those particular performance parameters are passed to the Welsh Office that actually fund the museum. So we will be showing, hopefully, improvement year by year not only on the upgrading of our storage, but also on accessibility.

Conclusion

I would like to conclude with a few points to be considered in drafting the *Accord*. We have been looking at valuation in a UK context, but basically it is a European meeting and what we are talking about is a holistic whole of all the collections and the resources within Europe, so to whom are we actually going to address the *Accord*? It is absolutely critical that we determine whether we are addressing just UK or European governments, or whether we are addressing the larger-scale proposals; we have the natural patrimony of many countries from abroad and especially developing countries. I know that there are two members here of the European Science Foundation Network for Systematic Biology, and I also think it is absolutely critical that whatever we come up with should be tied in with the actual guidelines which have already been accepted and funded within the Network; a two-pronged approach should be united. We have to help ourselves and come up with specific elements for European museums as we know that we are under-funded, and we must find machinery of working co-operatively together to make things more effective. But even more important is the fact that we use our resources and our collections which come from those countries, to assist those in the developing world under *Agenda 21* following the Rio Summit. There are some initiatives under way; the global workshop held in Cardiff in August 1995 of 'Bionet International', and the European Network who are proposing a massive database questionnaire on all resources in European museums. Bionet concerns itself primarily with invertebrates and microorganisms, the groups that are most difficult to item-document, and the ones most difficult to get access to and to use effectively.

The second point to note for the *Accord* is gearing ourselves to the actual users of our collections and resources. We have the FENSCORE database in Britain, we know what collections are in which museums, and what dates they were collected, and which collector collected them. We should be able to do the same in other areas as well. So we must concentrate on the user needs and use our infrastructure as best we can.

The final point I wish to make is the fact that the collections themselves might not have much value at all, unless the engine-house of people that use, interpret and research them, the curator-researchers, are also clearly highlighted in the *Accord*. We know from the European Science Foundation Report of 1982 that the number of systematists in museums is reducing, and the short-term aims of museums makes it more difficult for us to keep them. We also know that in universities the number of students taking up systematic studies is declining, and the question is, will we be here in twenty years time, will there be enough of us left to provide either for the core-collection activity, but more importantly, to train the next series of generations ? This question of training is one of the most important themes that should be included in the *Accord*, not only between ourselves in Europe, but also providing facilities for training for people from developing countries.

But the curator-researchers to me are absolutely critical, and when we talk about the value of collections, that is the one thing that quite often gets left out. Because we are curator-researchers, or managers of collections now, there is no reason why we should not shout it from the roof-top that we are essential to work on the collections because nobody else is going to do it for us. The numbers are declining and we must find a means of preserving those that we have and refine the machinery to bring more in. And to illustrate the fact, without the curators you don't get catalogues of the collections to be distributed world-wide, to make the resources accessible. The resources following restorage after only 10 years, include major books on areas of importance, not only for the scientific side, but also for commercial exploitation (e.g. oil and gas), biogeography (climate change and past climate change etc.), and key faunas to Britain. Who would have thought that somebody would find a new woodlice in their back garden when digging up a paving stone, but they did, and only the scientists would recognize it? Critically we know the value of our material, there are *n* publications showing the medical, the economic and the agricultural worth of our collections, and the work we do on them, and this is one clear area again where systematists help in terms of human populations, in food and agriculture.

Finally, and again linked to Biodiversity UK, our own biodiversity survey in the Irish Sea contains twenty new species of polychaete and who would have thought that in Wales or in the Irish or Celtic Sea there would be twenty new species, but they are there. We have to fulfil our local as well as our global activity and the only people that will do it will be the research curators, and I hope that none of them will apply to take early severance.

From grave to cradle, the changing fortunes of the giant Irish deer

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Introduction

Fossils of the giant deer, *Megaloceros giganteus* (Blumenbach), were known from Ireland long before scientists publicized their significance at the end of the eighteenth century. They posed a number of early questions, one of which led to their confusion with North American moose and their title *The Irish Elk*. They are found beneath peat bogs in lake deposits which are distributed widely in Ireland and which form the graves of these magnificent fossils. Their value arises from a number of factors, all of which have led to their being treasured possessions cradled by museums and private owners throughout the world.

Value as trophies

Novelty value of giant deer arose as a result of their recognition as the owners of the largest antlers known from the fossil record and led to their initial worth as trophies. That they were given as tributes is documented with the offering of a set of antlers by the Lord Chancellor of Ireland to his English counterpart during the reign of Queen Elizabeth I. Chancellor Adam Loftus (1533?–1605) held large tracts of land in south County Dublin at the end of the sixteenth century. As Archbishop of Armagh and Dublin and as first provost of Trinity College Dublin he was a significant figure in the politics of a country claimed by King Henry VII of England

Fig. 1. Contemporary drawing of a giant deer excavated in 1588 and presented by Adam Loftus to Robert Cecil.

Giant deer have a long fossil history (Lister 1994), but most bones and antlers are to be found in lake clays, normally sticky water-saturated marls made of pulverizd limestone which settled in standing water at the end of Pleistocene glacial activity (Monaghan 1995). At the time the giant deer inhabited this landscape (11 700–10 900 years BP) they would have seen a hummocky terrain with good grasslands and numerous small lakes. Wading into these lakes could be deadly as the tenacious clays caused miring, particularly of the large front-heavy males whose antlers could add up to 35 kg to the pressure forcing their hooves deeper into the lake sediments. These lakes would have filled with vegetation in succeeding years and many were destined to become the sites of peat development which initiated about 9000 years ago.

Rural Irish families have long relied on peat from bogs as a fuel; in the past, timbers of 'bog deal' were also extracted, formed of the remains of trees from earlier vegetation cover of various drier climatic episodes. Giant deer would have been encountered when the peat was cut by hand; this has become a rare sight in the modern Irish landscape as most peat extraction has been mechanized for several decades. The availability of well-preserved antlers discovered by turf cutters working at a slow pace would have been much higher in the nineteenth century than today. A similar pattern is seen in the availability of fossils from quarries where modern methods ensure that most fossils are destined for rock crushers and few are discovered by quarrymen. Most modern discoveries of giant deer notified to the National Museum of Ireland are related to drainage works or other land clearance where the grey marls of the Pleistocene lake sediments are trenched by large mechanical excavators in order to drain the overlying peat or waterlogged soils. In such cases the skeletons are normally badly damaged before their presence is noticed.

Complete antler sets or skeletons are now seldom seen in auction rooms. This has been matched by an unpredictable pattern of sales prices. Recent purchase records at auction have reached £20 000 for a full rack of antlers and £27 500 for a complete skeleton. The most recent sale of an antler set raised £9,000 which may be a more realistic reflection of current commercial values. This may reflect a demand from the more recently established museums which were not around in the nineteenth century when many giant deer specimens left Ireland for the international market. At that time there were a number of commercial dealers prospecting for specimens in Irish bogland and assembling bone collections (Fig. 3) from which composite skeletons or occasional near-complete genuine skeletons were assembled for clients. The last of these collectors in operation was a medical man, Dr Henry Stokes, whose residual collection was bought by the National Museum of Ireland after his death in 1968.

Fig. 3. Probing bogland for giant deer using steel rods, as practised by nineteenth century excavators. (From Millais 1897.)

Conclusion

New heritage legislation will provide protection for such fossils under law in the Republic of Ireland, causing a further change in the availability of these fossils. In order to maintain a market supply of giant deer for exhibition purposes the National Museum of Ireland has prepared moulds of a display quality set of antlers from which fibreglass replicas can be produced for sale or exchange with other museums (Fig. 4). The commercial value of these fossils in the marketplace has shown numerous fluctuations matching their popularity and availability over the centuries. It is perhaps worth noting the words of a famous son of a former curator of the Royal Irish Academy's museum which included a collection of giant deer. Sir William Wilde was curator of the museum which was transferred to the National Museum of Ireland in 1890 and perhaps his son

The effect of high market prices on the value and valuation of vertebrate fossil sites and specimens

SALLY Y. SHELTON

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Introduction

In the past few years vertebrate fossils have become highly sought-after items, and their legitimate and black-market values have soared. These prices, and the availability of buyers at these prices, have had serious adverse effects on the conservation of fossils and fossil sites worldwide. The rise in valuation has not yet been matched by a rise in public education about the scientific, educational and historic values of specimens, so many specimens lack the essential information and documentation to preserve their scientific value in any way. National and international protective legislation tends to be inadequate, unenforceable, or simply lacking in many countries. In the United States, fossil resources are protected by no single law and tend to fall into a regulatory twilight zone as non-renewable, non-mineral, non-archaeological resources.

The situation gravely affects the enormous public lands of the United States, which form the focus of this paper, but the problem is in no way unique to these areas. The fossil trade, legitimate and otherwise, is international in scope and will require a concerted world-wide effort to save the non-financial values of vertebrate fossils as part of the global scientific heritage.

What are the problems?

The monetary value of fossils has soared in a geometric progression, and theft from and vandalism of sites and collections have also risen sharply. Even when specimens are collected legally for profit, the pressures of the market and the lack of guidelines and codes of ethics for such collectors frequently result in hasty excavations that destroy more information than they save. Given that statistics can be defined as the most boring form of fiction, nevertheless some facts are in order here.

- More than fifty commercial fossil companies and countless individual prospectors participate in commercial fossil dealing.
- The estimated gross income of commercial fossil dealers in 1985 was three million dollars. More recent statistics are not yet final, but suggest an enormous rise over the past ten years (Crescenti 1994).
- The market value for many specimens is grossly inflated compared to 1975 prices, and the profits are generally not shared with or made known to land owners or managers. At one private dinosaur site, the owner was paid $1 in law for the right to all fossils from the site, which sell as articulated skeletons for over $300 000. Another rancher was paid $2000 for the only known Late Cretaceous ankylosaur, which was then sold to a Japanese company for $440 000 (Stucky 1993; pers. comm.). A Japanese firm offered a $10 million finders' fee for a *Tyrannosaurus rex* skeleton. A rancher accepted $13 000 from commercial dealers for such a specimen on his land before finding out the full fee value (Stucky pers. comm.).
- Of 53 pending felony cases in fossil trafficking world wide, 90% of the suspects have links to other criminal activities, primarily drug smuggling (Crescenti 1994).
- Reported thefts of fossils from museums have risen 10% in five years.
- Current catalogue prices include a *Triceratops* skull for $200 000, a complete *Edmontosaurus* for $350 000, and a mounted *Subhyracodon* skeleton for $40 000. Though some people claim that museums set aside funds for such high-market purchases, the sober truth is that most legitimate museums cannot compete at this level. The chances that these specimens will stay in the public domain after their sale are slight.
- Of the six known specimens of *Archaeopteryx*, one is missing and is believed to have been sold by its private owner.
- A recent fossil dig in Wyoming by a Harvard crew was disrupted when the site was raided overnight, removing most of a dinosaur that the scientists had uncovered.
- A John Hopkins University palaeontologist lost a *Hadrosaurus* nesting site on private

land in Montana when a commercial dealer from Canada offered money to nearby landowners for exclusive site access (D. Weishampel, pers. comm. 1993).

- In North Dakota, a rancher destroyed a *Torosaurus* on his land by attempting to excavate it with a spade and shovel upon learning its probable financial value.
- A 1991 study on the Oglala National Grassland in Nebraska found that, of the 11.4 square miles of fossiliferous bedrock surveyed, 20% showed signs of unauthorised fossil collecting. Of the 39 sites designated as having special importance because of exceptional preservation of fossils, 28% showed evidence of fossil collecting. The university conducting the survey has the only permit to collect in these areas (LaGarry-Guyon 1994).
- A Wyoming raid left holes twenty to thirty feet across.

Given the nature and magnitude of palaeontological resources in the US, the enormity of the Western public lands, and the lack of any mechanism to monitor the loss of fossil resources through commercial sale, theft, and destruction, it is difficult to determine the combined effect of these activities. One pattern, however, is evident. As the commercialisation of fossil collecting increases, so too does the disappearance of these resources into private hands, as well as the pressure to increase private access to fossil resources on United States public lands. Three quotes come to mind:

- 'Because of commercialisation, we're slowly losing access to our fossil resources.... High prices have stripped away the scientific value of these finds and left perhaps only the aesthetic value. They become merely curiosities for someone's coffee table' (Hugh Genoways, former Director, Nebraska State Museum).
- 'There's a very fine line between priceless and worthless' (Joseph Leidy, Director of the Philadelphia Academy of Natural Sciences and the first scientist to confirm the evidence that dinosaurs lived in North America).
- Nineteenth-century palaeontologists Edward Drinker Cope and Othniel Charles Marsh routinely paid for fossil specimens and information leading to sites while in intense competition with each other in what is now called 'The Bone Wars'. An eminent elder colleague commented, 'Professors Marsh and Cope, with their long purses, offer money for what used to come to me for nothing, and in that respect I cannot compete with them'.

It is safe to say that the recent exponential rise in market values, which was well under way even before the *Jurassic Park* phenomenon, but has skyrocketed since, caught the academic vertebrate palaeontology community completely unprepared. The threats posed by the increasing interest in fossils for commercial purposes include the loss of access to important scientific specimens that are acquired by private individuals; the loss of public access to specimens and information which, being from public lands, are supposed to remain in public trust in perpetuity; and the loss of access to important geographic, stratigraphic, taphonomic and micro-palaeontological information caused by hasty or careless collecting. (Specimens collected without data are very often lost to science and education forever even if they are later offered to museums. Scientific value is measured in terms of information associated with the specimen, a fact that is often not known or appreciated by commercial and some avocational collectors.)

Catalogue information for the sale of vertebrate fossils has made it onto the Internet and World Wide Web. In one, prices ranged up to $12 million (*c.*£8 million) for a *T. rex*, with no further information or provenance given (it is available only to interested buyers). This is frequently the case for catalogue specimens, and is commonly seen in the sale of art and artefacts, but not with scientific materials. Many dealers offer a 'certificate of authenticity' which verifies that the buyer has purchased a real fossil (as opposed to a cast or other replica), but carries very little scientifically useful information. Provenance information is very often sketchy or absent; too often, the dealers word that a specimen was collected legally is taken as true without further questioning, especially if the buyer is not a citizen of the country where the specimen was collected.

The public lands of the US are massive. 43% of Arizona, 61% of California, 34% of Colorado, 62% of Idaho, 30% on Montana, 82% of Nevada and 33% of New Mexico are under Federal stewardship. These lands were originally acquired by the Federal Government before the areas became states; many areas were initially earmarked for sale to other countries. The National Park Service and other land management agencies operating in the public trust arose at the beginning of this century. Each agency, such as the US Forest Service and the Bureau of Land Management, operates under a different associate of the museum (an institutional affiliation is necessary for most public land permits). 75% of the programme's graduates remain active as museum associates and the museum's donation rate in the earth sciences has sharply risen; these donations are documented and prepared to museum standards. One community programme managed solely by certified DMNH graduates is the Garden Park Palaeontology Society in nearby Cañon City, whose members survey and work the fossiliferous Garden Park area (and are in the process of establishing an on-site education and research centre). This is in some ways analogous to the US site steward programme in archaeology, in which local citizens are trained to survey, monitor, and report problems regarding affected archaeological sites in their regions. Building up a network of trained local avocational palaeontologists increases the likelihood that specimen information will be saved and that the specimen will remain in the public trust. Effective partnerships between agencies, citizen groups, and public collections-based institutions preserves the scientific, educational and historic values of the specimens.

At the moment, the fossil trade is a seller's market. There is no effective national or international overarching legislation. Some countries ban palaeontological exports, but not imports. One survey showed that many countries, including Third World countries, had better laws for regulating their fossil resources than does the US. There is no doubt that the US is losing much of its own scientific heritage at the same time that it permits poorly documented imports from other countries.

The most significant international treaty affecting the movement of cultural objects across international borders is the UNESCO Convention. The treaty defines cultural property as 'property which, on religious or secular grounds, is specifically designated by each state as being of importance for archaeology, prehistory, history, literature, art or science' In order to achieve the goals set forth by the UNESCO Convention, the co-operating member states must implement laws that protect cultural property within their own territories to secure protection of their cultural heritage and to prevent illicit export of important cultural property. The treaty also contains provisions that prevent museums from obtaining material illegally exported from another member state, and provides a mechanism for the repatriation of illegally exported objects, restated in the UNIDROIT treaty. There are, however, problems with this. The treaty is not self-implementing: each member state must enact its own supporting legislation. Other problems arise when the nation's domestic enacting legislation does not correspond with the treaty's definition of cultural property. Palaeontological specimens, for example, are included in the definition of cultural property under the UNESCO Convention, but the US legislation implementing the treaty is limited to archaeological and ethnological objects. It is a bilateral treaty: in order for the provisions to apply, both the market and the source nation must be signatories. Finally, the repatriation of stolen cultural property is limited to objects stolen from a museum, or from a religious or secular public monument; the item also must have been documented or accessioned. Therefore, objects stolen from public lands cannot be recovered under this provision.

At the moment federal legislation specific to the management of vertebrate fossils on public lands is being developed along two fronts in Washington DC, perhaps not the friendliest climate for these activities today. Two different Bills with very different agenda are being considered. One would make collecting by avocational palaeontologists with permits legal, defines qualifications for receiving a permit, and provides substantial criminal penalties for unauthorised collecting with intent to violate the law for personal gain. Another would allow commercial collecting on public land as well. The chances for either Bill clearing this Congress to become effective legislation is slight at the moment.Prospects for improving international regulations are somewhat more optimistic. The World Council of Collections Resources was discussed and formally established at the 1996 Second World Congress on the Preservation and Conservation of Natural History Collections (Cambridge). The possibility that WCCR will work with UNESCO to improve international treaties and standards in the protection of natural history patrimony is encouraging.

Public education through programmes for avocational fossil collectors, conducted with high levels of information and ethics, offers the best hope for developing a site steward programme for local resources. This is education in value, as opposed to valuation. Scientific information should be collected and preserved as diligently as are the specimens themselves. Education of teachers is also a top priority.

On an international scale, all would benefit by viewing fossils on the marketplace as part of our common scientific heritage. Have they been removed from their country of origin legally? Can their letters of certification or authorisation be confirmed? Is there enough good scientific information to warrant keeping them in the public trust?

Conclusion

It is naïve to suggest that no fossil should ever be bought or sold; the marketplace is powerful, and some commercial dealers have recognized the value of scientifically documented specimens and are working more with the academic community. The responsibility of that academic community is to demand consistency in supporting scientific documentation; to investigate questionable or vague claims directly, not through the dealer; to ensure that specimens sold from another country remain accessible to scientists and educators in the country of origin; and to educate the public as to the poor long-term investment that an undocumented or black-market fossil specimen really is. We will have to survive with the effects of high valuation, but we can seize the opportunity, as long as we are already the object of so much attention, to raise the public awareness of scientific value as well.

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References

CRESCENTI, R. 1994. Operation Rock Fish. *Airbeat magazine*, 9–12.

LAGARRY-GUYON, H. 1994. Results and recommendations of the 1991 palaeontological resource survey of the Oglala National Grassland. *In:* BENTON, R. & ELDER, A. (eds) *Proceedings of the Third Conference on Fossil Resorces in the National Park Service*, **NPS/NRFOBU/NRR-94/14**, 69–72.

LASERWITZ, D. J. 1994. Bones of contention: the regulation of paleontological resources on the Federal public lands. *Indiana Law Journal*, 601–637.

STUCKY, R 1993. Dinosaur futures: loss or preservation. *Museum Quarterly, Denver Museum of Natural History*, **summer issue**, 2–6.

——— *et al.* 1991. *Survey of 33 institutions that curate fossils*. Denver Museum of Natural History. [Original survey in the archives of the Association of Systematics Collections, Washington, DC.]

Museums and the mineral specimen market

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Introduction

The market value of a specimen may be considered as transitory compared with the historic, scientific, social and other kinds of value which a natural history specimen may possess. Generally it is one type of value that is most easily dismissed as insignificant or irrelevant to museums. This is despite the fact that such institutions are influential, either actively or passively, in the commercial market. They may be active as collectors acquiring in competition with private collectors. When not actively collecting, they retain their influence because their past collecting leaves them with highly marketable holdings, the museum pieces of the mineral world which can set quality standards for the market place. Knowledge of commercial values and the criteria which influence them, along with the availability of specimens is highly relevant to the way museums both acquire and manage mineral specimens and collections.

The commercial market in minerals

Mineral specimens are the subject of a large international commercial market, akin to that of art and antiques in that aesthetic appeal is a significant attribute in the valuation process. New material is marketed alongside second- and third-hand specimens which may be antiques in their own right. Sums from a few pounds to thousands of pounds can change hands for single specimens and there are few museums world-wide with the purchasing power to match that of the wealthier and most avid private collectors.

The market in minerals is not a new phenomenon. Mineral collecting as we know it today has been carried out since the sixteenth century (Wilson 1994, p. 155), and there have been dealers for just as long. Museums have benefitted greatly from this trade. The Oxford University Museum, for example, holds collections for the most part accumulated by gentlemen enthusiasts through purchase, and it is estimated that about 90% of specimens have passed through the hands of dealers at some stage prior to entering the museum.

The commercial market uses a different value equation to that of museums, placing heavy emphasis on aesthetic appeal. Ideally a mineral specimen should have well-formed crystals showing good colour and lustre. Perfection is sought and an absence of damage such as chipping and bruising is important. A crystal still attached to its host rock is generally considered more pleasing than a detached crystal providing that dimensions are in good proportions. An attractive association of mineral species is especially desirable. Size is an important factor since good cabinet or display specimens are far less likely to be undamaged than tiny microcrystals. Rarity enhances value and even damaged specimens of a rare species can command a high price. By comparison, a fine geode of amethyst crystals, currently abundant on the market, may be obtained relatively cheaply.

It is worth noting that scientific values can mirror aesthetic values in that good size, well-formed crystals, rarity of species or association and unusual properties or features are all attributes which make a specimen of greater potential use to the scientist.

Historical interest is also fundamentally important. The availability of minerals has always been strongly influenced by economics and politics since the majority of new specimens entering the market are by-products of mining and quarrying industries. For example the metalliferous mines of Cornwall and Devon have in the past provided fine and rare minerals, many of which are now in museums. Today, global economics favour overseas workings and only one Cornish tin mine remains open. The total heritage of specimens from this area is absolutely irreplaceable. Specimens are avidly repatriated from foreign collections by British dealers, but they are still relatively uncommon and are generally costly.

Another example is shown by the trade in specimens from Russia. Museums across Europe are rich in fine nineteenth century minerals from Russia. However, the Communist regime closed the doors to free trade in specimens, and samples reaching the West were mainly of rare species acquired via the academic network. The public awareness of the mineral world. Not surprisingly, the number of collectors is increasing. British shows cater for the preferences of British collectors. Specimens are generally small (suitable for storage in small houses with little storage space), and British provenanced material is especially popular.

A wider view of the commercial market can be obtained at shows overseas. The old Alsace mining village of Sainte-Marie-aux-Mines is taken over by dealers from all over Europe for a long weekend at the end of June. They occupying the school hall, theatre, marquees and much space around. This is a rewarding show for potential purchasers, enhanced by hot sunshine and world-famous local beverages. Open air tables can hold good bargains for collectors and the show includes a marquee dedicated to the sale of fossils.

The potential purchaser may need to consider exchange rates when deciding which shows to attend. The Munich Show is regarded by some as more expensive for specimen purchase, but it is the largest in Europe. It occupies around 6 large halls in the Munich exhibition centre and attracts around 500 dealers from all across the world. Many stalls are fitted out as shops and prices tend to match the quality of the fittings. A tour around the show reveals the new arrivals on the market, the variations in price between dealers, the cost of British specimens on the continental market, and the availability and cost of old-time material from historical localities typical of those in museum collections.

For those purchasing specimens for the museum, a visit to an overseas mineral show enables a curator to acquire world-wide material for the cost of a single airfare. This makes good economic sense when field collecting of such material would rarely be feasible. Shows provide the best opportunities to select the most suitable specimens from those on offer by a large number of dealers, to bargain hard and get best value for money.

It is particularly unfortunate that grant-aid from, for example, the PRISM fund (which provides government funding for acquisitions by UK museums) is difficult or impossible to obtain for such opportunist purchasing. On the other hand, because the curator is purchasing in the same market place as British dealers who are buying with a view to marking up the price for resale in the UK, a museum may end up paying little more at an overseas show than it would for the same specimen purchased through the UK dealer with grant-aid.

Mineral shows also hold another important benefit to museums and that is the opportunity to show their collections and encourage the support of and use by both amateur and professional mineralogists. In the UK, the Oxford University Museum has exhibited at the Sussex Mineral Show as other museums have subsequently done, and it will be exhibiting at the Southampton Show in the coming year. It collaborates with the Oxford Mineral Show organizers, holding a special Sunday opening for show-goers. In Munich, and at shows in the United States such as Tucson and Denver, an important part of the show is the area set aside for displays by museums. Curators are welcomed both as exhibitors and as potential customers, and also get access to special 'professionals' days' before the public are admitted. Although few curators from UK institutions regularly attend mineral shows, they are regular meeting places for curatorial staff elsewhere in Europe and in the USA. The Society of Mineral Museum Professionals, for example, regularly holds its business meetings at the Tucson and Denver shows.

Conclusion

It would seem that many natural history curators prefer not to recognize the financial values of their collections. Such knowledge is often seen as potentially dangerous should it come to the attention of cash-starved managing authorities seeking to raise funds from sales of specimens whatever the ethical considerations may be. Mineral collections, which are often non-local, may be especially vulnerable. But curators should be aware and kept informed of the commercial market in the material of which they are custodians because this can make significant differences to the ways they build up, manage, use and protect their collections. Mineral curators are fortunate in having shows at which they can evaluate the market, purchase specimens and promote use of their collections.

Recent concern has been raised about the image portrayed by a curator who took along an item from his museum's collections to a recording of the 'Antiques Roadshow' (Bell 1995; Edgar 1995), a television show in which members of the public bring their treasures from home for comment and valuation by experts. The dilemma is that museum curators are themselves expected to be experts. As custodians of an international heritage of both natural and man-made objects, they work in institutions which collect alongside the private collector, and so a degree of connoisseurship is the very least that can be expected of them.

Perhaps the most positive solution is for museum authorities to enable staff to attend commercial shows and sales as a fundamental part of their ongoing professional development as much as for any purchase of specimens. For many staff, it will be an eye-opening experience bringing a far greater appreciation of the collections in their care.

References

WILSON, W. E. 1994. The history of mineral collecting. *Mineralogical Record*, **25**.

BELL, J. 1995. Television exposure. *Museums Journal*, **95**(3), 49.

EDGAR, K. 1995. In the know. *Museums Journal*, **95**(4), 49.

The evaluation of natural history collections: some remarks

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Dealing with the problem of putting a value on collections does not mean that a museum is necessarily interested in selling its collections. Nevertheless, the evaluation of a museum's collections can be a test of the museum's responsibility, inasmuch as an evaluation implies a definition of the framework that justifies the function of collecting.

Natural history collections essentially have a transmission value: in other words, they are a resource for understanding nature. This condition is both a quality and a restriction. Museums collect natural objects essentially in order to find out about the composition and the workings of the Earth rather than to appreciate the singularities of each specimen as an object of study in itself. Natural history museums must rationalize their mission to form collections according to the reasons inherent in cultural and scientific desires to comprehend nature.

Natural history collections are a source of knowledge but not a goal in themselves. Whilst other types of museums have the urgent and endless function of housing the heritage that witnessed past phenomena, natural history museums are mainly orientating their activities towards knowledge of an active nature, albeit with the paradoxical help of removing samples from nature. The preservation of all remains of past or declining cultures should be sustained by the corresponding museums. Natural history museums, on the other hand, should collect responsibly, avoiding extinctions and being aware of their function of taking away from nature elements that had a value in their original situations. Natural history museums should try to compensate the loss of value in natural sites with the value achieved by their collections.

At the end of the twentieth century it is very important to recognize the responsibility of managing collections of natural elements from the perspective of utility in the transmission of information. The value of utility could be an essential condition, although not sufficient by itself, to justify collecting natural elements. As a consequence, the evaluation of collections may become a tool of diagnosis and management. Such a tool would measure the real and potential utility of collections in order to understand nature.

Economic value

Nevertheless, it is true that there are some circumstances in which museums have to give a monetary value to their specimens. Examples of the need for economic evaluation are:

- insurance of collections stored in the museum and on loan to or from the museum;
- appraisal of new collections or specimens to be incorporated into the museum, either through purchase or donation (if an evaluation is required by the donor);
- collaborations outside the museum, in which museum technicians act as appraisers;
- the adaptation of new models of management that require the evaluation of the museum's heritage. As an example, the Barcelona City Council might have asked all its museums to evaluate their collections if it had been impelled to ask for international credits in order to organize the Olympic Games.

These situations imply the calculation of a monetary value that is an equivalent to market price. In a historical or current context, market references through which it is possible to get an idea of the evaluation process include:

- professional networks devoted to buying and selling of specimens or collections;
- auctions;
- traffic between collectors;
- taxidermists;
- evaluations of hunting records by professionals or by public authorities.

These references are clearly insufficient to cover all natural history collections. Moreover, a museological factor has to be considered and added to the market price. Therefore, when there is no market reference, the replacement value is used. The replacement of a specimen might include the following expenses:

- trips;
- human resources;

- technical preparation of the specimen;
- storage.

Replacement value is very often impossible to calculate because of the singularities of the material or, at least, because of the uncertainty of costs involved. Monetary evaluation works, in the final analysis, as a means of dissuasion in order to avoid the misuse of specimens. If museums do not receive monetary benefits from loaning specimens, they can still filter external demands by means of insurance policies based on monetary evaluation. This criterion of dissuasion is clearer when we consider that museums do not normally obtain financial profit from their collections.

Cultural evaluation

Nevertheless, an evaluation of the 'quality' of the collections in a museum is more meaningful than any monetary evaluation. This affirmation is supported by cultural reasons derived from the function of museums, and especially of publicly-owned museums. However, there is also a practical reason. Only big museums frequently have external contacts that imply the need for monetary evaluations. But all museums, big and small, should have the capacity to evaluate work carried out in relation to their collections.

The quality of a museum in terms of its collections embraces both the housed collections and the plans for future collections. We should take the maximum advantages of registered specimens as well as designing projects aimed at filling gaps detected in the collections or at opening new museological services. The role of natural history collections in the transmission of useful information for understanding nature has to be calculated according to museum works.

Museums should avoid the mere accumulation of specimens. However, to achieve this, two things are recommended:

- measurable objectives;
- tools for evaluating collections and progress towards objectives.

Evidently these tools have to be based on calculations that are consistent with the objectives in mind.

A tool for the diagnosis and management of collections

What kind of calculations should be done? Calculations should quantify a museum's collection so that objectives and periodical diagnosis can be expressed as simple, numerical expressions. The following is a theoretical list of possible calculations or indicators in the context of zoological collections with some definitions and hypothetical objectives.

Size of collection. Number of records in a collection or in a set of collections. Possible objectives:

- maximum number (!) respecting all legal and ethical controls;
- a warning system to avoid the saturation of storage space, by means of a previously estimated limit.

Number of species. Richness of species or of higher taxa. Possible objectives:

- maximum number;
- obtain a complete inventory of species of a precise geographical area;
- even with a complete representation of the local fauna it could be interesting to reduce the index of biological diversity of the collection (H less than the maximum value for a fixed S).

Information attached to the specimens. How many specimens are (1) registered, (2) labelled, (3) documented on cards or (4) in databases? If the size of the collection is known, percentages are preferred. Possible objectives:

- a 100% for the four possibilities above;
- a sequence of completeness from registry through to the database.

Type specimens. Number of holotypes, paratypes, etc. Possible objectives:
maximum number;
to promote taxonomic and systematic studies.

Specimens of protected species. How many specimens belonging to species listed by CITES, European directives and local laws? If the size of collection is known, the respective percentages would be preferred. Possible objectives:

- hold none, in spite of the rareness of these specimens and their corresponding high value;
- to house legally protected specimens. For this, protected specimens have to be obtained through legal channels.

Methods of preservation. In how many different ways does the museum preserve specimens of the same species? As an example of the different types of preservation, a bird species can be stored as a skin, skeleton, in spirit, etc. It depends obviously on the systematic group. Possible objectives:

- at least one specimen of each conservation method per species;
- to promote one type of conservation technique;
- to balance several types.

Morphological diversity. How many 'morphs' does the museum house of the same species? Morph means all categories of morphological variation according to sex, age, etc. It also depends on the systematic group, and it is possible to cross-reference these data with the classification based on conservation techniques. Possible objectives:

- at least one specimen of each morphological type per species;
- to promote the representation of some morphological criteria of diversification in the collections.

Condition of preservation. A monitoring of the amount of specimens in good or bad condition. This condition will be assessed in a particular way for each systematic group. Possible objectives:

- to detect specimens that need restoration, if possible.

Consultations. Number and frequency of consultations of the collections by the staff of the museum and by external consultants. Possible objectives:

- as many consultations as possible;to promote external consultations.

Loans. Number and frequency of loans of specimens for scientific or other purposes. Possible objectives:

- filtering of non-scientific loans;
- monitoring of loans.

Publications. Number and frequency of published works based on museum specimens. It is possible to distinguish between those publications included in the Citation Index or not. Possible objectives:

- to increase the recognition of collections in scientific papers;
- to increase the documental value of the museum's collections.

Outside funding. Grants or funds devoted to the study or conservation of collections. Possible objectives:

- to promote external support.

Collectors. Number of collectors or donors according to certain periods of time. Possible objectives:

- to co-operate with Friends' Associations.

Volunteers. How many volunteers are helping in the management of collections? Possible objectives:

- to balance the distribution of tasks among volunteers.

Legal condition. Number of specimens according to ownership (purchase, loan, donation, exchange, etc.). Possible objectives:

- to diminish restrictions on use.

A flexible management tool

The above is a survey of probably the most relevant variables. The potential for adaptation to specific plans is huge. The number and type of variables can be selected. For instance, more importance can be given to the variables designed to monitor external links to the collections (consultations, loans, collectors, volunteers, etc.). Or, it may be more interesting to examine the variables directly dependent on museum decisions (documentation, procedures and condition of preservation, etc.). Moreover, external service data could be correlated with the actions that have been put in practice.

On the other hand, it is possible to fit the level of precision of variables to the museum's needs, so that analyses of differing levels of sophistication can be produced. Fortunately, biology has created methods to compare and study different inventories of natural elements in field conditions. These techniques can be easily adapted to the analysis of collections, and can make evaluation a standard process. Analyses of variance or multivariate statistics, for example, can be used in a myriad of ways to assess the quality of collections.

The number and the extent of the objectives are also adjustable. There may be one or more objectives for each variable, or some common objective suitable for a set of variables. Combinations of data such as mathematical functions or logical expressions with the use of if, so, etc., can even be created.

The important thing is to be able to be adaptable. In short, the programme of evaluation should be flexible. It is possible to select to what extent a programme of collection evaluation, such as has already been described, is going to be carried through: which collections? which calculations? to what level? what are the objectives? how often? etc.

On-going analysis

Temporary monitoring is also recommended. Two main kinds of objectives can be considered: fixed and dynamic. A fixed objective would mean achieving a set value, whilst a dynamic objective does not have any *a priori* target. Nevertheless, a sequence of evaluation, year by year, will provide good information for either fixed or dynamic objectives.

The measure of the quality of collections in relative and temporary terms can be estimated according to three criteria:

- other museums, if the budget is calculated according to a ranking or another similar unfair scheme;
- the own development of the museum. When the museum has results from tests carried out in different periods, the temporary evolution of collections can be monitored and compared, even with visitor statistics that nowadays are so popular;
- with regard to the goals established by the museum. If the money spent by the departments of collections is taken into account, the effectiveness of the development of the patrimony programme can be estimated.

The last two criteria could be interesting ways of creating static and dynamic diagnoses of collections. An evaluation according to these points of view can be useful and even necessary for planning and managing collections. Museums are full of memories, and so a condensed record of the collections should not frighten us.

Some museums even recommend emulating the powerful statistics of visitors with convincing statistics from the collections departments. This consideration could be extended to research programmes. Too often natural history museums are evaluated only by means of their success in attracting visitors to exhibitions.

How to start: Units of reference for evaluating

To make the evaluation a practical and useful tool, some previous requirements would be helpful.

Firstly, it is important to decide in which collections the evaluation programme will be applied. In this context it is useful to consider the possibility of regrouping traditional collections, not physically, but in concept and only by evaluating needs. All the collections of a museum could be arranged according to ease of management if, for example, the object of the evaluation is the assessment of management performance.

The congruence or coherence pursued by systematics need not be the same as that required in a management context. Therefore, scientific ordering with its evolutionary criteria is not necessarily the most adequate for analysing museological events. Instead of an absolutely orthodox classification it is technically possible to build a specific framework of collections for each museum whereby the new units of reference of collections would be coherent in terms of size, information, preservation, place in the museum, public use, research, etc. These units of reference should be as homogeneous in terms of management as possible and show a balance in respect of their relative weight within the museum.

For instance, in the Museum of Zoology of Barcelona we have drawn up a list of thirteen units of reference that are as follows:

Invertebrates excluding Arthropods

Non-Mollusc	1: Sponges, Corals and other small groups
Molluscs	2: Gastropods
	3: Bivalvia
	4: Polyplacophora and Cephalopoda
Arthropods	5: Beetles
	6: Butterflies and Moths
	7: Other Insects
	8: Arthropods excluding Insects
Vertebrates	9: Fish and Echinoderms
	10: Amphibians and Reptiles
	11: Birds
	12: Mammals
Other collections	13: Sound Library

Any systematic expert will be horrified by this classification in which Beetles have the same importance as all Arthropods excluding Insects. However, with a classification like this the recording of indicators of evaluation and their analyses at a later date are simplified. In our case thirteen cards detailing the aforementioned indicators for each unit of reference summarize a year's work on collections

The

Financial Value

of Collections

KEYNOTE ADDRESS

The financial value of cultural, heritage and scientific collections: an accounting fiction

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Introduction

Some government and accounting policy makers in the English-speaking world have found the notion of valuing cultural, heritage and scientific collections (hereafter collections) for financial reporting purposes to be appealing (Rowles 1992; Boreham 1994; Maslen 1994). However, our study provides evidence that the capitalization of collections as assets is not mandated by accounting standard setters in the USA, UK or Canada, or in the directives of the European Union; and that collections are not commonly recognized as assets in the financial statements of major arts institutions. Nevertheless, accounting standard setting bodies in Australia and New Zealand have now issued pronouncements requiring the capitalization of collections as assets, and HM Treasury in the UK has recently supported, in principle, the valuation of such collections (HM Treasury 1994 pp 35–36).

The context of the study is public sector not-for-profit arts institutions. For illustrative purposes, attention is directed towards the five major public arts institutions in the State of Victoria, Australia, because the Victorian Auditor-General has repeatedly qualified the accounts of four of those institutions for not valuing their collections.[1]

We show that collections cannot properly be described as financial assets, and do not satisfy all of the criteria for recognition as an asset as specified by the Australian accounting standard setters. We sympathize with the view of Adam (1937 p.2):

> 'To attempt an estimate of the money value of the contents of our museums would be an intellectual vulgarism. Individual art objects can be measured in terms of the market place, but collections created to illustrate the achievement of man's hand and eye lie outside the field of exchange. ... The concept of a museum as something that can be bought with money is common but misleading'.

Any such financial quantification would also be an accounting fiction.

Overseas and Australian accounting standards

A review of relevant accounting standards and developments in the United States of America, Canada, the European Union including the United Kingdom, New Zealand and Australia follows. The position of the International Accounting Standards Committee is also addressed. With the exception of New Zealand, the capitalization of collections as assets is not required in any of the overseas jurisdictions identified or by the International Accounting Standards Committee.

United States of America

In October 1990, the Financial Accounting Standards Board (FASB) issued an Exposure Draft of Proposed Statement of Financial Accounting Standards titled *Accounting for Contributions Received and Contributions Made and Capitalization of Works of Art, Historical Treasures, and Similar Assets*. This exposure draft proposed that collections be capitalized as assets in the period acquired at their cost or fair value, and that collection items acquired (but not capitalized) in previous periods be retroactively capitalised at their cost or fair value at date of acquisition, current cost, or current market value, whichever was deemed most practical (paras. 18 and 19).

Respondents to the 1990 Exposure Draft strongly criticized these proposals in both written responses and in public hearings con-

[1] These institutions are the Museum of Victoria, National Gallery of Victoria, Public Record Office, State Film Centre of Victoria and the State Library of Victoria. Only the accounts of the Public Record Office have not been qualified.

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The Value and Valuation of Natural Science Collections

edited by
John R. Nudds and Charles W. Pettitt
(The Manchester Museum, Manchester, UK)

The Value and Valuation of Natural Science Collections addresses a number of questions about the natural world and how we relate to it, as exemplified in the collections of biological and geological material held in museums and scientific institutions throughout the world.

The book explores the scientific, cultural and monetary values of natural science collections, with the primary aim of informing and influencing Government policy on the care, use and development of those collections. The input of thought, knowledge and experience has produced a focused consensus output in the form of a set of recommendations: the Manchester Accord. These recommendations have been presented to the United Kingdom's national museum advisory body, The Museums and Galleries Commission. It is hoped that these might also be taken to equivalent governmental organizations in other countries. This will reflect both the international representation at this conference, and the international currency of knowledge represented by natural science collections.

- 45 papers
- 240 pages
- index

Cover illustration: Giant deer skeleton (NMING:F7766) as illustrated by John Hart in 1830.

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