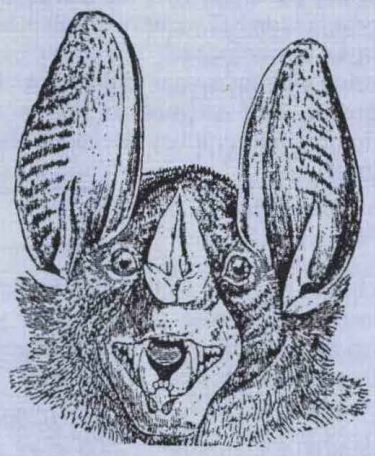

THE BIOLOGY CURATOR

BIOLOGY CURATORS GROUP

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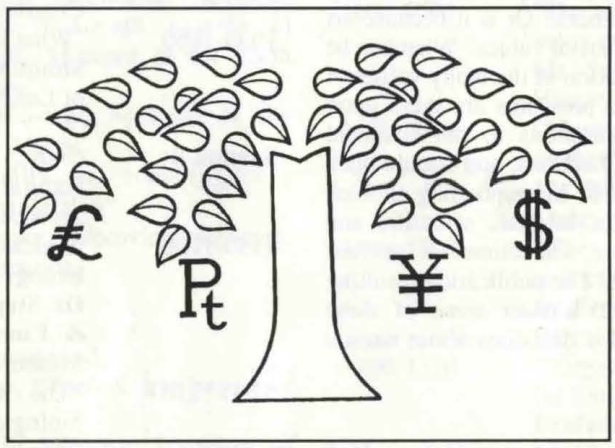

International Conference on the Value and Valuation of Natural Science Collections

The University of Manchester
April 19-21, 1995

ABSTRACTS

International Conference on the Value and Valuation of Natural Science Collections

Manchester University, UK, 19-21 April 1995

Introduction

This important conference, instigated by the Biology Curator's Group and organised by the Manchester Museum, will address a subject that is very timely, to judge from the responses we have received from around the world. This special issue of the *Biology Curator* contains the pre-conference printed Abstracts of the talks and poster papers offered. Since the topic is not one easily summarised in a poster presentation, some of the poster papers are published in full here, after the Abstracts.

Aim of the Conference

Natural science collections have scientific, cultural and monetary values. The conference will explore the nature of these various values and will reflect the experience of those involved in the care and use of such collections

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? If so, is it a consequence of the way society views the arts and the sciences? Or is it because art collections can have such high financial values? What can be done to increase society's appreciation of the many values of natural science collections? What pressures are there upon museums and other holding institutions to put financial values on their natural science collections, and should such pressures be welcomed or resisted? In responding to such pressures, is there a risk that the intrinsic scientific and cultural value of natural science collections is at best undermined, and at worst sold out? The publication resulting from the conference will help to answer some of these questions, and inform future policy decisions about natural science collections.

Venue

The conference will be held at the Hulme Hall Conference Centre. Hulme Hall is the oldest established residence in the University of Manchester and is situated on a 9 acre site in the quiet and pleasant Victoria Park, only 10 minutes walk from the centre of the University campus. Direct bus services leave every 2 minutes via the University to the centre of Manchester, and every half hour to the Airport. There is ample car-parking at no extra charge. Facilities include a 300 seat tiered lecture theatre with disabled access and induction loop, seminar rooms, dining hall, licensed bar, on-site squash, tennis, netball, table-tennis, pool tables and multi-gym, photocopying and FAX facilities, bleep and private radio systems.

Programme Outline

Reflecting the aims of the Conference, three major themes will be pursued during the various scientific sessions. These sessions will examine the **SCIENTIFIC VALUE** and **CULTURAL VALUE** of natural science collections, and address the question of the **FINANCIAL VALUE** of these collections.

The last theme presents four aspects - what pressures are there to provide financial valuations for natural science collections, what commercial valuations are *de facto* in existence already, what are the arguments for and against assessing such monetary values and, if we have to value, how should the consequent risks be minimised?

The final debate session will endeavour to draw together all these disparate threads, and attempt to define the principles that should inform future policy decisions about natural science collections.

Provisional Programme

Tuesday 18th April

1000-1400	Manchester Museum Collections available for inspection (please contact us if you wish to take advantage of this opportunity)
1000-1800	Conference Reception Desk open for Registration.
1600-1700	Biology Curators' Group AGM
1700-1800	Presentation by the UK Systematics Forum, followed by refreshments.

Wednesday 19th April

Session A:	*Chair:* **Tristram Besterman**, Director, Manchester Museum.
0930-1030	Keynote address, "The scientific value of collections" **The Earl of Cranbrook DSc DL**, Chairman, English Nature.
1030-1050	"What's important?" **Simon Knell**, Museum Studies, University of Leicester.
Session B:	*Chair:* Dr Goran Andersson, Director, Natural History Museum, Goteborg, Sweden
1130-1150	"Calculating the real value of systematic biology collections" **Dr Stephen Blackmore, Nicola Donlon & Emma Watson**, The Natural History Museum, London.
1150-1210	"The fundamental relationship between biological collections and scientific knowledge" **Woody Cotterill**, Biodiversity Foundation for Africa, Bulawayo, Zimbabwe.
1210-1230	"The Italian Association of Science Museums and its goals in regard to scientific collections" **Prof. Guido Moggi**, Museo Botanico, Florence, Italy.
1230-1250	"Archives of nature in natural history collections" **Dr Dumitra Muraria**, "Grigore Antipa" Museum of Natural History, Bucharest, Romania.
Session C:	*Chair:* **Ms Sally Shelton**, San Diego Natural History Museum, USA.
1400-1420	"Collections assessments and long range planning" **Philip Doughty**, Ulster Museum, Belfast, Northern Ireland.
1420-1440	"The National Zoological Collection of Zoological Institute, Russian Academy of Sciences"

Dr Roald Potapov & Dr Vadim Zaitzev, Russian Academy of Sciences, St Petersburg, Russia.

1440-1500 "Microbial genetic resources: their use and organization"
Dr D Smith, International Mycological Institute, Surrey.

1500-1520 "The educational and ethical role of the National Museum of Natural History in the Scientific Institute"
Prof. M Mouna, Scientific Institute, Rabat-Agdal, Morocco.

Session D: *Chair:* **Dr Ian Rolfe**, Royal Museums of Scotland, Edinburgh.

1600-1620 "Criteria for establishing the relative importance of natural history collections at international, national, and local levels"
Dr Andrew Jeram, Ulster Museum, Belfast, Northern Ireland.

1620-1640 "Depreciation, appreciation and inflation: the economics of botanical collections"
Dr David G Mann, Royal Botanic Garden, Edinburgh.

1640-1700 "Scientific and didactic criteria of valuing unique geological specimens (moveable monuments of inanimate nature) in experience of the Museum of the Earth Sciences, Warsaw"
Prof. K Jakubowski, Museum of the Earth, Warsaw, Poland.

1700-1720 "Notes on quality and economy of a natural history collection"
Dr Karel Sutory, Moravian Museum, Brno, Czech Republic.

Thursday 20th April

Session E: *Chair:* To be announced.

0930-1000 Keynote address, "The cultural impact of collections"
Max Hebditch, Director, Museum of London

1000-1030 Keynote address, "The cultural impact of natural science collections to society"
C W Pettitt, Manchester Museum.

1030-1050 Paper on ethics of disposal
David Clarke, former Chair, Museums Association Ethics Committee.

Session F: *Chair:* **Dr Barbara Hertzig**, Natural History Museum, Vienna, Austria.

1130-1150 "The educational value of university natural history museums"
Ms Jane Pickering, Oxford University Museum.

1150-1210 "Canada's experience at valuing scientific collections"
Peter G Whiting, The Outspan Group, Ottawa, Canada.

1210-1230 "Evaluating the earth sciences collections at the Royal Ontario Museum"
Ms Janet Waddington, Royal Ontario Museum, Toronto, Canada.

1230-1250 "A Dutch exercise in the valuation of natural history collections"
Dr J Krikken, National Museum of Natural History, Leiden, The Netherlands.

Session G: *Chair:* To be announced.

1400-1420 "A scientific/historical/educational heritage for whom? The value of geological collections in small museums"
Simon Timberlake, Cambridge (South Eastern Museums Service).

1420-1440 "Slaying the sacred cow"
W J Baird, Royal Museum of Scotland, Edinburgh.

1440-1500 "An attempt at valuating the zoological reference collection of the Department of Zoology, National University of Singapore"
Kelvin K P Lim & Mrs C M Yang, National University of Singapore.

1500-1520 "From grave to cradle, the changing fortunes of the giant Irish deer"
Nigel Monaghan, National Museum of Ireland, Dublin, Ireland.

Session H: *Chair:* To be announced.

1600-1620 "The effect of high market prices on the value and valuation of vertebrate fossils"
Ms Sally Shelton, San Diego Natural History Museum, USA

1620-1640 "Museums and the mineral specimen market"
Ms Monica Price, Oxford University Museum.

1640-1700 "The evaluation of natural history collections; some remarks"
Dr Francesco Uribe, Museu de Zoologia, Barcelona, Spain.

1700-1720 "Targeting the user short term - who pays for long term storage and maintenance?"
Professor Peter Morgan, National Museum of Wales, Cardiff.

After Dinner **Ms Sally Shelton** will give a talk entitled "Murder in the Museum"

Friday 21st April

Session I: *Chair:* **Dr John Edmondson**, National Museums and Galleries on Merseyside.

0930-1010 Keynote address, "The financial value of cultural, heritage and scientific collections: an accounting fiction"
Prof. G Carnegie & Prof. P Wolnizer, Deakin University, Victoria, Australia.

1010-1030 "Insurance implications of display of collections made up of unique items with little or no commercial market interest"
Colin McBride, Willis, Faber & Dumas Ltd., (Insurance Brokers), London.

1030-1050 Paper on valuing natural history collections
S Rollo-Smith, Institute of Loss Adjusters

Session J: *Chair:* **Prof. G Carnegie**, Deakin University, Australia.

1130-1150	"Valuing, a professional's view" **R Gowland**, Director, Phillips North West, (Auction House), Chester.
1150-1210	Paper on the public accountancy view of collections **Mr Martin Evans**, Chartered Institute of Public Finance and Accountancy.
1210-1230	"Valuation and title in Law" **Prof. Norman Palmer**, University College London.
1230-1250	"The cost of collecting: collection management in UK museums" **Barry Lord, Gail Dexter Lord & John Nicks**, Lord Resources Ltd.
Session K:	*Chair:* **Mr Peter Longman**, Director, Museums and Galleries Commission.
1400-1600	Debate on the value and valuation of the natural science collections
Session L:	*Chair:* **Mr Peter Longman**, Director, Museums and Galleries Commission.
1630-1730	Agreement of the "Manchester Principles"

Poster Papers

"The cost of natural science specimen conservation versus value of collections"

K J Andrew, Geological Conservator and Collection Care Consultant, Worcestershire.

"The Natural History Museum of the University of Lisbon"

J M Brandao, Museu Nacional de Historia Natural, Lisbon.

"The Culture Collection of Algae and Protozoa - A living resource"

Dr J G Day, Institute of Freshwater Ecology, Windemere.

"Financial value of natural science collections of the Museu de Ciencias Naturais, Fundacao Zoobotanica do Rio Grande do Sul, Brasil.

Dr M H M Galileo, V L M Callegaro & V L I Pittoni, Museu de Ciencias Naturais, Porto Alegre RS, Brasil.

"The Malacological Collections of the Royal Belgian Institute of Natural Sciences"

Dr J L van Goethem & T Backeljau, Inst. Royal des Sci. Nat. de Belgique, Bruxelles.

"*Strombus listeri* Gray, 1852 (Mollusca; Gastropoda); morals to be learnt from damage to one of the oldest known documented museum specimens - a retrospective valuation"

E G Hancock, Glasgow Museums.

"Collections as biogeographical archives"

Paul Harding, Institute of Terrestial Ecology, Monks Wood.

"The collections of the National Museum of Natural History in the Scientific Institute, and environmental research in Morocco"

Dr O Himmi, Scientific Institute, Rabat-Agdal, Morocco.

"The Historical Collections of the Botanical Museum of Florence and their scientific value"

Dr C Nepi, Botanical Museum, Florence.

"The Educational Value of Natural History Collections"

Ms S D Tunnicliffe, School of Education, Kings College, London.

"Practical examples of the Appraisal and Valuation of Natural History Collections"

John A Woods, Appraisers, Connecticut, USA.

Registration fees:

Full delegate £125.00. Members of GCG/BCG/Linn.Soc./Syst.Ass./ unemployed/full-time students £90.00. Accompanying person £20.00.

Deadline for registrations from Members of Sponsoring Societies - 31st March 1995

What this includes:

Attendance at all sessions (except for accompanying persons)

Morning coffee, lunch & afternoon tea, 19th-21st April

Attendance at evening receptions

Organising Committee

Charles Pettitt (Manchester Museum) (Chairman)
John Nudds (Manchester Museum)
Mike Hounsome (Manchester Museum)
Sean Edwards (Manchester Museum)
Ken Joycey (University of Cambridge)
Ian Wallace (National Museums on Merseyside)
Philip Doughty (Ulster Museum)
Steve Garland (Bolton Museum)
Colin Reid (Dudley Museum)

Supporters

Association of Systematics Collections
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Federation for Nat. Sciences Collections Research
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Glasgow Museum and Art Gallery
Higher Education Funding Council for England
Institute of Biology
Institute Scientifique, Rabat Morocco
International Council of Museums
Irish Museums Association
Linnean Society of London
Midlands Federation of Museums
Musie Zoologique, Lausanne
Museo Geominero-ITGE, Madrid
Museu de Zoologia, Barcelona
Museums and Galleries Commission
Muzeul de Istoria Naturale, Romania
National Audit Office
National Museum of Ireland
National Museum of Wales
National Museums of Scotland
National Museums and Galleries on Merseyside
National Museum, Prague

Natural Environment Research Council
Natural History Museum, London
Naturhistorisches Museum, Basel
Naturhistoriska Museet, Goteborg
North of England Museums Service
North West Collections Research Unit
North West Museums Service
Northern Ireland Museums Council
Palaeontological Association
Rijksherbarium, Leiden
Scottish Museums Federation
Scottish Natural Heritage
South Eastern Museums Service
Strecker Museum, Baylor Univ.,Texas
Swedish Museums Association
Tyne and Wear Museums
UK Institute for Conservation (Natural History)
UK Museums Association
Ulster Museum
Victoria University Geology Department
West Midlands Area Museums Service
Western Australian Museum
Yorkshire and Humberside Museums Council
Zoologisch Museum, Amsterdam

******36 speakers from 16 countries******

THE SPONSORS OF THE CONFERENCE.

The Manchester Museum, The Biology Curators' Group, The Geological Curators' Group, The Linnean Society of London, The Systematics Association, & The Group for Directors in Museums and Art Galleries.

The Manchester Museum

The collections and buildings of the Manchester Museum have a fascinating history. Their beginnings may be traced back to the foundation of the Manchester Society of Natural History in 1821 and some of our present collections were brought to the Museum in these early years. In 1835 an attractive classical style museum building (now demolished) was built in the centre of Manchester, and the collections of the Manchester Geological and Mining Society were added to those of the Museum in 1850.

In 1867 the Governors of Owen's College (now the University of Manchester) undertook the administration of the museum. Shortly after Owen's College moved to its present site, a new museum building, designed by the architect Alfred Waterhouse, was built in 1888. Extensions were added in 1912 and 1927, again designed by the Waterhouse family, and presenting a homogeneous and distinguished elevation to Oxford Road. In 1977 the adjoining building (previously the Dental School) was taken over, and the Museum also has space in another University building nearby.

In addition to natural history the Museum has outstanding collections of Archaeology, Egyptology, Ethnology, and Nusmatics, and also houses the Ingo Simon Archery Collection.

The Herbarium is one of the largest in the UK, and contains material from the voyages of the *Beagle*, from Linneaus, and from Admiral Franklin's expeditions in search of the North West Passage. The major collections came from Charles Bailey and Cosmo Melvill; Leo Grindon and Spruce are other well-known botanists whose collections rest here.

The Entomology department holds worldwide collections of nearly three million insects, the third largest and most comprehensive in the UK. The British collections (one and a quarter million specimens) are particularly comprehensive, with only a small percentage of known British species unrepresented.

Many of the extensive Geology collections were made in the second half of the 19th century. There are some ten thousand mineral specimens, a significant petrological collection, and several hundred thousand fossils, with many type, figured and cited specimens.

In Zoology the main strengths are the bird collections, notably the Dresser collection, and the Mollusca, which includes the collections of Darbishire, Haddon, Townsend, and Hadfield among many others. Other groups represented by important collections include the Bryozoa (Waters collection) and Foraminifera (Halkyard collection).

The Biology Curators' Group

The Group was founded 21 years ago, with the aim of improving the standing of biologyy curation. It holds Seminars and Conferences (such as the present one on Value and Valuation of Natural Science Collections), were various topics of interest to biology curators are discussed. Recently workshops have been held, to help curators develop their skills in various aspects of their work.

The Group publishes the *Biology Curator* (formerly the *Journal of Biological Curation)* three times a year.

Further details about the Group are available from the BCG Membership Secretary, Ms Kathy Way, The Natural History Museum, Cromwell Road, South Kensington, SW7 5BD

The Geological Curators' Group

The *Geological Curators' Group* was founded in 1974 to improve the status of geology in museums and the standard of geological curation in general by:

holding meetings and seminars
the surveillance of geological collections
documenting and conserving geological sites
conducting surveys appropriate to these aims.

The *Geological Curators' Group* supports the work of those responsible for the hands-on care of collections, and seeks to advance their training and proficiency. We aim to set standards for curation and encourage their proper implementation. We alert the authorities at all levels to their responsiblities to collections and curators as well as to the science of geology itself. We actively seek to publicise and popularise the science and encourage only responsible and useful collection.

The *Geological Curator* is the the Group's journal. It contains articles concerning all areas of interest for Group Members; historical articles, techniques of conservation, preparation and display, reports of meetings, as well as reviews and news. The *Lost and Found* column is an invaluable aid for the exchange of information on collections.

Coprolite is the newsletter of the Group and complements the *Geological Curator.* Published three times a year, it contains up-to-date news of meetings, people, exhibitions and events.

Membership of the *Geological Curators' Group* is open to anyone interested in geology, and will be of particular interest to individuals or organisations responsible for the care of geological collections, the interpretation of geological specimens or sites, as well as historians of geology.

For further details please contact the GCG Secretary
c/o Geological Society of London
Burlington House
Piccadilly, London W2V 0JU

The Group for Directors in Museums

The Systematics Association

The Systematics Association was founded in 1937 as the "Committee on Systematics in Relation to General Biology and Evolution" to provide a forum for discussion of the general, theoretical and practical problems of taxonomy. Its first publication, *The New Systematics (1940)*, edited by Sir Julian Huxley, has since become a classic.

Since then, the Association has pioneered discussions on many new developments in biosystematics. The Special Volume series, developed from symposia organised by the Association, have been among the first in their respective fields to assess the implications of advances in the subject. Several symposia are organized each year by members of the Association. Topics covered have included chemotaxonomy, scanning electron microscopy, data processing, biological identification with computers, molecular biology, and the biosystematics and evolution of particular groups. *For further information contact:* Z. Lawrence, International Mycological Institute, Bakeham Lane, Egham, Surrey TW20 9TY, UK.

ABSTRACTS OF PROPOSED ORAL PRESENTATIONS.

SLAYING THE SACRED COW.

W.J. Baird, Geology Department, Royal Museum of Scotland, Chambers Street, Edinburgh EH1 1JF

The proposal for this Conference posed a question:- *"It is often said that natural science collections are under valued (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 true when applied to science based collections and that we have only ourselves to blame. I believe that if we wish to be treated on the same footing as the humanities based collections we must become more rigorous in our collection policies and disciplines.

Collecting and storing objects is taken to extremes by humans and has been described as "the passionate pastime". With very few exceptions no collector wishes to be known as a collector of anything and everything. I know of few who through choice collect just anything and everything - broken, complete, incomplete, labelled, unlabelled. Such collections, stored in indifferent conditions, outdoors and indoors, un-catalogued and uncared for, do exist; they are known as junk shops. It is my opinion, and mainly for historical reasons, that in some areas of their collections certain National Museums are on their way to becoming little more than junk shops.

Most curators are by their very nature acquisitive collectors and by the limitations set upon us by lack of staff and storage space we are fast becoming simply hoarders of unclassified accumulations of objects. We continually add to our collections but we are not in the main upgrading these collections, leading to inadequate storage, inaccessible and badly curated material and conservation facilities become severely overstretched. I have so far not even raised the matter of what it costs to store and conserve specimens, but specimen housing is costly and has to be considered.

We have to be prepared to deaccession, within the framework of individual institutions' collections policies, material that has little or no scientific value. I believe there is no major collection which would not benefit from careful, considered pruning as part of a national policy of upgrading and rationalisation. The benefits of such a process would be considerable; savings in valuable storage space, improved curator moral, lower market prices for the standard level of museum objects [the price of the very top of the range acquisitions I would expect to remain high], better classified, conserved and more accessible collections. By using modern information storage facilities it is still possible to keep a lot of information about items even if they are not physically retained in an institution.

It is time the museum world came to its senses and put its house in order, decided sensible collecting policies and kept to them, put forward some accession ideals for the future and meant them. Perhaps under those circumstances governments could be encouraged to give us the increased funding and staff we will require in the short term to sort out the mess we have got ourselves into.

CALCULATING THE REAL VALUE OF SYSTEMATIC BIOLOGY COLLECTIONS

Professor Stephen Blackmore, Ms Nicola Donlon and Ms Emma Watson, UK Systematics Forum, The Natural History Museum, Cromwell Road, London, SW7 5BD.

It is often suggested that systematic biology is a "cheap" science in comparison with astronomy or particle physics, both of which require enormous capital investment. In systematic biology the experimental instrument is the collection. The UK's systematic biology collections have been assembled through centuries of effort and their real value is rarely appreciated. Not only do they contain the specimens brought back from expeditions that were, in their time, as complex as the Apollo moon missions but they have subsequently required a huge investment in curation and research.

The enormous scientific and cultural value of these collections have been emphasised by many contributors to this symposium. We will attempt to illustrate the real value of a major systematic biology collection by considering the example of the Natural History Museum in London.

THE FINANCIAL VALUE OF CULTURAL AND HERITAGE COLLECTIONS

Professor G.D. Carnegie, Head, School of Accounting and Finance, Deakin University, Geelong, Australia 3217 and Professor P.W. Wolnizer, Dean, Faculty of Management, Deakin University, Geelong, Victoria, Australia 3217.

While the cultural and scientific values of museum and like collections are widely appreciated, the propriety of assigning monetary values to collection items for financial reporting purposes merits critical examination. That is the object of this paper.

Some government and accounting policy makers in the English-speaking world have found the notion of valuing museum and other cultural and heritage collections for financial reporting purposes to be appealing. However, our study provides evidence that the capitalization of collections as assets is not mandated in the USA, UK, Canada and Europe; and that collections are not commonly recognised as assets in the financial statements of major arts institutions. Nevertheless, accounting standard setting bodies in Australia and New Zealand now require capitalization of cultural and heritage collections and H.M. Treasury in the UK has recently foreshadowed a similar requirement.

We argue that museum and other cultural and heritage collections cannot properly be described as financial assets. Upon examination of the nature of the repositories of such collections, and the statutes that govern the operations of public arts institutions in Victoria, Australia, we demonstrate that those collections do not satisfy the criteria for recognition as an asset as specified by the standard setting bodies.

To represent the cultural and scientific values of museum and like collections in financial terms for inclusion in balance sheets would be an "intellectual vulgarism" (Adam, 1937, p.2) and an accounting fiction.

THE ETHICS OF DISPOSAL

Mr David T D Clarke, 1 Orchard Close, Combe Withey, Oxfordshire

[Abstract awaited]

THE FUNDAMENTAL RELATIONSHIP BETWEEN BIOLOGICAL COLLECTIONS AND SCIENTIFIC KNOWLEDGE

Woody Cotterill, Biodiversity Foundation for Africa, Secretariat: P.O. Box FM730, Famona, Bulawayo, Zimbabwe

Biological collections are repositories of information on the natural world, yet the relevance of this stored information to science and society is widely disregarded. This paper explores the relationships between biological collections and the scientific knowledge of the biosphere where specimens originate. Collections constitute historical references: their specimens are irreplaceable and cannot be valued in economic terms. The accuracy of existing biological knowledge ultimately depends on scientific specimens - maintaining its integrity requires the preservation of these collections. Taxonomy and systematics interpret the identities and origins of specimens, supplying and organising accountable information essential for all biological sciences. Specimens are the foci in this process. They underpin any biological investigation seeking to interpret complexities of the natural world and generate reliable knowledge. If specimens are preserved for future interpretation, scientific findings can be independently verified and results of studies compared. This central dependence of biology on collections is insufficiently appreciated within the scientific community. Solutions to the problems facing humanity and the environment requires scientific knowledge of a complex natural world: our existing knowledge is seriously inadequate. The fundamental relationship between collections and this knowledge, and thus their value, underpins their future management, utilisation and expansion.

THE SCIENTIFIC VALUE OF COLLECTIONS

The Earl of Cranbrook, Chairman, English Nature, Northminster House, Peterborough PE1 1UA

Nature conservation is one of many science-based applications of biological knowledge. English Nature (EN) is the statutory body responsible for wildlife and natural features, and adviser to government for nature conservation in England. With the Countryside Council for Wales (CCW) and Scottish Natural Heritage (SNH), EN shares wider national and international responsibilities administered through the Joint Nature Conservation Committee (JNCC).

The global action plan Agenda 21 adopted by the United Nations Conference on the Environment and Development (UNCED) at Rio de Janeiro in 1992, together with Convention on Biological Diversity, call for participating countries to establish national strategies to inventory and understand their own biodiversity and develop programmes

to conserve it for the future. The UK response was published in January, 1994.

In support of the task to define ecosystems, designate sites and categorise rare or endangered species in need of conservation, staff of English Nature (and of any other national conservation organisation) depend on systematic knowledge and reliable identifications.

A worldwide trade has placed severe pressures on some natural populations. Effective monitoring and enforcement of laws preventing illegal trade, for which EN is responsible through JNCC, depend on accurate identifications of species, many of which often look very similar.

In 1990-91, a study of systematic biology research was undertaken by the House of Lords Select Committee on Science and Technology, under the chairmanship of Lord Dainton, FRS. In its Report, the Select Committee recognised that properly curated specimens are fundamental to the conduct of accurate and useful systematic biological research and noted that practically every witness stressed the importance of collections. The House of Lords enquiry also emphasised requirements for the reliable identification of organisms in other important contexts. In all this multitude of important uses, properly curated and identified reference collections are indispensable. Paramount among these are collections of preserved material in museums or similar institutions. It is also important to note that relevant collections may also take the form of living organisms maintained in zoos, aquaria, insectaries, aviaries and botanical gardens, or specialised repositories of germplasm, frozen tissue, and type cultures of micro-organisms.

A prior requirement to managing the biosphere intelligently is to discover, describe and inventory its species. Because most species are very small, organisms are often difficult to study and the biological diversity in all parts of the world remains imperfectly known. The many ecosystems in the world certainly contain millions of species, having extraordinarily complex interactions. Nature conservation managers study the dynamics of these interactions, but because of gaps in knowledge about the identity of even some common species and their distributions, basic descriptions of how these ecosystems function are inevitably incomplete. Managers charged with conserving biodiversity in protected areas need to know the identities and geographic distribution of species so that they can design and implement effective strategies.

The collections held in United Kingdom museums are particularly important because of their international scope and, in some cases, their antiquity. In the museums of our universities and local authorities, with independent or private museums, the grand total in this country must exceed 70 million specimens. Worldwide, it has been estimated that natural history collections house over 2 billion specimens. These preserved collections of plants, animals, and other organisms provide the only permanent record of world biota.

Critical among biological specimens are the 'types' - those to which scientific names are permanently linked. These form the basis of biological nomenclature and are essential in ultimately establishing the correct usage of names. The regulatory bodies of taxonomic nomenclature have laid down special rules for the care and safe-keeping of type specimens.

Collections of specimens can provide a record of alterations in biological communities and ecosystems, and thus document responses to environmental stresses over time. These same collections, because they contain the primary scientific evidence for the existence and identification of different species, also provide the most reliable documentation of species extinction. Without documented scientific knowledge of which species exist and where they live, accurate evaluations of ecological change and species extinction are not possible. While the specimens themselves provide this database of geographical distribution, other information attached on labels or in original field collection notes can also be important. Technical innovation in biology in recent years has benefited from the variety of methods of collection and preservation, providing new means to define species and to distinguish between them. DNA recovery and reconstitution is an example of an inordinately valuable character for science, totally unanticipated by the collectors or original curators of the specimens from which it is being obtained.

The apparent decoupling of morphological and molecular evolution deduced by molecular studies on African rift-valley lake fishes is exemplified by the mean level of mtDNA sequence divergence among these species and genera being less than that within a single species of horseshoe crab or within the human species, which itself exhibits low intraspecific mtDNA differentiation compared to many vertebrates, including other fishes.

Over exploitative fisheries have seriously affected the biodiversity of the world's seas and the proper management of fisheries is a vital step in achieving environmental sustainability for the benefit of consumers as much as the wildlife. Proper identification of target species is essential for the management of fisheries.

To safeguard their value, the managers of collections must organise them so that all items are accessible at any time. They should expect constant referral to the resource in their care. The process of curation must also 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. The ideal curation technology should conserve these unknown characters: witness DNA recovery.

Botanists are therefore fortunate that the traditional procedure for preservation was by desiccation. Cryo-preservation offers an ideal, but the simple, dried herbarium specimen, without further treatment, is probably a near substitute. The modern preference for initial fixation and field storage in methanol solution may prove to be less than ideal. Any secondary treatment is probably undesirable although there is obvious temptation to use the chemical insecticides or fungicides that are now available.

The curatorial task, properly pursued, is highly professional, intellectually demanding and of itself inherently rewarding. New computer technologies provide means of handling massive databases that would have overwhelmed sytematists and curators a generation ago. Electronic knowledge bases on a global scale can ensure access for the benefit of all nations.

In effect, systematic 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. They meet the needs of applied biology, including the health sciences (parasitology, epidemiology, diagnostics), agriculture, resource management and biotechnology. They provide broad support for public and formal education

programs. Through exhibits, they promote public awareness of nature and biodiversity.

Data centres, libraries, and archives associated with systematics collections also provide an essential resource for research in systematic biology. These specialised libraries are not limited to bound books and periodicals but may also include card indices, catalogues, manuscripts, illustrations and photographs, microfiche records, cartographic information, bibliographic files and different forms of electronic media. The enormous proliferation of scientific information over the past few years can only be met by significant expansion of infrastructure, along with major advances in the storage, retrieval and utilisation of systematic databases.

Ms Nicola Donlon see *Professor Stephen Blackmore.*

COLLECTIONS ASSESSMENTS AND LONG RANGE PLANNING.

Philip Doughty, Science Division, Ulster Museum, Botanic Gardens , Belfast BT9 5AB

[Abstract awaited]

ACCOUNTING FOR MUSEUM COLLECTIONS

Martin Evans, Head of the Technical and Research Division at the Chartered Institute of Public Finance and Accountancy, 3 Roberts Street, London WC2N 6BH.

This session will consider how accountants will record and value museum collections for inclusion in an organisation's published accounts. From 1 April 1994, local authorities in Great Britain have been required to account for the fixed assets, which include museums and their collections, on a new basis, which brings their accounting practice more into line with that in the private sector. The new system of accounting for fixed assets will require local authorities to compile asset registers and to record all material assets in their balance sheets at cost or current value. In July 1994, the Government published a Green Paper 'Better Accounting for the Taxpayers Money' which will require national collections to be accounted for on a similar ('resource accounting') basis. The session will outline the new accounting requirements, their practical implications for museums, and the guidance available.

Gerald R Fitzgerald see *Peter G Whiting.*

VALUATIONS - A PROFESSIONALS' VIEW

R.G. Gowland, FRICS, Phillips North West, 43 Cunning Street, Liverpool L8 7NN

Introduction including the essential and important differences between a valuation which is a matter of opinion and a price, which is a matter of fact.

The various reasons for which instructions may be given to value an object, including insurance, whether on the world open market or locally, probate, family division, sale, other tax purposes, rent.

The factors which influence a valuation including age, rarity, condition, fashion and sub-divisions of the above, all of which are the subconscious factors that the experienced valuer considers before giving an opinion.

Comparative pricing information such as auction records, reference books and retail prices.

Outside factors above and beyond an individual purchaser or valuers control including political embargo, international exchange rates and internal Bank rates.

DEFINING AND DISPOSING OF SPARE COLLECTIONS - AN UNRESOLVED PROBLEM.

Max Hebditch, Director, Museum of London, London Wall, London EC2

Museum collecting can be characterised as "front end", representative objects selected to meet the needs of an educated visiting public; or "scientific", comprehensive sets of objects and data meeting the needs of a discipline. Art galleries, cultural history museums and technology museums are examples of the former. Natural science, archaeology and anthropology museums reflect the latter approach.

The Museum of London, dealing with the history and present state of a great metropolis, follows both approaches to collecting, particularly in relation to the archaeology of early London. Tension between the two raises a range of problems: sampling strategy, priority in the allocation of financial resources, relative scientific importance, cost of the collecting processes, definition and disposal of unwanted material.

This experience suggests that while a financial valuation of the "assets" might be an interesting exercise, it is unlikely to assist the solution of the problems, which require professional judgment and confidence.

SCIENTIFIC AND DIDACTIC VALUATION OF MOVABLE MONUMENTS OF INANIMATE NATURE IN MUSEUM'S GEOLOGICAL COLLECTIONS

Prof Krzysztof Jakubowski, Museum of the Earth, Polish Academy of Sciences, Muzeum Ziemi PAN, 00-488 Warsaw, Al.Na Skarpie 20/26, Poland.

Geological collections in museums play an especially important role for the protection of natural heritage. A considerable part of these collections is gathered because of the necessity to protect valuable finds of unique minerals, rocks, and fossils from classical sites. The fact of their inclusion in museum collections often creates the only chance for the preservation of these invaluable specimens. Many times we are forced by circumstances to transfer a monument from its site of occurrence for fear of inevitable destruction. In Polish museological traditions these kinds of museum objects are defined as so-called "mobile monuments of inanimate nature", different from "immobile monuments of inanimate nature" protected in the natural environment . Both are the subject of direct interest, which is reflected in the research and popularization carried out by natural history

museums, and by some measures taken to provide their active protection.

One of the most important criterions in valuing a museum's geological collections is its significance for the protection of the natural and cultural heritage. The opportunity, if we take it, will also have implications for a museum's collecting policy, including the acquisition and disposal of geological collections as a result of research and educational activity.

The inanimate nature monuments in the world are protected in a different manner, in accordance with the legislation of nature conservation of a given country. They are dependent upon the inherent natural conditions characterizing the particular environments whhich are also influenced by native traditions, customs and economic, cultural history of the country concerned. Some actual problems concerning inanimate nature conservation protection in Poland will be discussed.

Today, particularly important from a museological view point is the safe-guarding of mobile monuments in various kinds of protected areas and sites. Generally we shall distinguish the following main categories of mobile monuments of inanimate nature:

- collections of specimens from most valuable natural area and sites protected by law in global, regional and local scale (e.g. national parks, nature monuments, landscape parks, documentary sites). Recommendations for safe-guarding in museums of such objects is in the first List of World Heritage Geological Sites Inventory UNESCO (1990). A good basis for of estimation of museum inanimate monuments could be useful studies on the construction of unified criteria network of Sites of Special Scientific Interest (SSSI), Regional Important Geological Sites (RIGS) and other international and national initiatives (e.g. European Association for the Conservation of Geological Heritage - ProGEOL);
- collections of preserved rare or unique geological specimens (minerals, rocks, fossils as well as meteorites) from great scientifically important and classical localities long since exhausted (e.g. old mines, quarries, outcrops). Note that many valuable specimens cannot be collected today and may be only clues to the geology of these sites. It is especially important now, as man modifies the Earth with increasing vigour;
- historical collections connected with names of eminent scientists, discoverers, collectors and history of establishment of natural history cabinets, museums and other scientific centers. These collections represent the cultural and scientific heritage of natural science and science history. Lastly, we must remember - Earth Science moves on and finds new uses for the 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 museums educational activity, especially the problem of nature conservation. They are excellent material for educational exhibits. Geological specimens are especially "museable". Display collections of minerals, rocks, fossils are for visitors "the real thing", in other words "natural" nature objects, different from other natural history museum specimens of the recent living world which are only dead objects torn from its natural environment. Possibilities of stimulating the imagination through direct contact with real nature is an extremely essential factor for the popularization of both natural sciences and the fundamental problems of nature conservation as a basis for preservation of man's natural environment.

CRITERIA FOR ESTABLISHING THE SCIENTIFIC VALUE OF NATURAL SCIENCE COLLECTIONS.

Dr Andrew J. Jeram, Department of Geology, Ulster Museum, Belfast, BT9 5AB

Valuation can be a very subjective process, particularly where there is no established frame of reference or procedure for arriving at a valuation. The philosophical basis of science is one of objectivity. Therefore it should be possible to construct an objective set of criteria for establishing the relative value to science of natural history collections.

The act of collecting is not in itself a scientific exercise, but may be a component of one. Once observations have been made, the preservation of material evidence is only important to science when its loss would prohibit repeated observation of a reported phenomenon, either because the evidence is unique, or re-collection is impractical.

Taxonomy and nomenclature are fundamental to many aspects of the natural sciences. Whilst the stability of nomenclature requires the designation and preservation of type specimens, other material requires preservation when there is, or might in the future be, reasonable doubt about its identity, or observations made from it. Specimens which do not form the basis of published observations have no intrinsic scientific value. However, they may be of value to the process of science, for example as reference material to aid identifications. Potential for scientific study cannot be a criterion for assessing the scientific value of collections, although it may be an important factor in collections management or acquisitions policy.

In assessing the relative importance of natural science collections, the number of type, figured, and cited specimens may be used as a rough guide, but it is reliable only in the case of very large collections. In zoological and botanical collections, counting taxa tends to even out distortions caused by a variety of factors, for example large type series, or differences in practice between scientists. It is assumed that in the eyes of science, all species are considered of equal importance. The following formula may prove to be useful for comparisons if collection parameters are compatible;

$$n = (f - T)(T + g) + R$$

Where
- T = number of species represented by type material
- f = number of species which are figured
- g = number of genotype specimens represented
- R = number of cited and referred taxa

The formula is weighted to emphasise the importance of certain categories of material and should fairly reflect the value of material in smaller collections. It does not take into account the usefulness of comprehensive reference collections as this would be difficult to measure objectively. As computerised databases become increasingly widespread it should be possible to obtain the statistics required relatively easily. It is hoped that if sound objective criteria can be established for assessing the scientific value of collections, the case for promoting better management and

financial support for scientifically significant collections will be enhanced.

WHAT'S IMPORTANT?

Simon Knell, University of Leicester, 105 Princess Road East, Leicester, LE1 7LG.

This paper will essentially concern the fallibility of the collecting and curatorial process. It will test the basis on which decisions are made concerning the evaluation of collections; the role of connoisseurship; and the underlying assumptions of the collecting process. It will then go on to examine how value judgements concerning specimens are involved in the curatorial process - acquisition through to disposal - and how the process of collecting alters our perceptions of the material concerned.

Basically my argument is that natural science collections are too complex to evaluate effectively - they originate from a diversity of causes and then are wrapped up in a web of subjective assumptions in the hope that they will ultimately fulfil some immeasurable potential. Is it possible to make objective judgements about the value of natural science collections?

I do not intend to go into the valuation of collections - really my arguments concern the process that precedes valuation.

A DUTCH EXERCISE IN THE VALUATION OF NATURAL HISTORY COLLECTIONS

J. Krikken, National Museum of Natural History, P.O. Box 957, NL-2300 RA Leiden, The Netherlands.

A massive rescue operation for the preservation of cultural heritage in The Netherlands was initiated in 1990. This government sponsored national programme required a complete inventory of the considerable backlog in the conservation, restoration, housing, registration and documentation of collections in museums and archives of all sorts. This inventory involved a classification of all the state-owned collections and their included objects into four categories of relative importance, A through D, applicable to all cultural heritage disciplines, from the arts to archives. Top level material, e.g. type material in natural history collections, is in category A; bottom level material, unsuitable for storage or any further action other than complete disposal, comes in D. This nationally uniform approach to valuation questions was a *conditio sine qua non* for setting priorities in the allocation of funds by the government agency concerned, ie the Ministry of Welfare, Health and Cultural Affairs. The application of the A-D valuation system to natural history collections required a further refinement and more precise definition of the four categories. This was achieved by the formulation of straightforward criteria representing widely accepted indicators of biological, geological, and display values, as well as some supplementary curatorial criteria, such as ownership status. In The Netherlands the system is now widely used, not only for grant allocation, but also in planning documents, acquisition proposals and other collection management tools. In this paper the A-D categorization is described and problems encountered in its application as a tool in implementing collection management policies are discussed.

AN ATTEMPT AT VALUING THE ZOOLOGICAL REFERENCE COLLECTION OF THE DEPARTMENT OF ZOOLOGY, NATIONAL UNIVERSITY OF SINGAPORE.

Kevin K.P. Lim and Mrs C. M. Yang, Zoological Reference Collection, Department of Zoology, National University of Singapore, Kent Ridge, SINGAPORE 0511, Republic of Singapore

An attempt is made to review the scientific, cultural and monetary value of the Zoological Reference Collection of the Department of Zoology, National University of Singapore (ZRC). We feel that its overall value is essentially the same as many other established zoological collections.

The ZRC consists largely of the original zoological collection of the former Raffles Museum, presently the National Museum of Singapore. It is a repository for research collections of Southeast Asian fauna and is one of the largest and most complete in the Sundaland region. It is unique and irreplaceable because a lot of the material originates from biotopes which are lost to development. Therefore, it is valued as a "natural heritage" for the region. The specimens continue to form the basis of many scientific publications. Although mainly consulted by taxonomists and systematists, the ZRC is also used by other biologists, as well as illustrators.

The ZRC plays a significant part in Singapore's cultural history and is valued as a "national heritage". It was founded by Sir Stamford Raffles, who was also the founder of modern Singapore. Assembled sometime before 1887, it has survived the Second World War and unfavourable government policies in the 1970s. Many specimens were donated by famous personalities in Singapore's history. A small part of the collection is on display for educational purposes.

It is very difficult to assess the monetary value of the ZRC. Ways of valuing each specimen through division of the amount used to procure and maintain resulted in ridiculously high prices. The only way to come up with a "reasonable" price is through arbitrary quotation. We concur that the collection is priceless as many species are presently endangered and are quite irreplaceable in our rapidly changing world.

THE COST OF COLLECTING: COLLECTION MANAGEMENT IN UK MUSEUMS.

Barry Lord, Gail Dexter Lord and John Nicks (1989), Lord Cultural Resources Ltd, 10 Windmill Row, London SE11 5DW

Lord Cultural Resources was engaged by the Office of Arts and Libraries to conduct a national study on the cost of managing collections in British museums including systematic collections. This pioneering study combines quantitative survey data with detailed case studies of representative museums to develop a profile of the state and costs of collection development and management, and

proposes a process by which individual museums may analyze and account for such costs. This study was published in September 1989 by HMSO Books in the United Kingdom. The presentation will focus on the major findings of the study, especially those concerning natural history and systematic collections.

DEPRECIATION, APPRECIATION AND INFLATION: THE ECONOMICS OF BOTANICAL COLLECTIONS.

Dr David G. Mann, Royal Botanic Garden, Edinburgh EH3 5LR,

It is relatively easy to work out how much it costs to collect a plant specimen and maintain it in good condition and such costs should always be minimized. They equate with value only in the sense that they indicate *past* commitments and priorities; they also give some idea of what would be needed to replace lost or damaged specimens, although with the loss of biodiversity world-wide, replacement will sometimes be impossible. With more difficulty, one can estimate how much other collectors and institutions might be prepared to pay for specimens, were they to be offered for sale. This indicates value in the same way that, for paintings or sculpture, the current price of similar art works at auction can be used as a valuation for insurance purposes (or to impress visitors). The analogy with art works is in some ways appropriate for preserved plants, since each specimen is usually unique (and so, strictly speaking, cannot be replaced), unlike books or coins. Well-preserved specimens of rarely collected species, with good information about their provenance and ecology, would probably command much higher prices on the open market than poorly documented, incomplete specimens of common species - just as the few remaining Leonardo paintings have a value far in excess of what one would pay for one of the myriad landscapes painted by the pupils of Victorian drawing masters. Living specimens require separate consideration since they are potentially self-renewing and can be used for many different purposes, including commercial horticulture, screening for drugs or other plant products, etc.

However, plant specimens have an extra dimension not possessed by works of art, since they are intended principally to serve as raw material for scientific research. Some specimens (types) have a special status as 'biological standards': they define the units of biodiversity (genera, species, varieties, etc) in much the same way as the standard metre defines a particular unit of length. These aspects too could be assigned a financial value. For instance, the presence of many types at the Royal Botanic Garden, Edinburgh, will attract visiting scientists to Edinburgh and thus provide income to the city. But a number of paradoxes arise from simple attempts at valuation. Intuitively, one feels that a specimen that has been studied thoroughly and documented well by a distinguished scientist should become more valuable as a result of the work done upon it. From an economic standpoint, however, the specimen would seem to be less valuable after the study is completed than it was before, since there is less potential for further work; most valuable of all, then, would be specimens that had not been studied at all. Perversely too, a specimen would appear to lose value more slowly through slipshod work than through careful, accurate studies, since the errors would prompt new work. These assessments are clearly flawed.

Perhaps the mistake lies in trying to value the collections themselves, rather than what is done with them and what depends upon them. Plant collections are an essential basis for plant taxonomy; plant taxonomy is an essential basis for all other plant science, and this in turn supports conservation, plant breeding, genetic manipulation and other activities underlying wealth creation and improvement in the quality of life. This, surely, is the message that needs to be emphasized if the importance of natural science collections is to be appreciated by those who fund them.

INSURANCE IMPLICATIONS OF DISPLAY OF COLLECTIONS MADE UP OF UNIQUE ITEMS WITH LITTLE OR NO COMMERCIAL MARKET VALUE.

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[Abstract awaited]

THE ITALIAN ASSOCIATION OF SCIENCE MUSEUMS AND ITS GOALS IN REGARD TO SCIENTIFIC COLLECTIONS

Prof. Guido Moggi, Associazione Nazionale Musei Scientifici, c/o Museo Botanico, Via La Pira 4, 1-50121 Firenze, Italy.

The Italian Association of Science Museums (A.N.M.S. = Associazione Nazionale dei Musei Scientifici) was created in 1972 with the aim to re-evaluate national scientific culture through a knowledge of museum collections and to promote the most appropriate use thereof.

Among its goals we can mention: to protect the national wealth of science museums, promoting campaigns and programs aimed at preventing the loss and deterioration of those assets and to help update and protect them; to protect the moral, legal and economic conditions under which the institutions' activities are carried out; to maintain public interest in those institutions, strengthening their educational and cultural roles, etc.

The Association includes at present 407 members, of which 128 are "institutional" (museums) and 279 "individual". Since 1984 a periodical concerning scientific museology ("Museologia Scientifica") is published twice per year. In the first 10 volumes 368 articles have been published concerning the following topics: descriptions of museums and collections (39%); research, concepts and historical aspects (17%); methods and techniques for collection preparation, conservation and cataloguing (15%); teaching, exhibitions, legal matters, etc. (29%).

21 symposia and 9 national congresses have been organized during the last 22 years.

FROM GRAVE TO CRADLE, THE CHANGING FORTUNES OF THE GIANT IRISH DEER.

Nigel Monaghan, Geological Section, National Museum of Ireland, 7-9 Merrion Row, Dublin 2, Republic of Ireland.

Giant deer were known from Ireland long before scientists publicised 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 led to 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.

Novelty value as the owners of the largest antlers known from the fossil record led to their initial worth as trophies. They were given as gifts of importance as is documented from that of the Irish Chancellor to his English counterpart during the reign of Queen Elizabeth I.

Value as trophies increased with the international growth of museums in the 19th century. The theory of evolution also cast the spotlight on these animals as they were used to support arguments on either side of the debate.

These changing attitudes over the centuries have merely changed the reasons why people sought specimens of these fossils. Regardless of why they were sought there has always been a market for full racks of antlers. The availability to the commercial market has changed drastically over the last two centuries and complete antler sets or skeletons are now quite rarely 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 scientific value of these animals has also undergone a recent increase due to several independent research projects. These have investigated giant deer extinction, antler design and function, diet, locomotion and taxonomy. New heritage legislation will provide protection for such fossils under law in the Republic of Ireland.

THE EDUCATION AND ETHICAL ROLE OF THE NATIONAL MUSEUM OF NATURAL HISTORY IN THE SCIENTIFIC INSTITUTE.

Professor Mohamed Mouna, Scientific Institute, P.B. 703, Rabat-Agdal, Morocco.

The National Museum of Natural History was created in 1920. Its collections which refer to the branches of natural science branches have been continually completed, safely housed, preserved and kept accessible.

The exhibited part of these collections presents an educational and ethical approach towards the increasing understanding of nature and resolving environmental issues, besides illustrating natural science courses for pupils and students.

Thus we receive public, pupils, students and some educational institutions' staff in the Museum. During these assisted educational visits we present the fauna's role in its ecosystems and the necessity to preserve it. For the same goal, more than ten educational programmes on television and radio broadcasting were produced as well as some published articles.

The collections constitute a data bank and an inestimable scientific heritage preserved for future generation's education because the fauna is threatened in its environment.

ARCHIVES OF NATURE IN NATURAL HISTORY COLLECTIONS.

Dumitru Murariu, "Grigore Antipa" Museum of Natural History, 505 Kisselef No.1, Secturol 1, 79744 Bucharest 2, Roumania.

All institutions which possess collections of natural history have a special educational and scientific importance. Due to these collections a series of natural phenomena are explained and, afterwards, understood. Among them, the evolutionary process is the most obvious.

According to any kind of synthesis, no matter how general it is, on the collections of natural history those preserved in the developed countries are the richest. Within the areas with a rich biodiversity, such collections are recent or they are still to be organized. Taking into consideration the strong bond between the development degree of the economy and the information on the collections of natural history, developing countries have to make a financial effort in order to enrich them. In this respect specialists for preserving, keeping and estimating them from an educational and scientific point of view are very necessary.

The specimens of such collections give important information on soil, water and air chemistry and on pollution degree at one time. They are real documents of nature concerning the valuable characteristics of the flora and fauna to which they belonged. There are cases when such specimens remain the only proofs of some extinct species. Other specimens are representatives of type categories and others are used as examples in demonstrating the necessity of environmental protection in order to inform on rare or threatened species. The main principles of plants and animals, known by popular medicine and homeopathy, were discovered by the help of such "documents" from the archives of nature, the collections of natural history.

The enriching, preserving, keeping and researching of these collections give a special responsibility to the specialists which are implied in their management and governmental resolutions of financial support.

VALUATION AND TITLE IN LAW.

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[Abstract awaited]

THE CULTURAL IMPACT OF NATURAL SCIENCE COLLECTIONS.

Charles Pettitt, Manchester Museum, The University of Manchester, Manchester, M13 9PL

Natural science collections have many and varied impacts upon different aspects of the culture of society. Too

often people fail to understand this important role of such collections, so that while a government grant of a million pounds to purchase a famous painting may be seen as a public benefit, the use of ten thousand pounds to conserve and document a major natural science collection is likely to be regarded as a drain on the public purse.

This paper will seek to demonstrate the great value society should place upon research collections by presenting evidence of the wide-ranging ways in which these irreplaceable storehouses of information are used to support such aspects of the structure of society as education, law enforcement, medicine and health, commerce, agriculture and fisheries, and historical studies, as well as the way they have influenced fine and decorative art.

THE EDUCATIONAL VALUE OF UNIVERSITY NATURAL HISTORY MUSEUMS

Ms Jane Pickering, University Museum, Parkes Road, Oxford OX1 3PW

University natural history collections form some of the oldest and largest such collections in the U.K. The changes in university funding mean that central facilities such as museums are coming under increasing scrutiny. Coupled with this the traditional use of natural history collections for teaching has declined dramatically, particularly in the life sciences. Museums must emphasise their educational value which does not mean redefining past objectives in the light of the prevailing ethos but recognising their true value to the whole community.

The Government's recent White Paper on Science and Technology has said that all users of public money must consider the public understanding of science. Museums as a whole have a responsibility in this area, which is made easier by the public interest in natural history collections, but what about university collections? They provide a direct link between the public and the research scientists in the universities. Also the collections have been developed for teaching which gives them a broad coverage and global perspective. This complements the facilities in local natural history museums and means they provide a regional resource where otherwise the public would rely on the national museums.

The recognition of university museums' value to the whole community has led to recommendations that these museums should be funded directly through the DNH.

THE NATIONAL ZOOLOGICAL COLLECTION OF ZOOLOGICAL INSTITUTE, RUSSIAN ACADEMY OF SCIENCES.

Professor Roald Potapov & Professor Vadim Zaitzev, 199034, Zoological Institute, Russian Academy of Sciences, Universitetsyaya nab.1, St. Petersburg, Russia.

The Zoological Museum was established in 1832 and from this time until now it was the centre of the zoological investigations of Russian scientists not only in Russia and adjacent countries but all over the world. Due to the efforts of several generations of zoologists in the Museum numerous collections of all groups of animals were assembled, and the total amount now is nearly 15 million specimens. The collections of animals from Polar and Pacific oceans, North-West North America, Central Asia, Siberia and Eurasian Tundras are most complete and rich. Now no serious research on Palaearctic faunas can be complete without a study of this collection. The Institute (the Museum was transferred to the Institute in 1930) constantly expends serious efforts, including financial, to support the collections and to increase its value.

MUSEUMS AND THE MINERAL SPECIMEN MARKET

Ms Monica T. Price, Assistant Curator, Mineral Collections, Oxford University Museum, Parks Road, Oxford, OX1 3PW.

Mineral specimens are widely collected for their beauty and rarity and a thriving worldwide market revolves around these natural works of art. It is influenced as much by politics and economics on a national or local scale as by the chance find of a pocket of fine crystals or the break-up and sale of an old collection.

An up-to-date knowledge of the mineral market is part of the connoisseurship which enables a curator to make judicious decisions about how an existing collection is used or expanded. Mineral shows in Britain and overseas provide curators with excellent opportunities to evaluate the ever-changing specimen market and, in turn, to establish the value of the collections in their own care. Museum authorities should encourage and enable their curatorial staff to attend shows as much for professional development as for any purchasing of specimens.

PAPER GIVING A LOSS ADJUSTERS VIEW OF THE VALUATION OF COLLECTIONS.

Mr Stephen Rollo-Smith, Robins, Davies House, 1-3 Sun Street, London EC2A 2BJ

[Abstract awaited]

THE EFFECT OF HIGH MARKET PRICES ON THE VALUE AND VALUATION OF VERTEBRATE FOSSILS.

Ms Sally Y. Shelton, Collections Conservation, San Diego Natural History Museum, San Diego, California 92112, USA

In the past few years, vertebrate fossils have become highly sought-after items, and their catalogue prices have climbed. These prices and the availability of buyers at those prices have had serious adverse effects on the conservation of fossils and fossil sites worldwide. Can museum staff working with vertebrate fossils fairly assess the value of these specimens for administrators, insurers, and the public, without basing their values on runaway market prices? Does the purchase of top-price vertebrate fossils by museums encourage activities which work against the conservation of those fossils and their sites? Does a market value or an appraised monetary value make an assessment of scientific and scholarly value more difficult? Are these values

mutually exclusive? Is a high market value an open invitation to quick deaccessioning for profit? And can the costs of recovery and preparation be fairly factored in to an appraised monetary value? Ongoing legal and political activities spurred by the value of vertebrate fossils will provide some answers, and may set some precedents for natural history valuation as a whole. Examples of the effect of high market values on vertebrate fossil excavation, sales, ethics and scientific data will be discussed.

MICROBIAL GENETIC RESOURCES: THEIR USE AND ORGANIZATION.

Dr David Smith, International Mycological Institute, Bakeham Lane, Egham, Surrey TW20 9TY.

Microbial genetic resources are essentially collected to provide an organism base for future sustainable use. They are maintained to provide reference points for names, representatives of research and patent strains, organisms used in industrial production processes and organisms for screening and research. The discovery of new natural products with properties of relevance to humankind stimulates the collection, isolation and storage of organisms. There are 481 collections worldwide registered with the World Data Centre for Microorganisms but they hold only a small percentage of the microorganisms known to man. There are several organizations that support collections but there is some way to go before a coordinated policy is put in place. There is a growing awareness of this problem and the need to have a comprehensive inventory of microorganisms. The present microbial resource collections have been established on an *ad hoc* basis and currently do not appear to be capable of adequately conserving the vital world resource. In the fungi various estimations have been made of the numbers of species: 1.5 million is one suggested figure, of which 72,000 are described and yet only c. 11,500 are held in collections. There are around 1,700 new species of fungi described annually. The task is enormous; exploration of as yet unexplored environments is yielding large numbers of new species. Microorganisms can be collected without depleting natural populations and maintained in relatively small laboratories. However the task of maintaining representative collections of microorganisms cannot be left to chance. *Ex-situ* conservation of microorganisms has an essential role to play in making available this enormous resource for future use and benefit to mankind.

NOTES ON THE QUALITY AND ECONOMY OF A NATURAL HISTORY COLLECTION.

Dr Karel Sutory, Department of Botany, Moravian Museum, Preslova 1, Brno, 602 00 Czech Republic

Using the Department of Botany of the Moravian Museum in Brzno (Czech republic) as an example, possible ways to enhance the quality of the botanical collection are suggested. This could be achieved only by higher demands on newly obtained material. A new approach to old preserved material would also be advisable. The full use of computers in museums and new attitudes to museum material documentation generally would be profitable as well.

From the financial point of view the highest demands in the botanical collection are made by the wages, which amount to over 75% of all expenses.

A SCIENTIFIC/HISTORICAL/EDUCATIONAL HERITAGE FOR WHOM?: THE VALUE OF GEOLOGICAL COLLECTIONS IN A SMALL MUSEUM.

Simon Timberlake, Travelling Geology Curator, South Eastern Museums Service, Brighton Building, Dept. of Earth Sciences, Madingley Rise, Madingley Road, Cambridge CB3 0EZ.

How much do we value our heritage of natural science collections and on what basis or assumption do we collectively make this valuation? I would anticipate that there is currently plenty of discussion on the issue of their monetary value. For instance, old 'museum' specimens of fossils, reptiles in particular, are now beginning to command high prices in the auction houses. There is also the matter of their insurance and undoubtedly this will also be the concern of many of those people attending this conference. However, there is another common approach and that is that of the scientist. Indeed, such is the weight of this opinion that one is unlikely to find many willing to disagree with this rule-of-thumb yardstick of measuring a specimen's worth by its value to science. However, both of these approaches worry me.

A debate carried out between scientists, dealers and valuers alone offers little in the way of help and encouragement to those fighting to keep specimens of moderate scientific or historical importance within the context of the small local museums where they belong. The situation is even worse for those of us engaged in trying to raise enthusiasm and support for the other 99% of specimens not perceived to be of national or local importance, or of any financial worth whatsoever. Reports dismissive of the value of some of these collections, or else the plundering of these same collections for specimens 'in order to safeguard items for research', has helped contribute, as much as has ignorance and the lack of funding and specialist help on the ground, to the disintegration and present appalling demise of small museum collections. It is vitally important that we should now be seen to be sending out the right messages. In the great majority of cases all of a collection has a value.

There is no inherent reason why a TYPE specimen should be seen as any more **worthwhile** an object to be cared for than an unlocalised mammoth's tooth or ammonite which is popular amongst visitors and regularly used in a handling collection. What is absolutely essential however is that both are managed and used in the right way. The irony is that it is so often the moderate to poorer quality material which proves to be of the greatest practical value to visitors.

This paper argues for a broader based approach to this problem which would be designed to safeguard the future of natural science collections in situ within small museums.

THE EVALUATION OF NATURAL HISTORY COLLECTIONS: SOME REMARKS.

Francese Uribe, Museu de Zoologigia de Barcelona, Ap. Correus 593, 08080 Barcelona, Spain.

Dealing with the problem of evaluation does not mean that a museum has interest in selling its collections. To evaluate might mean make available a tool of diagnosis and management.

For an essentially practical point of view the current needs of evaluation are:

- insurance of collections stored in the museum and/or of loans.
- appraisal of new collections or specimens to be entered in the museum both for purchases and donations (when required by donor).
- in off-museum dealings where the technicians of the museum act as appraisers.
- the adaptation of new models of management that require the evaluation of the heritage.

These needs imply monetary value. Market references (historic or current) with which it is possible to have a guideline in the process of evaluation:

- buying and selling specimens or collections
- auctions
- traffic between collectors
- taxidermists
- hunting evaluations by professionals or by public authorities.
- ...

These references are clearly insufficient to cover the whole of natural history collections. Therefore, the value of replacement is used in these cases. However, this value is very often impossible to calculate because of the singularities of the material. Consequently, monetary evaluation can become valuable in order to avoid bad uses of the specimens. This affirmation is more clear when we consider that museums must not obtain financial profit from their collections.

Nevertheless, an evaluation of the "quality" of the collections in a museum can be more meaningful. The quality could be expressed in an absolute or relative way by means of several measures. These measures would be dimensions of the collections housed in a museum. The variables that can be more or less quantified are:

- size of collections
- number of type specimens
- amount of information attached to the specimens
- number of specimens of rare, endangered or extinct species
- rhythm of consultations of the collections by the staff of the museum and by external consultants
- methods of preservation and their diversity in each species specific series
- condition of conservation of collections
- rhythm of published works based on museum specimens
- grants or funds devoted to the study or conservation of collections
- number of collectors or donors
- ...

These measures would allow direct testing on the "health" of the collections. The measure of the quality in relative terms could be

- other museums ranking
- own history of the museum: when the museum has results of these tests in different times, we would be able to know the temporal evolution of collections
- goals established by the museum: estimation of the effectiveness of development programmes involving collections

The two latter contexts can be interesting ways to obtain static and dynamic diagnoses of collections. An evaluation according to these points of view can be useful and even necessary for planning and managing the collections.

Fortunately, biology has created methods to compare and study different inventories. These techniques could be easily adapted to the analysis of collections, so that evaluation would become a standard process.

EVALUATING THE EARTH SCIENCES COLLECTIONS AT THE ROYAL ONTARIO MUSEUM

Mrs Janet Waddington, Curatorial Assistant, Department of Invertebrate Palaeontology, Royal Ontario Museum, 100 Queen's Park, Toronto, Ontario, Canada, M5S 2C6.

In 1994 the Board of Trustees of the Royal Ontario Museum approved implementation of **ROM 2000**, a vision statement setting out the goals and priorities of the museum to the year 2000. One objective in achieving this vision is to identify, strengthen, and concentrate on excellence in the museum's collections and research activities. An evaluation of the collections was seen as the necessary first step in identifying areas of excellence.

As a pilot project, the collections of the Earth Science departments (Geology, Mineralogy, Invertebrate Palaeontology, and Vertebrate Palaeontology) were assessed, chiefly for their research value, by a committee consisting of members from each of the four departments. The study looked at coherent subsets of the collections and attempted to determine for each one: a) how significant this collection is at an international, national, or regional level; and b) how this collection might contribute to research results that would be judged by peers to be significant on an international, national or regional level.

In attempting to produce an objective assessment, the committee took into consideration the results of recent external peer reviews of departments' operations commissioned by the museum; records of external use of the collections through research loans and academic visitors; levels of recent grant support for collections-based research by ROM scientists; the record of publications citing ROM specimens; and citations of ROM collections published in external surveys.

The collections were also evaluated for their present and potential use in education, display, public programs and for the level of media interest. The Public Programs and Education division of the museum will be carrying out an independent assessment of the value of the ROM's various collections for their programs.

The process developed in the pilot project will be applied to the evaluation of other collections within the ROM. The final results of the collections evaluations will be used to help focus financial and human resources in areas of

demonstrated excellence in keeping with the vision of ROM 2000.

Ms Emma Watson see *Professor Stephen Blackmore*

A COMPARISON OF METHODOLOGIES FOR ECONOMIC VALUATION OF COLLECTIONS.

Peter G. Whiting[1] and Gerald R. Fitzgerald[2]
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It was recognised that the market value of most natural science collections does not provide a true reflection of their economic value. Exploratory research was carried out by the Canadian Museum of Nature to develop a methodology to estimate replacement costs of collection holdings. In addition, further research was initiated on developing a capitalized value of collections through the analysis of operational and capital costs, and through an analysis of benefits. The methodologies were applied to the fish collection of the Canadian Museum of Nature. The replacement cost approach required the scientists involved to look at three collecting scenarios (local, accessible by road and isolated locations) to estimate the costs and numbers of specimens collected and extrapolate this across the current collection to arrive at a replacement cost estimate. The capitalized cost approach used historical operational cost data to estimate a capitalized total collection value by treating annual costs as carrying costs of a larger investment. Replacement cost methodology produced a result of approximately $9 million, while the capitalized cost approach gave a result of approximately $14 million. The analysis of benefits did not produce useful quantitative results. None of the methodologies provide a true economic valuation of the collection, but the cost approaches do provide a base value from which collections management decisions can be made.

Professor P W Wolnitzer see *Professor G D Carnegie*

Mrs C M Yang see *Kevin K P Lim*

ABSTRACTS OF PROPOSED POSTER PRESENTATIONS.

COST OF NATURAL SCIENCE SPECIMEN CONSERVATION VERSUS VALUE OF COLLECTIONS

Ms Katherine J. Andrew, Geological Conservator and Collection Care Consultant, 59 The Common, Abberley, Worcs WR6 6AY

A natural science specimen requiring conservation, such as a small broken fossil, will take a minimum of fifteen minutes to conserve where conservation comprises photography, documentation and minimal treatment. Fifteen minutes of work is the bare minimum; most specimens take several hours, even months or years to conserve. The cost of materials, specialised equipment and laboratory facilities have also to be included in the equation. Conservation of a 15 minute specimen is unlikely to come to less than £5 at current prices.

Occasionally, the £5 figure is viewed with horror and said to be too much, but exactly how much is the specimen worth, or put another way, how much has been spent on it already?

Where is it stored at the moment? Presumably in some kind of container in some kind of cupboard, how much did these cost? Where is the specimen stored? City centre rents are high, heating and lighting and climate control are not included in rent and are on-going costs. How much time did the specimen take to document and pack? Finally, how much did the specimen cost to collect in the first place, or how much would it cost to replace if conservation were not carried out?

These calculations will be expanded and examples given. A common ammonite with good data might have cost four times as much as the cost of conservation to collect, curate and pack with on-going costs every year. The cost of conservation in these terms does not seem excessive, but is only worthwhile if the specimen is properly documented and all preventative conservation measures including proper storage are taken to prevent further damage.

Dr T. Backeljau see *Dr Jackie L. van Goethem.*

NATURAL HISTORY MUSEUM OF THE UNIVERSITY OF LISBON.

Jose M. Brandao, Museu Nacional de Historia Natural, R. da Escola Politecnica, 58 1294 Lisboa codex, Portugal.

The Natural History Museum was formally created in 1919, assembling the three museums (Mineralogical, Botanical and Zoological) which belonged to the Polytechnic School, precursor of the contemporary Faculty of Sciences.

Almost completely destroyed in March 1978 by a tremendous fire, the N.H.M. has started gradually acquiring new collections, by purchase of specimens in the national and international markets, donations and sponsoring research projects on Master's and Ph.D's Thesis.

Sixteen years after the fire, the building is not yet completely restored. There are no conditions to prepare a new permanent exhibition, involving the three branches of Natural History. So, the most significant parts of the collections are available only for researchers and only a small part of the different items have been displayed in several temporary exhibitions.

Vera Lucia M. Callegaro see *Dr Maria Helena M. Galileo*

COSTING AND TARGETING COLLECTION CARE IN NORTH WEST ENGLAND - THE NORTH WEST (OF ENGLAND) COLLECTIONS RESEARCH UNIT (NWCRU) SURVEY 1990-1993.

Dr Gary Cleland1, Velson Horie[2] and Dr Ian Wallace[1]
[1]National Museums and Galleries on Merseyside, Liverpool, L3 8EN; 2 Manchester Museum, Manchester M13 9PL, UK

The cost of physical care and documentation is a value to be attached to natural history collections. The North West Collections Research Unit (NWCRU) survey set about

locating, and then assessing, all institutionally held collections in the geographical region of North West England. It transpired there are 8.7 million specimens held in 60 institutions. Participants, all working curators, divided the region between them, and using specially designed forms recorded the number of specimens found and their discipline. The surveyors looked at the quality of store-rooms and of individual cabinets, at the computer documentation, and at the percentage of specimens with data together with the precision of that data.

21 different surveyors using these forms over a prolonged period resulted in some standardisation problems, notably where qualitative judgements such as label assessment were concerned. However, the results from this low direct-cost approach, as opposed to the higher cost of employing one paid surveyor, seem satisfactory because it was possible to devise statistical methods to analyse the information gathered to give results that the institutions involved generally agreed were about correct.

Money, being limited, must be targeted by ranking collections on their potential usefulness. Display and educational potential are very difficult to assess, eg. a non-data specimen of little value to a large museum may have considerable value in a small museum educational operation.

Scientific potential can be assessed by the statistical treatment of information about overall quality of label information or rarity of the specimen in museum collections.

The methodologies can be improved and ranking measures in particular require further testing, but the NWCRU survey suggests strongly that it is feasible to arrive at defensible figures for costing collection care for large geographical areas and to rank collections to prioritise resource allocations.

The NWCRU survey is obtainable from the North West Museums Service, Griffin Lodge, Blackburn BB1 7AJ, UK.

THE CULTURE COLLECTION OF ALGAE AND PROTOZOA - A LIVING RESOURCE.

Dr J.G. Day

[See full paper below]

FINANCIAL VALUE OF NATURAL SCIENCE COLLECTIONS OF MUSEU DE CIENCIAS NATURAIS, FUNDACAO ZOOBOTANICA DO RIO GRANDE DO SUL, BRASIL.

Dr Maria Helena M. Galileo, Vera Lucia M. Callegaro, Vera Lucia I. Pittoni, Museu de Ciencias Naturais, Fundacao Zoobotanica do Rio Grande do Sul, Caixa Postal 1188, CEP 90001-970 Porto Alegre RS, Brasil.

The "Museu de Ciencias Naturais (MCN), Fundacao Zoobotanico", Porto Alegre, is the Rio Grande do Sul State Natural History Museum. Regional and national botanical and zoological surveys have been carried out by the Museum staff ever since its foundation in 1955. The research for the knowledge of biodiversity and the exchange activities provide a continued expansion of its scientific collections. Other activities carried out by the staff include editing of the scientific periodical *Iheringia*, promotions and organisation of public expositions, and consulting services in the fields of planning and monitoring the management of protected areas.

The classical financial undervaluation of the scientific collections caused a serious imbalance between the gains and profits figures (here including the patrimonial gains) in the Annual Financial Report of the Museum, and this seriously compromised the approval of next year's proposed budget. The staff were thus forced to provide an up-to-date financial value for the Museum Collections. The criteria for this monetary valuation is based on the cost of acquisitions, amount of types, geographical coverage, species diversity, and prices available in laboratory collections catalogues. The 303,456 catalogue entries in the MCN scientific collections are presently evaluated to a total of US$ 8,663,882. However, this amount doesn't correspond to its scientific value.

HISTORY AND VALUE OF THE MALACOLOGICAL COLLECTIONS OF THE ROYAL BELGIAN INSTITUTE OF NATURAL SCIENCES.

Dr Jackie L. Van Goethem & Dr T. Backeljau, Royal Belgian Institute of Natural Sciences, Vautierstraat 29, B-1040 Brussels, Belgium.

Shortly after the foundation of the Institute in 1846, mollusc specimens and collections were inventorized. Much of this material already existed for decades in private hands. The oldest specimens so far traced date from 1789. The general mollusc collection grew rapidly and still grows, as a result of gifts, explorations, purchase and exchange. Wet material dates from the beginning of the 20th century. Important acquisitions resulted from expeditions e.g. MERCATOR (1935-1938), Hydrobiological Exploration of Lake Tanganyika (1946-1947), MBIZI (1948-1949), Explorations of the National Parcs of Zaire (1933-1957) and more recently from expeditions in Papua New Guinea (1976-1994). The estimated total number of records of the world wide collection exceeds 300,000. Over the last decade the mean annual growth varied in the order of 1-2%.

Belgian material is kept separately. The oldest samples date from the beginning of the 19th century. An important marine collection resulted from the explorations of the North Sea by G. GILSON (1898-1925). Regarding non-marine molluscs, in the 1930's and 40's and again in the 70's and 80's huge numbers of live specimens were sampled throughout the Belgian territory. At present 53,000 records of Belgian non-marine molluscs are computerized.

In June 1935, the Institute purchased the Ph. Dautzenberg collection. It contains 32,000 recent and 7,000 fossil mollusc species and more than 6,000 named varieties and subspecies. This collection is of utmost importance not only because of its size, but also because it contains a very high number of voucher specimens including types of nearly 1,900 taxa named by Ph. Dautzenberg himself. The total number of records is in the order of 400,000. Together with this collection, an invaluable malacological library with 7,957 titles was acquired.

The total number of mollusc specimens in the R.B.I.N.S. collection exceeds 9 million, arranged in more than 700,000 samples. A reference collection of this size is an excellent tool for developing malacological research. A review of users of the collection is given.

STROMBUS LISTERI GRAY, 1852 (MOLLUSCA; GASTROPODA); MORALS TO BE LEARNT FROM DAMAGE TO ONE OF THE OLDEST KNOWN DOCUMENTED SPECIMENS - A RETROSPECTIVE VALUATION.

E. Geoffery Hancock

[See full paper below].

COLLECTIONS AS BIOGEOGRAPHICAL ARCHIVES.

Paul Harding, Institute of Terrestrial Ecology, Monks Wood, Abbots Ripton, Huntingdon, PE12 2LS

[Abstract awaited]

THE COLLECTIONS OF THE NATIONAL MUSEUM OF NATURAL HISTORY IN THE SCIENTIFIC INSTITUTE AND THE ENVIRONMENTAL RESEARCH IN MOROCCO

Dr Oumnia Himmi, Scientific Institute, P.B. 703, Rabat-Agdal (Morocco)

The National Museum of Natural History has developed since 1920 a unique and irreplaceable collection of specimen lots in Botany, Zoology and Geology. These have been safely housed, safeguarded, documented and kept accessible.

These collections are an integral part of Morocco's natural heritage and will be preserved in trust for research and posterity. Hence the scientific staff is pursuing a variety of research subjects, encompassing a wide range of disciplines in the natural sciences.

Because of its richness, diversity and its natural types, our collections respond to all scientific demands both nationally and internationally. Cooperation is established with many universities in Morocco. Its purpose is to use collections and to share research knowledge for the resolution of environmental issues to enhance their productivity. Colleagues from abroad visit our collections or request information also.

The aim of the National Museum of Natural History is to provide creative scientific and economically viable solutions to environmental problems. The museum's data bank of treasures will be available to future generations.

Velson Horie see *Dr Gary Cleland*

THE HISTORICAL COLLECTIONS OF THE BOTANICAL MUSEUM OF FLORENCE AND THEIR SCIENTIFIC VALUE.

Chiara Nepi, Botanical Museum, Via La Pira 4, 50121 Florence, Italy.

One of the chief tools for the improvement in systematic information about plants continues to lie with the herbarium whose origin, as a *"hortus siccus"*, dates from the beginning of the sixteenth century.

Apart from the importance of all these more or less recent collections of dried plant specimens for floristic, phytogeographic and more strictly systematic studies, many pre-eighteenth century herbaria, as well as those that are the result of the first expeditions to some regions (or even continents) hold particular importance either from a historical point of view or for scientific reasons, where they contain "type" material.

The Botanical Museum of Florence has, as well as the Herbarium Centrale Italicum (about 3.6 million specimens), numerous important historical collections. Of these, three herbaria can serve to illustrate in different ways the value of older collections.

The first is the Herbarium of Andrea Cesalpino (dated 1563). It is one of the most ancient herbaria in the world and, undoubtedly, the first to be organized according to a systematic principle.

The second is the Herbarium of Pier Antonio Micheli (1679-1737), comprising about 19,000 specimens (including those of Micheli and some of his pupil, G. Targioni Tozzetti), which is an important pre-Linnaean herbarium containing a large number of types. Linnaeus himself used Micheli's illustrations and descriptions extensively, and other botanists of eighteenth and nineteenth centuries referred to the specimens of this herbarium in the description of new species.

The third is the Herbarium of Philip Barker Webb (1793-1854), containing about 300,000 specimens and including, besides Webb's own important collections (from the Canaries, Madeira, etc.), numerous other collections such as those of Desfontaines (from Northern Africa), Labillardiere (from Australia, Syria, etc.), Ruiz and Pavon (from Peru, Chile, etc.) and Gardner (from Brazil, Ceylon), etc.

In this study the present scientific value of these historical collections is illustrated by some examples.

Vera Lucia I. Pittoni see *Dr Maria Helena M. Galileo*

THE EDUCATIONAL VALUE OF NATURAL SCIENCE COLLECTIONS

Ms Sue Dale Tunnicliffe

[See full paper below]

Dr Ian Wallace see *Dr Gary Cleland*

THE SOCIAL HISTORY VALUE OF NATURAL HISTORY COLLECTIONS.

Graham Walley, Nottingham Natural History Museum, Wollaton Hall, Wollaton Park, Nottingham NG8 2AE
and
Chair of the Federation for Natural Science Collections Research - FENSCORE.

Collections of natural history specimens and information are the work of individual people - the collectors. It is suggested that collections have much to offer in the study of the social history as well as the natural history of the area, whether that be a county, region or country.

Collections combine information about places, times, people and species. They represent actual transactions, dated moments in history as valuable as dated letters and contracts in terms of the amount of information can be related to and derived. By using examples from the Midlands of England (UK) and the FENSCORE National Database the author hopes to show how collections have a value in providing new information of a social historical as well as a scientific interest.

There are many aspects that are illustrated and that will repay further study. For example collections represent scientific and personal fashions as well as the pursuit of science. The situation of the collector collecting varies; they may be on holidays, or commuting, or even coming under enemy fire! They may result from a personal part-time hobby or a full-time burning obsession. They may involve extreme personal danger or inspire extreme envy and theft. The paper attempts to show how the study of collections can both pose and answer questions which have great social and historical interest. Why do people collect? Is collecting a sexually dimorphic characteristic?

The sources of collections are also important. The geographical origins illustrate not only the favourite haunts of individual collectors but also, on the wider scale, the extent and wealth of worldwide contacts within the old 'empires' of Europe and the UK in particular. Contacts change over time. Whilst some of these contacts have declined in recent years others have grown; for example the rapidly increasing collections from Eastern Europe and selected third world countries reflect the increase in academic contacts with these areas.

Through this type of analysis the wealth of social data that are explicitly available within collections and some of the implicit connections with the wider social context can be shown, placing natural history collecting and collections more at the centre of worldwide human endeavour.

PRACTICAL EXAMPLES OF THE APPRAISAL AND VALUATION OF NATURAL HISTORY COLLECTIONS.

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Valuation in the natural history area and presentation of the numerical results in an appraisal report depends on a number of considerations. The use of photographs is sometimes the best indicator of what an object is and what it is not.

Examples of how photographs should be taken will be shown and the errors of description without photographs will be described.

THE CULTURE COLLECTION OF ALGAE AND PROTOZOA - A LIVING RESOURCE.

Dr J.G. Day, Culture Collection of Algae and Protozoa, Institute of Freshwater Ecology, Windermere Laboratory, Far Sawrey, Ambleside, Cumbria, LA22 OLP.

Abstract

The primary remit of a protist collection, in this case micro-algae and free-living non-pathogenic protozoa, is broadly similar to that of other collections of biological material, that is to act as a depository and to make the material accessible for end-users, effectively a genebank. At the Culture Collection of Algae and Protozoa (CCAP), one of the UK microbial service collections, this involves collecting, maintaining and preserving the protists, and providing viable, authentic, documented cultures and their associated information to the scientific community.

The live cultures form the core of the collection. Their scientific value primarily lies in their current and past use in taxonomic and other research fields and the extensive literature published citing CCAP strain numbers. In terms of conservation of biodiversity, the collection arguably encompasses one of the largest degrees of biodiversity which can be found in any collection or genebank. This is particularly true for the algal collection which currently includes representatives of 50% of the algal species lodged in culture collections worldwide. They are also widely employed in teaching science at both secondary and tertiary levels of education.

The commercial value of cultures is more difficult to quantify. For those which are regularly employed commercially eg. *Selenastrum capricornutum* CCAP 278/4, which is used in ecotoxicity testing, a value could be calculated using its potential income generation from sales. Other commercially used organisms eg. those screened for novel pharmaceuticals, have the potential to generate substantial income, however the likelihood of a product being developed is low, even where pharmaceutical activities are observed. Most strains held in any major collection are probably of little direct commercial value, however, their scientific value and the costs which would be incurred in replacing the culture should it then be required demonstrates the necessity for their retention in the collection.

This paper discusses the above points in fuller detail and also focuses on the additional implications of maintaining a culture in a live or a preserved state.

Introduction.

The Culture Collection of Algae and Protozoa (CCAP) was founded by Professor Ernst Pringsheim at the Botanical Institute of the German University of Prague in the 1920's. Pringsheim and his cultures moved to England in the 1930's where the collection was enlarged and eventually taken over by E. A. George for Cambridge University. In 1970 these cultures formed the nucleus of the Culture Centre of Algae and Protozoa at Cambridge, financed by the Natural Environment Research Council (NERC). In 1986 the cultures and their associated activities were transferred to the Institute of Freshwater Ecology (IFE) Windermere laboratory (freshwater algae and all protozoa) and Dunstaffnage Marine Laboratory (DML) near Oban (marine algae). The CCAP currently maintains approximately 2000 strains of algae and protozoa at these two sites.

This paper discusses the various roles and functions of CCAP, a protist culture collection. Both primary and secondary roles of the collection and its associated scientists are detailed. The commercial, educational and scientific value of the algae and protozoa retained are also discussed. In the final section, future developments and the merits of maintaining a collection in a live or preserved state are discussed.

Primary remit of microbial culture collections.

The primary remit of all microbial culture collections is to act as a depository of strains. In the case of CCAP the range of micro-organisms is restricted to prokaryotic cyanobacteria (blue green algae), eukaryotic microalgae and free-living non-pathogenic protozoa. The collection functions as the national service collection of algae and protozoa in the UK and is linked with other service collections world-wide via the World Federation for Culture Collections (WFCC). Within Europe there is liaison between collections via the European Culture Collection Organization (ECCO) and nationally via the United Kingdom Federation for Culture Collections (UKFCC).

Most of the major protist culture collections located in Europe, North America and Japan act as service collections, performing not only the primary basic remit of being a microbial culture depository, but also providing cultures for third parties (Table 1). These collections are charged with the task of collecting or obtaining cultures from other researchers, the organisms should then be purified if possible to axenic clonal cultures, or at least in the case of the algae to unialgal cultures. For protozoa this may not be technically possible, but where achievable, clonal, axenic or monoxenic strains are preferred. Each organism should then be authenticated and a maintenance/preservation protocol developed prior to accession into the collection. The most important component of the primary remit is the maintenance/preservation of the cultures under conditions which produce maximum strain stability, prevent genetic drift, and allow the culture to remain in a viable state. The provision of viable, stable cultures and their associated information to outside bodies/researchers is the end point of this process. This involves the development of an administration which is responsible for the production of strains, their packaging and posting as well as the invoicing and other financial and regulatory considerations.

Culture collections including CCAP perform a number of additional functions and also provide a range of services, these are discussed in greater detail below.

Secondary roles of culture collections.

CCAP, as for some other collections, is associated with its host research institutes, and is as a result involved in the research programs of IFE and DML, this includes the provision of authentic cultures and also the active participation by individual scientists who are connected with culture collection. Areas of research include microbial taxonomy, physiology, and ecology, as well as research into preservation techniques and various aspects of algal biotechnology.

CCAP is also actively involved in education, previously this was largely restricted to the provision of reference cultures for research and teaching, as well as interaction with research students working on projects associated with the collection. Now, courses covering algal identification, culturing, basic physiology and preservation are held periodically. Also in the past, CCAP only produced catalogues with all other publications tending to be contributions to scientific publications. Over the past ten to fifteen years this has expanded to cover educational resource materials including booklets, practical experiment kits and videos.

The role of CCAP in biotechnology.

Most of the major collections, including CCAP, are currently required to provide services and information for industrial clients as well as their more traditional role as suppliers of cultures to the academic community. Some of these services are discussed in greater detail below.

The provision of pure/axenic well documented cultures is one of the core activities of culture collections, this is becoming increasingly important in biotechnology. The provision of axenic cultures is particularly relevant for those who intend to employ mixotrophic or heterotrophic culture systems. In addition, the isolation, purification and identification of cultures for commercial customers is occasionally undertaken by CCAP. The development of media and culture conditions are usually associated with this service.

CCAP offers a safe depository for commercially valuable cultures. This ensures that cultures are maintained at a second site, in case there is accidental loss of the master stock cultures held by the customer. This facility allows continual access of the owner to their culture, but prevents any third party obtaining it. CCAP along with a number of other algal collections is a signatory to the Budapest Treaty (1988) and is an International Depository Authority (IDA), this allows commercial concerns to deposit strains of algae for patent purposes, again there is restricted access to the cultures lodged.

A commercial usage of microalgae, which is on the verge of algal biotechnology, is their use as bioassay/ecotoxicity testing organisms, see Table 2. This usage is increasing in importance as ecotoxicity testing becomes a statutory requirement for new products. CCAP is also a major international supplier of marine algae for use as food organisms for larval shellfish, or for invertebrates which are then fed to larval fish. All the strains listed below (Table 3) are easy to maintain, of a suitable size and almost all contain significant amounts of the highly unsaturated fatty acids; EPA 20:5(n-3) [eicosapentanoic acid], or DHA 22:6(n-3) [docosahexaenoic acid]. The provision of starter cultures for aquaculture is regularly undertaken by CCAP and this could easily be expanded to provide larger volumes of axenic starter-cultures for other applications.

Contract research, including screening for pharmacological activity and studies on the biological control of algae have been undertaken. This area could easily be expanded to include; strain selection, and mutant generation to increase productivity for a commercial partner. Furthermore, the development/improvement of production processes (culture systems), down-stream processes and product development could be carried out in association with a commercial partner or customer.

Finally culture collections by their nature have a large amount of in-house expertise and this allows them access to a bank of information, which could be used to provide literature surveys and paper feasibility studies for commercial customers. Future developments in this area, including the growing interest in algal data bases will undoubtedly improve this aspect of the services which CCAP currently provides.

The value of CCAP

The value of some of the commercial and educational aspects of CCAP have been outlined in the sections above. CCAP, as in other collections of this type, can not generate

Table 1. List of major protist culture collections[1]

Acronym	*Name*	*Country*	*No. of cultures*	
			Algae	*Protozoa*
ASIB	Algensammlung am Institute fur Botanik.	Austria	1570	—
ATCC	American Type Culture Collection.	USA	108	950[2]
CALU	Collection of Algal Cultures Leningrad Univ.	USSR	600	—
CCALA	Culture Collection of Autotrophic Organisms.	Czech Rep.	498	—
CCAP	Culture Collection of Algae and Protozoa.	UK	1631	328
CCMP	Provasoli-Guillard Centre for Culture of Marine Phytoplankton	USA	1000	—
CS	CSIRO Culture Collection of Microalgae.	Australia	300	—
EATRO	Uganda Trypanosomiasis Research Organisation.	Uganda	—	550[2]
IAM	Institute of Applied Microbiology.	Japan	500	—
IPPAS	Culture Collection of Unicellular Algae.	USSR	340	—
LMS	Carolina Biological Supply Co.	USA	165	30
NEPCC	North East Pacific Culture Collection.	Canada	340	—
NIES	Microbial Culture Collection	Japan	500	6
NIVA	Culture Collection of Algae (NIVA)	Norway	260	—
PCCIP	Pasteur Culture Collection of Cyanobacterial Strains	France	200	—
SAG	Sammlung von Algenkulturen.	Germany	1400	—
SVCC	Sammlung von Conjugaten Kulturen.	Germany	400	—
UTEX	Culture Collection of Algae at the Univ. Texas. at Austin.	USA	2089	—

[1] Major collections = Collection with >200 cultures lodged.
[2] Largely parasitic/pathogenic protozoa.
(Day and Turner, 1992; Takishima *et al.*, 1989).

Table 2. CCAP strains used for routine ecotoxicity testing

Organism	*CCAP No.*	*Other reference Nos.*	
Freshwater			
Selenastrum capricornutum	CCAP 278/4	UTEX 1648	ATCC 22662
Scenedesmus subspicatus	CCAP 276/20		
Chlorella vulgaris	CCAP 211/11b	SAG 211-11b	UTEX 259
Marine			
Skeletonema costatum	CCAP 1077/3		
Skeletonema costatum	CCAP 1077/5	CCMP 1332; SKEL	
Phaeodactylum tricornutum	CCAP 1052/1A		

(Day and Turner, 1992)

Table 3. CCAP algae routine algae aquaculture

Flagellate algae		*Diatoms*	
Isochrysis sp.	CCAP 927/14	*Chaetoceros calcitrans*	CCAP 1010/5
Isochrysis galbana	CCAP 927/1	*Thalassiosira pseudonana*	CCAP 1085/3
Tetraselmis chui	CCAP 8/6	*Skeletonema costatum*	CCAP 1077/5
Tetraselmis suecica	CCAP 66/4		
Pavlova lutheri	CCAP 931/1		
**Rhodomonas* sp.	CCAP 995/2	*Now renamed as *Rhinomonas reticulata*	
**Chroomonas salina*	CCAP 978/28	var. *reticulata*	
Others			
Chlorella salina	CCAP 211/25		
Chlorella sp.	CCAP 211/46		
Chlorella sp	CCAP 211/78		
Nannochloris atomus	CCAP 251/4A		
Nannochloris atomus	CCAP 251/4B		
Nannochloropsis oculata	CCAP 849/1		
Nannochloropsis gaditana	CCAP 849/5		

(Tompkins *et al.*, in press)

Table 4. The number of species of microorganisms compared with those maintained in service culture collections

	Number of species		*Number of species in culture collections*	*Number of species in CCAP*
Group	Described	Est. total		
Algae	40,000	50,000	1,600	800
Bacteria	3,000	30,000	2,300	0
Fungi	69,000	1,500,000	11,500	0
Protozoa	nda	nda	nda	215
Viruses	5,000	130,000	2,200	0

Est. — Estimated.
nda — No data available.
Based on data compiled by Hawksworth and Mound (1991).

sufficient money to cover its costs. Current income from sales and services is >£25,000 per annum; however, this is only a fraction of the full economic costs of running the collection.

Undoubtedly, increased sales and the expected expansion of biotechnology will increase the income generated. However, these alone can not justify the expense of running CCAP. The major justification, has to be the scientific and historic value of the collection. The vast amount of scientific literature citing CCAP strain numbers make the collection effectively irreplaceable. Even to contemplate the collection, reisolation and purification of a replacement for CCAP's current holdings would probably cost 1 - 2 million pounds. In addition, increased interest in taxonomy and the need to conserve biodiversity, both *in situ* and *ex situ*, particularly post-Rio convention, provide additional political and scientific justification for CCAP. The role of conserving biodiversity is particularly relevant as CCAP currently retains 50% of the algal strains maintained in culture collections (Table 4).

Future developments

At present culture strains are primarily maintained by serial sub-culture, although approximately 30% of the algal strains and 2% of the protozoan strains are cryopreserved (stored frozen at -196°C). In order to maintain genetic stability most effectively, research is continuing to develop protocols to increase the number and diversity of cryopreserved organisms in the collection. Increasing the number of cryopreserved organisms, not only guarantees their genetic stability, it also reduces the amount of man-power required and hence costs of routine maintenance. This method has one major disadvantage, that is the loss of the ability to respond immediately to a customers request for a culture. Only small volumes of certain cultures can be successfully cryopreserved, therefore frozen material needs to be thawed, used as an inoculum, and a fresh culture generated prior to dispatch to a customer.

Other planned future developments include: increasing the number, and diversity of strains in CCAP; improving the availability of data on-line, accessible to customers; expanding the key research areas of preservation, taxonomic and biotechnological research; expanding CCAP's role in secondary and tertiary education. All of these are dependent on the future structure and stability of culture collections within the UK. The recent Office for Science and Technology review on culture collections (1994), has suggested major restructuring of the UK microbial culture collections. It is however envisaged that CCAP will form a key component of the proposed UK culture collection and will be retained in its current format. This review has still to be accepted as government policy and its acceptance will be directly linked with the results of the Governmental efficiency scrutiny on public sector research.

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STROMBUS LISTERI GRAY, 1852 (MOLLUSCA; GASTROPODA); MORALS TO BE LEARNT FROM DAMAGE TO ONE OF THE OLDEST KNOWN DOCUMENTED MUSEUM SPECIMENS - A RETROSPECTIVE VALUATION.

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Introduction

Between 31 August and 6 September 1986, the Ninth International Malacological Congress (Unitas Malacalogia) was held in Scotland. The main sessions were held in Edinburgh but one of the days included the opportunity for delegates to view an exhibition on the "History of Shell Collecting" curated by F.R. Woodward , and installed in Glasgow Museum and Art Gallery especially to coincide with the congress. This in itself included the launch of the new edition of the work by Dance (1966) Shell Collecting: an Illustrated History, retitled as A History of Shell Collecting, which took place on 3rd September, 1986. One of the items featured in the exhibition and the book, a mollusc of great interest, had met with a most unfortunate accident the day before. The story of the shell and the lessons to be learnt from this event are described below.

The specimen

The history of the shell, which has connections with the oldest public museum in Britain and is one of the oldest known documented natural history specimens, was only realised in recent years. This brief history of Strombus listeri is based on Dance (1986) and Dance & Woodward (1986). Glasgow University housed the specimen, the only one known to have come from Tradescant's 'Ark', as the result of having acquired Dr John Fothergill's (1718 -80) collections through those of Dr William Hunter (1718 - 83), whose bequest formed the basis of the Hunterian Museum in Glasgow. (Not to be confused with the Hunterian Museum founded four years later in 1811 in London at the Royal College of Surgeons of England which has at its origin in the collections of William's brother, John Hunter (1728 - 1821).)

In 1852, Thomas Gray[1] described Strombus listeri as a species new to science using the specimen from Hunter's collection. He referred to the similarity between it and an illustration in the first edition of Martin Lister's Historia Conchyliorum, a pioneer iconography of shells of the world, published between 1685 and 16922 . Gray even conjectured that it may have been the same shell because of it apparent age and physical similarity to the figure although he had no means of proving this assertion (Gray, 1852). This is not the place to give the detailed evidence confirming this, which is planned for separate publication.

The exhibition and the accident

The exhibition was designed to celebrate both the beauty and history of molluscs, mainly through shells, illustrated books and works of art. It drew principally on the collections of Glasgow Museums but a number of significant items were borrowed from other organisations, one of the most relevant being the example of Strombus listeri.

The day before the exhibtion was due to open, the last minute touches were being attended to. It was about 8.30am. Some of the cases had been finished and had the specimens and labels in position and the tops fixed or locked as appropriate. Near the entrance, in a prominent position were some free-standing pedestal-type cases with screw down perspex tops. At the entrance a title board was being suspended in its usual postion from a portable scaffolding tower when it slipped and fell. It was quite heavy and its momentum knocked over the first two cases like a pair of dominoes. The first of these contained Strombus listeri (being in pride of place) and the worst possible occurrence took place. As the case fell, the top was dislodged allowing the shell itself to fall out and be crushed by the weight of the case itself. The second case, as a result of the top being secured, contained some shells which remained almost undamaged within its confines.

The lessons are as follows:

a) operations involving the use of portable scaffolding towers or ladders should be treated in the same way as more permanent overhead work. In other words it should be completed before the objects are positioned anywhere nearby or the cases moved out of the way. Note that the use of portable scaffolding can be widespread in positioning spotlights, changing light bulbs, etc., at any time within a museum gallery (or store). Accidents involving this equipment may be quite common but do not appear to have been quantified

b) all members of the team involved with an exhibition should be present at the same time. In Glasgow Museums, joiners and electricians normally start work at 8.00am and finish at 4.00pm, whereas it is the practise of curators and conservators to work flexible hours. We have now introduced a system whereby work schedules are matched in the crucial times leading up to the completion of an exhibition of other project.

c) the use of free-standing cases with relatively narrow bases needs careful consideration. Ideally they should be screwed to the floor. In the temporary exhibition area being used for this shell display this was not possible as the floor is of marble tiles. An alternative is to weight the bottom of the case with sandbags or something similar, a precaution normally deployed to prevent visitors moving these cases by leaning on them. It is probably best to avoid that design where possible, although they can be very effective for single exhibits requiring some prominence - precisely the most valuable and vulnerable.

d) never leave the case top unlocked or unfixed if unsupervised.

Insurance and valuation

Whereas many objects in the exhibition were insured for their estimated or known market value, including books, paintings and all the other shells on loan from other musuems, Strombus listeri was not mentioned on the insurance memorandum. No agreement could be made on its value which was linked to its history alone which is essentially irreplaceable. The value of any particular object can reside in one factor or a combination of several attributes which in turn can express themselves in monetary terms. There are aesthetic qualities, that is display potential purely in terms of beauty, a culturally controlled aspect of perception. There is also rarity, a factor of significance in the Strombus listeri because until about 1960 it was known from very few examples in collections. It was then being sold from D300 to D400. Indeed, for well over a century the Hunterian Museum example was the only one known. As a result of greater awareness as well as changes in technique there is now a plentiful supply of this species and so they can be purchased for as little as D10. It is difficult to extrapolate between prices of 200 years ago and those of today, even if the relative rarity of the shells remained the same, because of change in fashion. This has not been studied in any detail, although examination of the relative prices paid for the Great Auk (Pinguinis impennis) have been analysed recently (Bourne, 1993).

Thus sociological factors are at work influencing monetary values over time. The example of Strombus listeri was also a type specimen and thus had scientific value. This status has had an effect on monetary value of natural history specimens in the past and may still do so when such specimens are offered for sale. This is thought to be an undesirable phenomenon because such specimens should be the property of the scientific community. Indeed, the current codes of practice strongly recommend the deposition of any newly created types in public institutions which instantly removes them from the whims of the commercial market. There is no doubt that the value of this particular example of a shell lies in its past. The settlement arrived at between Glasgow Museums and the Hunterian Museum was £5,000. This can be divided as follows:

a) as an example of the species	£10
b) the holotype of listeri	£100
c) history	£3,890
d) cost of restoration of damaged shell	£1000
Total	£5,000

There are several implications within this breakdown. The figures for historical value and its type status are purely nominal and are difficult if not impossible to test. Even taking into account the changes in fashion mentioned above, direct comparison with the price Fothergill, Tradescant or Hunter might have paid for it is not possible because it never appeared on the open market to our knowledge. So the figure for the value was arrived at after the event in the form of a damages payment to Glasgow University. If a figure could have been arrived at before the exhibition this would not have prevented the accident; merely protected Glasgow Museums from its loss. It is also debateable whether or not the valuation would have been the same figure. Now it provides a precedent for the historical value of a particular natural history museum object with over four hundred years of documentation.

There are some basic lessons which might be drawn from this account:

a) consider carefully the value of the object - if in any doubt consult colleagues with relevant experience or consult with specialist insurance brokers, dealers, auctioneers, etc

b) when lending or borrowing specimens insist on all discussions on valuations or other agreements and security and other relevant working practices being put in writing.

c) do not take risks - always insure

These are simplistic and it is assumed that few curators would not follow such procedures in the case of obviously valuable objects such as those made of precious metals. However, natural history items have long been undervalued both for their monetary value and curators find the intrinsic worth of such material difficult to quantify in terms of hard currency. This is changing, linked with the increasing difficulty in obtaining some specimens and a burgeoning market for certain kinds of material such as fossils (Rolfe, et al. 1988). Also, the development of Registrar sections in at least the larger museums in recent years has helped to standardise procedures and involve a number of different viewpoints in what was previously a dialogue between curators.

Repair of damage

The fragments of the shell were sent to a ceramic conservator for repair, a proportion of the shell being restored because of the crushing of the shell fragments. The purchase of a live-collected shell in an unfaded condition and without the filed lip, is useful for comparison.

Incidental discoveries made as a result of the damage.

Inside the apex of the shell was a small amount of sediment which indicated that it was not a live caught specimen. This has been analysed and the combination of planktonic and benthonic foraminifera is reported as typical of the outer shelf of low to moderate latitudes and the aspect is described as Indo-Pacific. These tangible though dubious advantages ot the accident are worth reporting and the full list of identified organisms is on file (in litt. R.W. Jones, 23 June 1987).

It is hoped that the rather painful process of setting down these details will be of interest to others. If the morals from it help to prevent similar accidents then it will have been worthwhile.

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Notes

1. Thomas Gray (1820-1910), a founder member of the Glasgow Natural History Society, was an enthusiastic conchologist and artist whose own shell collection is now in Glasgow Museum and Art Gallery. A biography and account of his collection and artistic achievements is given in Dance & Woodward (1986).
2. Martin Lister (1639-1712), eminent physician and author of numerous publications about natural history and especially about molluscs. For bibliographical details of Historia Conchyliorum, Lister's magnum opus, see Keynes (1981)

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THE EDUCATIONAL VALUE OF NATURAL HISTORY COLLECTIONS

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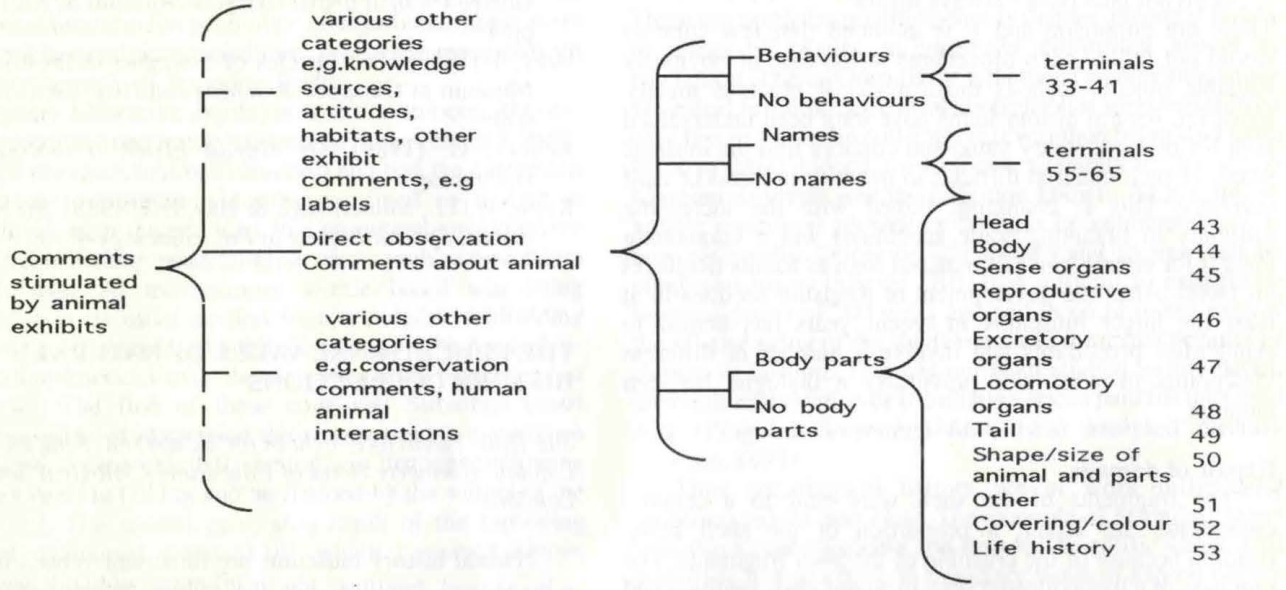
Natural history museums are important venues for both schools and families, but the public perceive museums, rather than zoos, as places of learning. Zoos are regarded as a more appropriate place to take young children (Rosenfeld, 1980; Linton & Young, 1992). In the period April 1990 - March 1991 the Natural History Museum, London, had over one and a quarter million visitors, of whom thirteen per cent were school parties (pers comm. Department of Public Services). In contrast, London Zoo had over one and two third hundred thousand visitors, of whom five per cent were school parties (Zoological Society of London, 1991). Museums, and indeed zoos, have a role in the education of school children far beyond that of zoology or, in more general terms, science (Goodhew, 1989; Goodhew, 1994; Tunnicliffe, 1992a; Tunnicliffe, 1992b), yet the primary education function of natural history museums is seen as 'stimulating interest in the natural world' (Stansfield, 1994a:2). Collections, although usually 'a poor substitute for living organisms in their natural habitat', do 'provide opportunities for close examination in a way that is seldom possible in the wild' (Stansfield 1994b: 235).

This paper focuses on the observations and related comments, focused on animal specimens, of primary school children and their accompanying adults in school and family groups. The content of the comments are indicators of the innate interest in animals of this group of visitors and also, therefore, of potential learning/teaching opportunities, that occur in the museum. Whilst the museum data are of inherent interest, they are even more relevant if compared with data for similar groups visiting London Zoo to look at live animals, and may indicate which site has the greatest present, or potential, educational value in terms of learning about taxonomic zoology, which is the fundamental element in biodiversity and conservation education.

Human beings have an inherent need to categorise objects to make senses of their world and such taxonomies render referring to the items less time consuming (Bruner, Goodnow, & Austin, 1956). Berlin (1973;1978) observed the use of a basic term of family/order level for living organisms, psychologists observed that the basic level term is in the middle of the hierarchy and furthermore, is this term that is taught first to children. (Cameron, 1994; Moore, 1973).

Fig. 1: Part of the Systemic network used in coding the conversations



Whilst it is popularly supposed that there is a definite difference in the topics attended to and learnt in a zoo, compared with those done at preserved specimens exhibited in a natural history collection, little work has been done in this area. Birney (1986) compared responses from sixth grade children (10-11 year) after a visit to either a museum or zoo visit to look at the same species exhibited in a different state. At the museum specimen, but not in the zoo, the children spontaneously observed both structural adaptations of the specimens and aspects of the habitats presented through the exhibit, without having a talk that drew their attention to these phenomena. Disconcertingly, 40% of all the purpils surveyed, both museum and zoo visitors, thought that wild animals lived in a similar type of environment to the one in which specimens were exhibited.

Whilst this paper considers the factual observations made, it must be remembered that there exists an emotional or affective side to viewing animals, (Tunnicliffe in press), and there are drawbacks to exhibiting taxidermically preserved specimens. Falk and Dierking (1992:122) discuss the fascination of a child with 'stuffed' animals, perhaps because of disappointment at their not being 'alive'. Furthermore, children interpret other animals in anthropomorphic terms (Carey, 1985). The students whom Birney studied used more affective terms in their responses about the live animals, reinforcing the popular assumption that museums are for learning and zoos are for creating an emotional bond between visitors and animals (Krakauer, 1994; Tunnicliffe in press).

The attributes of animals about which children spontaneously comment are unknown, but classroom based work shows that children cite the possession of a head and legs and particular body coverings as defining attributtes (Braund, 1991; Mintzes, 1984; Mintzes, 1989; Mintzes, Trowbridge & Arnaudin, 1991; Natadze, 1963; Ryman, 1974a; Trowbridge & Mintzes, 1985; Trowbridge & Mintzes, 1988). If this pattern represents the concept of 'animal' held by children, it is likely that similar attributes would be mentioned by children when they look at live and preserved specimens. However, the content of the conversations of primary aged children, in family or school groups at preserved animal exhibits, has not been documented. It is known, however, from work in zoos, that families categorise the animals, talk about behaviours and body parts, try to instigate interactions with them and occasionally are involved in reflective thought (Rosenfeld 1980: 60).

Thus, before any meaningful discussion of the educational value of natural history collections per se, and a comparison with live collections, could be drawn, the conent of the conversations had to be established. The results presented in this paper are part of a larger study which sought to investigate the attributes about which primary school children and their accompanying adults, on school or leisure visits, notice and comment, and the naming categories that are employed, when looking at animal specimens of various kinds, within England and the USA.

Method

I identified school parties that had booked with the museum, and which contained children of appropriate age, and met the group in the reception area of the Education Department, requesting permission from the teacher-in-charge of each group to accompany groups and record the conversations. Demographic data which included the age of the group and the name of the school was recorded. Not all the family groups were approached, but a sample selection were asked, there were no refusals, but accordingly no demographic data was collected. Conversations from families were collected mostly at the weekends whilst those of the school groups were recorded during weeks days in term time. The two locations have a wide variety of animal specimens on show, covering all the major phyla, but themost favoured locations for observations by the groups were mammals and reptiles.

The study is ethnographic in nature, and details of the

methodology used for analysis of the transcripts of conversations has been discussed in detail elsewhere (Tunnicliffe, 1994 d). Essentially, the study is descriptive, setting out to describe and explain *'what is'*, he researcher accounting for what has occurred (Cohen & Manion, 1989), and is concerned with providing descriptions of people in their contexts (Hensel, 1987). A systemic network (Bliss, Monk, & Ogborn, 1983) was devised after pilot study transcripts had been studied (Fig. 1).

Spontaneous conversations at animal exhibits were tape recorded, transcribed and coded according to the network in the following manner.

Location: Mammal Gallery Group of 6 year olds and their teacher

	22 /	40 /	56
Teacher:	The one / over there/ is a cheetah		
	56		
Boy:	Cheetah!		
	22 /	15 /	53
Boy 2:	All these animals/ are real,/ well they were,		
	3/		70
Teacher:...	and yes, some of them/ were very dangerous		
	12		
Boy:	They're not now!		

The results were entered into category columns, one for each terminal of the network, plus some additional demographic columns. The Minitab statistics package was used. Columns were amalgamated into superordinate groups that had been established from reviewing literature e.g. Rosenfeld (1980) and Hensel (1987), and were related to 'accessing the exhibit', comments about 'exhibit furniture' (Tunnicliffe 1994) and four categories for each of the main areas of observations. Hence, the body part categories were comments about the front end, head and sense organs, dimensions, size shape and coverings of the body, disrupter, parts that projected, e.g. legs, and unfamiliar parts such as exretory or reproductive organs. The behavioural categories were position in the enclosure, locomotory behaviours, food related and attention attractors such as noises or play. Naming comments were divided into those that named, or 'labelled', the naimsl with the everyday popular or common names, those that categorised the specimens, e.g. a bird, those which compared the specimens with something else, such as a human or other animals, and lastly naming comments which allocated an incorrect name or category to the specimen, categories were not mutually exclusive. Whilst the study was not specifically interested in management, e.g. 'Stop that!, 'Come on' or social comments, the category was recorded. Social comments were either an acknowledgement or use of someone's name, e.g., 'Yes!', 'Sarah!', or a comment unrelated to the exhibit with the total conversational exchange which was about it.

Results

A total of 407 conversations were collected from school groups in the Natural History Museum during 1991-92 and 184 units from families, mostly in May 1994. A small number collected in July 1992. The results of both the conversations of school groups and family groups were obtained. A two by two contingency table was used to assess the significance of the results between the groups and to establish if there were any significances in the data. An example of a contingency table is shown in Table 1 which presents the information for comments about the front end of the animal and which is part of Table 2.

A comparison between the content of the conversations of the primary school and family groups looking at preserved animals is shown in Table 2.

It is surprising that both groups discussed behaviours in approximately one third of all conversations and that more of the school conversations contain reference to the animal being 'real', or alive, than in the family groups. Almost nine tenths of conversations provide some type of naming comment. The similarity on other exhibit comments and the far higher management and social component of conversations in family groups is striking.

School groups, whilst following the same pattern of observational comments as that shown by families, are focusing on particular aspects of the animals whilst in the museum, but name and categorise less than do the families. Both groups appear to depend on their personal knowledge in interpreting the exhibits. In summary, the two groups in the museum:

- looked at similar features of the preserved animals, including potential behaviours;

but:

- schools groups commented more about the attributes, in particular all the body parts and the position of the animal in the exhibit, than did the families;
- families named animals significantly more, labelling and categorising the specimens, but made more mistakes, yet there was no difference in label reference in the conversations. This suggests that the visitors were using their own knowledge in naming and not the interpretation provided by the museum.
- schools compared animals more and discussed the authenticity and alive/dead state more;
- school groups commented about other aspects of the exhibits significantly more, but not labels;
- family groups had more conversational exchanges with management or social comments.

Thus school groups appear to be using the exhibits for discussing the location of the animals and the physical attributes of the specimens and comparing these with other forms whilst family members made comments about the animal specimens but were experiencing a social occasion which they organised through verbal social acknowledgements and management comments.

Discussion

Whilst the data suggest that school groups use the specimens for discussion more than do the family groups, the data is relatively meaningless unless it is compared with similar data obtained from the conversations of similar children in the zoo.

Such data had been collected in London Zoo in the first study in this series, and the results are shown in Table 3.

It is striking that there is such similarity in the proportion of the comments from both groups about the animals during zoo visits. In the zoo:

- the content of conversations contains more references to animals and less about accessing the exhibit;

Table 1. Example of Contingency table used in the analysis

Category	School groups n= 407	Family groups n= 184	Totals
With 'front end' comments	67	17	84
Without 'front end' comments	340	167	507
Total	407	184	591

Value = 5.42 which is significant, at 1 degree of freedom, at the 0.025 level.

Table 2: A Comparison of the number of comments made by primary school and family groups at preserved animals in the Natural History Museum London

Category of topic in conversation	Number School Groups n=407	% of all conversations	% of total of comments in next highest category	Number Family Groups n = 184	%	% of total of comments in next highest category	Chi Square	Significance
Management or social conversation	219	54	54	142	77	77	29.10	p <. 005
Exhibit access	248	63	63	108	58	58	0.26	
All Exhibit focused	407	100	100	184	100	100	N/A	
Other exhibit*	220	54	55	52	28	28	33.3	p< 0.005
Reference to labels	60	15	27	18	10	35	2.72	
Animal focused	405**	100	100	181	100	100	1.95	
All body parts*	248	61	61	80	40	44	15.63	p< 0.005
Front end	67	17	27	17	12	21	5.42	p <.025
Dimensions	198	49	74	62	43	76	11.14	p <.005
Unfamiliar	67	17	27	7	5	9	18.54	p <.005
Disrupters	39	4	16	15	8	19	0.312	
All behaviours*	152	38	37	56	30	31	2.65	
Position	69	17	45	19	10	34	4.39	p <.001
Locomotory	40	4	26	12	7	21	1.72	
Food related	28	7	18	13	7	23	0.04	
Attention attractor	63	16	42	26	14	46	0.18	
All naming comments*	344	85	73	167	91	92	4.21	p < .05
Label	297	74	86	154	84	92	8.05	p <.005
Category of animal	232	57	67	126	69	76	6.98	p <.01
Compare	166	41	48	46	25	28	13.72	p <.005
Mistake	23	6	7	22	12	13	7.61	p <.01
Real/not real	65	16	-	18	10	-	4.01	p < .05

* next highest categories;** 2 conversations were entirely about the telephones at the elephant exhibits and did not refer to the animal exhibit at all.

Table 3: A Comparison of the number of comments made by primary school and family groups at live animals viewed at London Zoo

Category of topic in conversation	Number School Groups n=459	% of all convers ations	% of total of comments in next highest category	Number Family Groups n = 143	%	% of total of comments in next highest category	Chi Square 1DF	Signifi-cance
Management or social comment	354	77	77	125	85	85	7.08	p< 0.005
Exhibit access	289	63	63	123	86	86	26.8	p< 0.005
All Exhibit focused	458	100		140	99	99	0.76	
Other exhibits*	227	60	61	62	43	44	11.21	p< 0.005
Reference to label	53	21	19	14	10	23	0.34	
Animal focused	459	100	100	143	99	99	3.07	
All body parts*	280	61	61	75	53	44	8.016	p< 0.005
front end	77	17	27	17	12	23	1.97	
dimensions	237	52	85	62	43	83	2.94	
unfamiliar	32	6	11	7	5	9	0.77	
disrupters	57	12	20	15	11	20	0.38	
All behaviours*	301	66	66	95	66	67	0.03	
position	177	24	59	49	34	65	0.85	
locomotory	130	28	42	35	25	37	0.81	
food related	54	12	18	12	8	13	1.27	
attention attractor	115	25	38	30	21	32	0.99	
All naming* comments	401	88	88	126	88	89	0.005	
Label	318	69	73	91	64	72	1.59	
Category of animal	220	48	55	57	40	45	5.8	p< 0.025
compare	87	19	22	62	43	49	34.8	p< 0.005
mistake	17	4	4	6	4	4	0.01	
real/not real	41	6	-	6	4	-	3.39	

- school groups notice other aspects of the exhibit more and comment about the label more often;
- school groups refer to body parts more, particularly the dimensions of the animals, which are often the focus of the activity or task that the children are doing;
- school groups compare the animals with other things, animals, self and inanimate e.g., 'That iguana looks like it's covered with tights!'.
- there are statistically significant differences between the two groups in comments about behaviours.

However, both groups:

- name animals in over three quarters of conversational exchanges.

Thus, both groups of zoo visitors are concerned with naming the animals to their own satisfaction but school groups do pay more attention to other aspects of the exhibit and body parts. Body parts are likely to be part of the topic of study whilst reference to the exhibit furniture is made when trying to explain the location of an animal within the exhibit.

Does the content of the school conversations vary with the location? The results are compared in Table 4.

The proportions of the topic mentioned in conversations of school groups varies. Conservations within the museum contain fewer management and social comments than those in the zoo, suggesting that the museum presents an environment more conducive to looking and discussing the specimens without additional distractions or need for control. Whilst the groups presumably notice and then discuss similar attributes, the museum groups comment on unfamiliar aspects significantly more as well as noting the authenticity of the animals.

School groups observe and then comment about a similar range of attributes, but, in the natural history collection:

- there are significantly fewer management/social comments in conversations;
- fewer 'other exhibit' comments, including significantly fewer references to labels;
- significantly more discussion about unfamiliar attributes;
- significantly less discussion about behaviours, but over

Table 4: Comparison between the number of conversations of school groups containing comments at preserved and live animals

category	Pre-served n= 407	per cent	'Live' n=459		Chi Square (1DF) value total conversation	significance	Chi Square (1DF) value of category total	significance
man/ Social	219	54	354	77	52.58	p<0.005		
Exhibit access	248	63	289	63	0.32			
Other exhibit comments	220	54	227	60	30.77	p<.005		
Reference to label	65	17	53	21	1.94		4.62	p < .05
All body parts	248	61	280	61	.0004			
Front end	67	17	77	17	0.15		0.15	
Dimensions	198	49	237	52	0.79		2.09	
Unfamiliar	67	17	72	6	19.18	p <.005	20.97	p <.005
Disrupters	39	4	57	12	1.76		1.89	
All behaviours	152	38	301	66	68.91	p <.005		
Position	69	17	177	24	49.52	p <.005	7.13	p <0.01
Locomotory	40	4	130	28	46.78	p <.005	12.26	p <.005
Food	28	7	54	12	6.00	p <.025	0.15	
Attention attractors	63	16	115	25	12.11	p <.005	94	p <.005
All naming comments	344	85	401	88	1.45			
Label	297	74	318	69	1.42		6.36	p <.025
Category	232	57	220	48	7.12	p <0.01	12.27	p <.005
Compare	166	41	87	19	49.7	p <.005	58.24	p <.005
Mistake	23	6	17	4	1.8		2.18	
Real/alive	65	16	41	6	9.94	p < .005		

Table 5: Comparison between the number of conversations of family groups containing comments at preserved and live animals

Category	Preserved n= 184	per cent	Live n=143	per cent	Chi Square (1DF) value of total	significance	Chi Square (1DF) value of category*	significance
Man/ Social	142	77	125	85	5.6	p<. 025		
Exhibit access	108	58	123	86	28.95	p< .005		
Other exhibit comments	52	28	62	43	8.07	p<. 01		
Reference to label	18	10	14	10	5.97	p < .025		
All body parts	80	40	75	53	2.59			
Front end	15	12	17	12	1.27		0.36	
Dimensions	69	43	62	43	2.49		0.37	
Unfamiliar	13	5	7	5	0.65		1.64	
Disrupters	12	8	15	11	1.67		0.67	
All behaviours	56	30	95	66	41.95	p <.005		
Position	19	10	49	34	27.99	p <.005	4.43	p <.05
Locomotory	12	7	35	25	21.07	p <.005	3.9	p <.05
Food	13	7	12	8	0.20		2.85	
Attention attractors	26	14	30	21	2.69		3.32	
All naming comments	167	91	126	88	0.001			
Label	154	84	91	64	17.2	p <.005	20.9	p <.005
Category	126	69	57	40	26.74	p <.005	27.95	p <.005
Compare	46	25	62	43	12.25	p <.005	14.7	p <.005
Mistake	22	12	6	4	6.18	p < .025	5.8	p < .025
Real/alive	18	10	6	4	3.6	3.69		

1/3rd of conversations contain such a comment. This is interesting, because the animals are static;
- the overall naming pattern of specimens is similar but significantly more animals are labelled, categorised and comapred by the visitors to the natural history collection;
- not unsurprisingly, the authenticity of the animals is discussed to a significant extent.

In a similar manner the data can be compared between the family groups in the two locations (Table 5).

The data from Table 5 shows that, compared with the zoo groups, the family groups in the museum:

- find the animal in the exhibit more easily than in the zoo, with less comment, but pass less 'other exhibit' comments, including use of the label;
- comment on the body parts in similar proportion of their conversations as do zoo visitors;
- comment about behaviours but significantly less than the zoo families;
- name and categorise the animals significantly more but:
- make more mistakes in their naming;
- compare the specimens less.

It is apparent from this study that the natural history collection of preserved animals presents an opportunity for school groups to focus on the specimens. The ambience and physical characteristics of the museum provide an environment in which the management of the group is significantly less, judged from conversational content, permitting groups to focus their attention on the animal specimens. The museum exhibits, as Birney (1986) found, are the focus of significantly more comments about other aspects of the exhibit, including labels,. The visit to a natural history collection presents an opportunity to discuss unfamiliar parts of the animals and, whilst it is not unexpected that the zoo visitors discuss behaviours to a significant extent, it is interesting that museum groups do so to the extent that has been identified.

The comparison of data suggests that museum interpretation could develop further the opportunities for conversation about the features which constitute the content of spontaneous comment, and develop further involvement of children in 'talking science' (Lemke, 1990). The data also reinforce Falk and Dierking's observation that children at preserved specimens are concerned about the authenticity of the specimens. Furthermore, it is of interest to note that the school visitors to the natural history collection both assign animals to everyday taxonomic groups and compare the specimens, often referring to the human form (Carey 1985).

The natural history collection experience for families has a particular emphasis, derived from the analysis of the content of the conversations of the groups at the exhibits. The families who visit natural history collections to view animals:
- say more management comments than do school groups;
- make significantly fewer comments about other parts of the exhibit;
- 'find' the specimens in exhibits with significantly more ease than do zoo family visitors;
- refer less to 'other exhibit' comments, including referring to labels, than the zoo families looking at live specimens;
- natural history collection visitors comment about the attributes of the animals significantly more than do the zoo visitors, except in the category of body parts where there is no significant difference;
- Families in museums comment less about behaviours than the zoo families but name and categories animals significantly more in museums, comparing them less but make more mistkaes in categorising and labelling the specimens.

In terms of educational 'value', the natural history collection offers school and families:
- the opportunity to view animals with ease. The specimens are 'framed' within the exhibit and are thus more easily observed;
- the relative ease of making observations on the exhibited specimens facilitates the learning of the criterial attributes, thus establishing a sound foundation for further learning of taxonomy and for encouraging children to 'talk science' and use the science process through their own observations.

This study shows that there is a definite and inherent pattern in the way which visitors look at animals. However, this agenda could be built on by teachers and institutions to develop a student's understanding of the animal specimens. The data from this study suggest that the preserved animal collections afford a more opportune collection for developing such education initiatives and that those that they have are more effective than those of the zoo. Furthermore, the behaviours of the school groups in the museum reflects a greater concentration on the task, looking at animals, than appears to be the case in the zoo.

Visitors already use a functional naming system, in both the natural history collection and zoo, through which they refer to the animals using basic terminology, the everyday system of society. Hence monkeys, cats, snakes, birds and fish, are the everyday terms employed. However, there is no spontaneous development of, or use of known, superordinate categories such as reptile or mammal, and whilst on a few occasions a subordinate term is used, .e.g. Blue Whale, it is relatively rare and often associated with label use. Effective interpretation, at the level of the understanding of the visitor and employing their familiar terminology, could assist in their learning the scientific terms and further relevant background information, starting at the topics about which they are interested, not the institution.

Whilst collections may be, as Stansfield said, 'poor substitutes for the natural habitat', they appear to be of prime importance in teaching children taxonomic zoology, relationships and adaptations of structures, behaviours and adaptations to habitat. Natural history collections should be regarded as the essential primary source of zoological education for both future scientists and for the public understanding of this particular science, leading into the areas of biodiversity and conservation. Museums have the distinct advantage that their specimens are clearly visible and predictable hence teaching points can be planned with certainty. Moreover, whilst both institutions provide a 'frame' for the specimens through which they are viewed, that of the natural history collection is more defined, helping the visitors to allocate and observe the specimens more easily.

The museum collection, unlike that of most zoos, provides examples of the range of biodiversity so students can learn an overview, not, as in many zoos, focus on birds and mammals or one group, such as butterfly houses or hawk sanctuaries. Whilst this study did not focus on botanical specimens, it is likely that the pattern of observations would be similar. The value of natural history collections, in terms

of education, is high, and superior to that of zoos, but the potential has not been fully exploited.

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