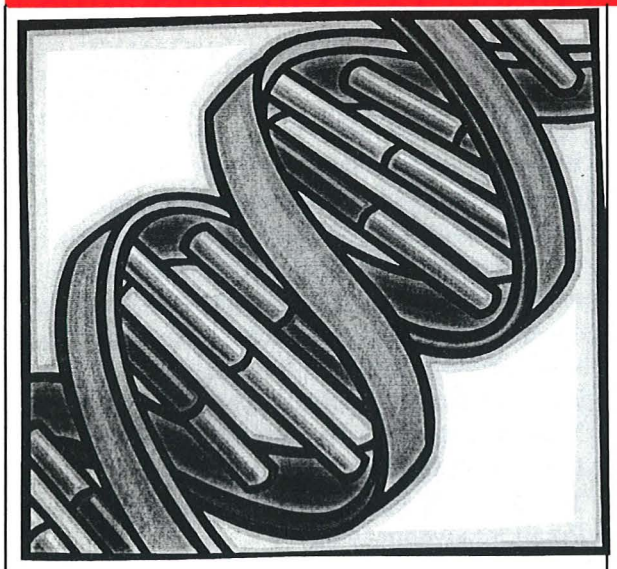
The Biology Curator

Issue 20 August 2001

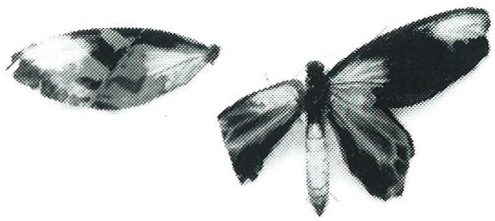


Edinburgh Meeting

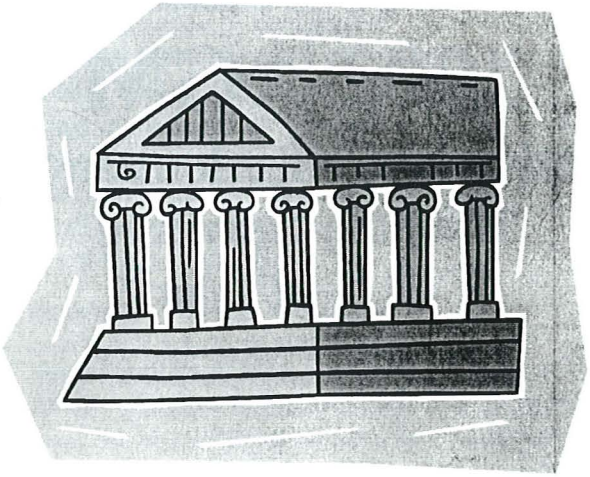
Biology Collections and DNA

Digital Learning

Biology Collections and New Technologies



Conservation of Birdwing Butterflies



Regional Museums Taskforce Response

Sheffield Museums & Galleries Trust—NH Section

BCG/NSCG Merger Discussion Paper

Diary Dates

Mammal Collections

Curation, Conservation and Uses
17th December, 2001
Grant Museum of Zoology, University College London

CALL FOR PAPERS

Due to the study trip taking place in February 2002 instead of the usual end of the year, the next training meeting has been moved to mid December. The cost will be approximately £7 but this will not include lunch due to problems organising catering.

The meeting will aim to cover curation, conservation, documentation, educational and scientific uses of mammal collections. Full details will be circulated at the beginning of November

Anyone wishing to present a paper, demonstration or poster please contact: Nick Gordon, New Walk Museum, New Walk, Leicester, LE1 7EA. Phone: 0116 2554100 Email: gordn001@leicester.gov.uk

2002 AGM

Biology Collections and Lifelong Learning Call for Papers

The subject of the 2002 AGM will be lifelong learning. Life long learning is a comparatively new phrase and one increasingly used in museums, education organisations and funding bodies literature. This conference will aim to explore what we mean by life long learning and look at the issues, theoretical aspects and practical projects relating to biology collections and the life long learning agenda. Date and venue are to be confirmed but a tentative date is 10 –11th April, possibly at Newcastle Upon Tyne.

Anyone wishing to present a paper, demonstration or poster please contact:

Nick Gordon, New Walk Museum, New Walk, Leicester, LE1 7EA
Phone: 0116 2554100
Email: gordn001@leicester.gov.uk

Insect Pests in Museums 13—14 March 2002 Natural History Museum

Insect Pests in Museums, a 2 — day course by David Piniger, of interest to all those with responsibility for natural history specimens, ethnographic collections, folk collections, textiles etc. Covering: pest monitoring and control, and pest management among other topics. Further details from:

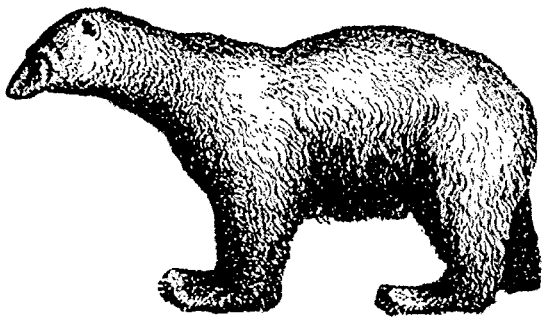
Phil Ackery, Department of Entomology, The Natural History Museum, Cromwell Road, London, SW7 5BD.
Tel: 0207 942 5612
Email: pra@nhm.ac.uk

Request for Information

Polar Bears

Calling all natural history museum departments. I'm currently doing a survey of polar bears in collections in the U.K. and require information pertaining to these animals. If you have a polar bear in your collection could you please send information about their location, age, sex, when acquired and any other data available to:

Bryndis Snaebjornsdottir, flat 2/1, 60 St. Vincent Cr. Glasgow G3 8NQ
Email: Bsnae@aol.com



A PROPOSAL TO MERGE BCG WITH NSCG

Steve Thompson (Secretary BCG)
Paul Brown (Chair NSCG)
August 2001.

At the recent AGMs of both BCG and NSCG, there was a desire expressed to look again at the idea of merging the two groups. Many people at both meetings felt that there were considerable benefits to be gained from such a move, and that any drawbacks were outweighed by these benefits. An exploratory meeting was held on Thursday, July 27th, at the Natural History Museum, which concluded that such a merger appeared to be highly desirable, and what follows summarises the points that were discussed at the meeting.

We are seeking to gain benefits in two ways. The first is to improve the efficiency with which the groups are operated and the second is to improve the effectiveness with which we achieve our aims. The principal aim of the groups is to promote the care, development and use of the collections entrusted to their members and institutions. To support that aim, we are concerned with raising awareness of both our collections and our workers, and are aware of the ongoing problems facing the Geological and Biological Museum community.

With the above in mind, we believe the principal benefits to be the following:

A single committee. We are only too well aware of how difficult it is to attract committee members who are able to offer the commitment necessary to do the job effectively. In addition, any communication problems that might exist between separate committees would be removed, and the problem of co-ordinating group activities would also be removed. The more groups that are involved, the worse this situation becomes. Good committee members are in high demand!

A single meetings programme. There are few preferred slots in the year to run meetings, and all the groups go for them. Avoiding conflicting dates should elicit greater attendance. Furthermore, it is not uncommon for meetings by two groups to be on similar themes, which duplicates effort. Poor communication would cease to be an issue and meetings should be more economic to run.

A single journal, and newsletter. One newsletter would carry more news and advertising and one journal would have more, and better, peer-reviewed papers, which would be of greater appeal to members and have a greater outside influence. Also, such a journal would have a larger and wider circulation and have more funds available for improving it. The merging of two sets of articles would go a long way towards relieving the pressure on editors to find copy for the publications and would avoid the repetition that occurs at present. There would be a considerable cost saving both in production and postage.

A single subscription and set of finances. A single subscription would be greater than the current individual subscriptions, but substantially less than two. This would, of course, benefit those who currently belong to more than one group, but would also reflect the wider scope of the single organisation. The financial resource would also be considerably greater than that of an individual group, allowing us to achieve, for example, more one-off publications, improved publicity material, expensive keynote speakers, sponsorship of events, support for junior members, to name but a few.

Greater influence. It is almost always the case that a bigger organisation has a bigger impact than a small one. Big trade unions or companies carry more influence, and are taken more seriously than little ones, and those of you who work in small museums will know of the extra advantages that the large museums have. However, there is more than simply being able to shout louder.

A more streamlined operation, with the removal of conflicting meetings and duplication of effort, would mean that committees can be more effective and give members better value for money. Greater

resources mean greater, and more focused efforts in the areas where we do act. Higher quality products mean greater impact on outside bodies.

A single body is easier to deal with than a number of smaller bodies, which is crucial when we are trying to get people to pay attention to us such as government bodies and SPNHC. Furthermore, it is also more likely to attract new members, including influential individuals who may be able to help us achieve our aims more effectively. It may also draw in members from abroad who might not join **any** of a selection of smaller groups. A bigger and better run group is potentially more attractive and so becomes yet bigger and more influential. United we stand, divided we fall.

There are potential drawbacks, as various people have pointed out. The key issue is a perceived loss of identity of individual groups and their aims and a reduction in their voice and influence. None of the aims and purposes of the individual groups are in anyway incompatible with those of the single larger group. It is proposed that the aims, committee and constitution of any new group would be established in such a way that all of these aims would be explicitly included, promoted and mutually supported. Smaller groups can gain the support of a much larger membership. It was felt that other issues raised, such as affiliations to other groups and charitable status, are practical issues, to which there are satisfactory practical solutions. With the right people on committee, there need not be a reduction in any groups' voice or influence!

The question of which groups would be involved was addressed. There are three sister groups in the UK, the Biology Curator's Group, the Natural Sciences Conservation Group and the Geological Curators' Group. This proposal was raised, and is being discussed, by the first two of these groups. However, if the above potential benefits are actually realised by the merger of these two groups then it should be apparent that merging all three groups would be even more effective and beneficial to all concerned. There appears to be a feeling within GCG that they do not wish to be involved at the present time but they are invited to become involved to whatever extent they feel appropriate. Should they still decide not to be involved, this should not stand in the way of the continued co-operation, collaboration and mutual support currently enjoyed by the three groups.

We would like to gauge the feeling of the memberships as a whole on this issue and therefore would be grateful if you would fill in and return the tear off form below (in the SAE provided). We want this to be a true representation of all views so please return

Regional Museums Task Force — BCG Response

The Regional Museums Task Force was set up by Resource to look at 'finding a unified vision for the future of museums and galleries and a clear sense of how museums should play a part in society beyond being simply repositories'.

Stuart Davies, Director of Strategy and Planning at Resource, was invited to speak at the recent AGM meeting in Oxford about the work of the Task Force and seek opinion of BCG members. He unfortunately received a rather rough reception and it was felt that this was a missed opportunity to inform what would be a document of fundamental importance to the future of museums.

A meeting was quickly arranged at the Natural History Museum to discuss a response document from BCG. (Apologies to those who were unaware of this meeting, it was at very short notice and only able to be advertised via emails and phone calls). A number of ideas and issues were discussed and a draft repsonse drawn up. This was circulated to those who attended the meeting, with a final version produced and submitted in light of comments received. The Task Force report is expected to appear sometime in September.

The following is the text of the BCG submission.

Biology Curators Group Submission to the Regional Museums Task Force

The Biology Curators Group is a group of Museum professionals who are responsible for the care, display and interpretation of natural history collections. We are dedicated to their better care maintenance and use.

The group is managed by a committee consisting of officers and committee members who discuss and comment upon topical subjects and published reports, advises the Museums Association on matters concerning biological collections and curators, formulates BCG policy, liases with other groups with common aims (NSCG, GCG, SPNHC, SHNH) and monitors biological collections reported to be at risk through disposal or neglect. Current membership is over 350 individual and institutional members, most from the UK and some overseas.

Our Objectives:

We aim to raise awareness on issues of national importance with particular reference to the continued support of biological collections and their curators.

The following comments follow on from a special meeting of the Biology Curators Group where opinions of the membership were sought for this response. A draft was subsequently circulated for comment and further views sought.

Unified Vision

The Regional Museums Task Forces remit of developing a unified vision for museums is to be welcomed. There are however an number of concerns and issues which need to be taken into account.

There is not, and should not be, one 'solution' applied across all types of museums and collections. What may be beneficial for art collections may not be applicable to biological collections. The 'one size fits all' approach while tempting in creating a unified vision, will ultimately weaken some elements of museums collections at the expense of others. Different collections are utilised and accessed in different ways and hence require different responses, they have different requirements, objectives and uses.

Similarly all museums services are different. They are wed to local history, politics and culture and as such have their own idiosyncrasies which make that museum a unique experience. Within these museums the collections are similarly different to other institutions of comparable age, size and structure. Best Value has already led to some degree of homogeneity as museums seek comparators and benchmarks with which to measure their service. To try and apply the same standard and vision to biology, art geology, social history etc collections is a sure recipe for disaster. This is not an argument against rigorous standards to which museum services should aspire conform to, rather it is a reflection of the diverse nature of collections and the way museums have developed. The Museums & Galleries registration scheme and Standards in the Care of Collections are two such standards, which while rigorous, and certainly demanding to achieve the higher levels of care, did not impose a sweeping conformity across different institutions and services.

Any unified vision must be crafted in such a way so as to enable and allow each museum service to maintain its own identity, individuality and idiosyncrasies, and continue to develop as local priorities and needs permit, rather than have to develop into some identikit museum providing exactly the same services, exhibitions, IT access, educational and outreach provision, staffing structure and collections. There is a strong case for museums signing up to and following common standards in areas such as collections care and documentation for example, but not at the expense of the museums own identity.

Access

The fundamental concern with regard to museum biological collections is one of access. This does not simply mean being able to see all of a particular museums collections, rather it is how access, physical, cultural and scientific, is enabled. Consider the numbers. A

large art collection might be just a few thousand items (the National Gallery has only around 2300 paintings). An average local authority museum collection has perhaps 20,000 items. A large regional museum such as Bristol, Leicester, Nottingham or Brighton, may between 250,000 to 1.2 million. The statement that 'over 95% of items not on display' is therefore a misapprehension of the nature of access. There is no conceivable way in which people could take in this number of specimens, even if they could "see" them what kind of experience and understanding would they come away with? If all you can say after the event is that you "saw a lot of things in the museum", then there is no practical outcome to that form of access.

Enabling effective access therefore demands practical outcomes. This raises a number of questions. Who wants access? Why? What does access mean? In what ways can access be achieved? How are collections used?

In broad terms, access to collections means being able to gain benefits from them. This can be done in many ways, of which exhibition and display are probably the most obvious. Other ways may include:

- Exhibition and display (permanent, temporary, travelling)
- Electronic access via web pages, databases, virtual displays
- Physical access to stored collections
- Access to archives of images of the objects, preferably with accompanying data
- Books, catalogues and computer based media derived from the collections
- Access to expert curatorial and collections knowledge
- Attendance at workshops that make use of the collections
- As a resource in providing an enquiries and information service
- As a resource for local naturalists, schools, further and higher education and lifelong learning groups

For those objects that are used, or need to be available for access for any of the above purposes, there is a need for them to be easily available to the curator in the first instance, and for the relevant data to be available with them. This means being reasonably close to hand and well documented. For them to continue to be accessible over a long term, they need to be in good quality storage. And for them to be useful, and therefore called upon, they need to be relevant and appropriately supported. This, again, means being well documented, and being in an appropriate historical, cultural and geographical context, with the appropriate expertise to hand to enable all this to be used.

Different users have different needs, for example local naturalists will need access to local material, visiting specialists need access to species groups across the whole collection, schools and colleges may need access to local, national and international material. It is difficult to predict what elements of a collection may be used by any one user group, their needs are many and varied and expanding.

Nevertheless, it is true that some museum objects are rarely used in any way. This is often because they are poorly documented, a result of there being insufficient resources available to rectify this situation within a short timeframe. This is a particular issue with biological collections which may contain hundreds of thousands, and in some cases millions, of objects. Nevertheless, the great majority of museums are actively working to rectify this situation, thus enabling potential access in the long term.

Recommendations

Develop regional superstores, where all the collections can be brought together. This has a number of benefits:

People will only have to go to one place for in order to get access to museum services.

It may provide a focal point for marketing and raising public awareness.

The economies of scale may enable a concentration of appropriate resources, such as are not available to individual museum services.

However, there are a number of disadvantages:

The concentration of resources has been a function of Area Museum Councils in the past, though at present this is rarely the case, as finances have been withdrawn to the point where the AMCs cannot maintain these services, even where they have been notably successful. Which begs the question, will regional superstores be any more successful in obtaining finance?

Regular access is only effectively available to those people in the locale of the store. It is also dependant on users from the wider region having access to a car or the store being near reliable and regular public transport.

Many people visit local museums for local information on there doorstep. They are less likely to do so if the museum is in another town

Material is much less likely to be donated to non-local collections

Centralisation of collections will result in the closure of local museums

A regional centre is unlikely to be able to cater for the local needs, or to cater for the number of people regionally in the detail provided by local services

The logistics of moving curators and objects between local and regional centres will be untenable

The maintenance of expertise in the collection and interpretation of local heritage will be lost

A major incident could result in the entire loss of the region's collections

The net effect of all the disadvantages above will be an overall loss of local heritage and a severe reduction in access for the greater majority of potential users. However, a modification of this proposal could be:

Develop the role of the AMC's.
This would involve reinstating the concentration of resources within the AMC's. AMC's would become providers of advice peripatetic curatorial and conservation services and act as grant giving bodies, distributing funds according to national and regional priorities.

Develop major regional museums as regional centres of excellence

Many of the largest and most important collections are located in major regional museums (though not exclusively). These major regional museums also generally have the main concentration of curatorial staff. Funding could be used to increase curatorial expertise within these centres concentrating on documenting and upgrading storage conditions and access. This would be a fairly cost efficient way of improving and enabling access to a large proportion of biological collections in the UK. This increase in curatorial expertise could also then be used to support other museums in the region through curatorial advice and curatorial and conservation projects perhaps funded through the AMC's. Many of the problems currently faced by existing museum services are the result of bad, or at least uninformed, practice in the past, along with present day starvation of funds and the resources thereby made available. Well targeted additional funding directed at this part of the problem would go a long way towards achieving the desired aims. Increasing curatorial and conservation expertise must be seen as a priority. If we do not know what we have in our collections and be able to store them correctly we will be unable to access and use them effectively as a resource for life long learning, social inclusion, scientific research and cultural enrichment.

Conclusion

It must be understood that the crucial problem is that there is currently not enough money to do the tasks required. It will not matter which solution or solutions are selected if there is still not enough money to make them work.

Local and national government objectives for lifelong long learning, outreach and social inclusion can only be met if we can enable effective access to our collections. This will take time and money to address the fundamental problems of poor documentation, poor and inadequate storage and declining specialist curatorial and conservation expertise. Only when the basic collections management functions are adequately catered for will be will be able to make possible the full access the many and varied user groups want and deserve.

The Natural History Section of Sheffield Galleries & Museums Trust – An update

There is currently much interest and debate surrounding the concept of "Trustification" of local authority museums ("Best Value and Trusts", Museums Journal, April 2001) As someone who finds himself in this position I offer this article as a "snap-shot" of what is currently taking place in and around the Natural History section at Sheffield City Museum. I offer no personal opinion to this debate, but simply present an update of where we are at, perhaps for your own comparative purposes or just to reassure you that we still exist. This article does not include details of the extensive developments to the geological and meteorological aspects of the section's work, but simply focuses on the biology activities.

In April 1998 Sheffield Galleries and Museums Trust was established to take over the management of the non-industrial museums and art galleries in Sheffield from the local authority. The Trust is chaired by Sir Hugh Sykes, Chairman of Yorkshire Bank and former Chairman of Sheffield Development Corporation. It is a registered charity and a company limited by guarantee. A Board of Trustees has been recruited and has ultimate responsibility for policies, plans and performance of the Trust. The formation of the Trust was supported by the Arts Council of England through a grant of £1.15m from the Arts Lottery Fund through its Stabilisation Programme.

The Trust administers the multi-disciplinary collections of the City Museum and Mappin Art Gallery, Graves Art Gallery, Ruskin Art Gallery and Bishop's House. A series of legal agreements govern the relationship between Sheffield City Council and the Trust. The gallery and museum sites operated by the Trust remain in the ownership of the City Council but are managed by the Trust under the terms of a Collections Agreement between the two bodies. A Funding Agreement sets out the relationship between the two bodies in terms of accountability, provision of funding by the council and so on. The buildings and collections are still owned by the city and are supported by local authority grant of £1.4m which funds the bulk of the current operational costs of the Trust.

A similar Trust has been in operation for a number of years running the industrial museums in Sheffield.

For over a decade the galleries and museums now in the control of the Trust have suffered very significant budget cuts, as a result of local authority spending controls. This led to a wide variety of strategies being implemented by the Natural history section for the generation of income (Whiteley 1996, Richards 1996) Despite the financial restrictions placed on the museum as a whole, natural history at Sheffield became a significant flagship for the public face of the museum. Ironically, an injection of cash has refocused the priorities of the service and the public profile of the museum has slipped in relation to the resurgence of the art galleries. This is to be redressed through a proposed site re-development as detailed below. Overall, however, investment in the building fabric and facilities, expansion of marketing, commercial activities and audience development are providing improvements across the board. The key challenge for the Trust during this period is to ensure that the new initiatives maximise the potential for long term benefits to the Trust and the people of Sheffield rather than short term cosmetic improvements.

During the last two years the major project for the Trust has been the development of the Millennium Galleries in the City Centre. This is a £15million state of the art exhibition space, which provides a cultural flagship for the £120m heart of the city regeneration scheme. The galleries are part-funded by a grant from the Millennium Commission and other local partnerships. They have been developed in association with the Victoria and Albert Museum. The aim is to present Sheffield as an exciting cultural centre and provincial outlet for exhibitions normally restricted to the capital. Already further partnerships have been developed with the Tate and other similar collaborations are

envisaged within other disciplines, such as Natural History.

The designated status of the metalware collection has attracted funding for a new computer-based documentation and information system ("The Museum System" by Gallery Systems) which will be introduced during 2001. Ultimately this will be the collection management system for all disciplines. It has not previously been used extensively for Natural Science collections but appears versatile enough to manage these effectively. We are currently endeavouring to determine how well it will communicate with other external systems such as RECORDER.

Further HLF funding is currently being sought for the upgrading of the off-site storage facility. This will enable a mezzanine floor and racking to be introduced to expand the physical constraints under which the Trust collections find themselves. A radio-telemetric monitoring system will be introduced to monitor and control environmental conditions from back at the main museum site. Initially this store will continue to house all the vertebrate and marine collections as at present, but the aim is to return these to the site of the City Museum in Weston Park within the next four years.

The City Museum site itself has been the subject of a successful £15m Heritage Lottery Fund bid. The Trust has been awarded £444,500 for the development of the project, with a further £11 earmarked for its implementation. The Trust must raise the remaining £3.5m from other sources. The plan is for a total refurbishment of the City Museum and Mappin Art Gallery site. These are the oldest public galleries in the city, dating from 1875 and their fabric has become increasingly difficult to maintain in recent years. The initial proposals include restoring the original architectural integrity of the buildings, the provision of state of the art exhibition and visitor facilities, a learning and activity centre, new storage facilities for Natural History and wider access to collections for the public. The aim is to create a regional centre of excellence for the people of Sheffield and beyond. The Trust is therefore entering a period of consultation about what the Museum can hope to provide and achieve for our user groups and the collections in our care. This project is also linked to the renovation of Weston Park within which it stands, which has itself been the subject of a HLF grant bid through the historic parks initiative for a major overhaul and return to its former glory. The programme of work is likely to see the museum closed for up to two years from around March 2003 while the collections are re-housed, the building gutted, the galleries re-designed and the natural history collections returned. A current challenge is to determine how we may make the collections available to the public during this period of closure.

Staffing levels have suffered in the Natural History section in recent years. In 1995 there were 6 members of staff, including two in the City Ecology Unit, a principal keeper, an assistant keeper of Earth Sciences/ Meteorology (Gaynor Boon), an assistant keeper of conservation (Paul Richards) and a curatorial assistant. At the inception of the Trust in 1998 the establishment was three (the Ecology Unit remained with the local authority). The assistant keeper of conservation became a part-time assistant curator post. The (now termed) Curator, Derek Whiteley resigned in June 2000. This post remained vacant until July 2001. In the interim, a part-time curatorial assistant, Paul Smith was appointed who has now returned to his other job of gallery cleaner! Due to the reduction in staff levels at this time, responsibility for the Biological Records Centre has now been handed over to the Ecology Unit in the Leisure Services department. Volunteer, Alistair McLean has been appointed as full time curatorial assistant for six months on the New Deal scheme until November 2001. The Curator post has been filled by Paul Richards and the next job is to fill the subsequently vacant assistant curator post.

In anticipation of the new documentation system and the potential arrival of a new Curator of Natural History an audit was undertaken in 2000 by volunteer, Alistair McLean to assess the current size and scope of the collection. The last audit was undertaken in 1977 as part of a survey of zoological and botanical material in museums, collated and

PHYLA	County	British	Foreign	Figured & types	Additions since 1977	Total
ZOOLOGY						
PROTOZOA						*0*
PARAZOA	1		85			*86*
PORIFERA & CNIDARIA	1	118	940	Fifteen		*1059*
Actinozoa (anthozoa)		10	262			*272*
PLATYHELMINTHES	1					*1*
NEMATODA	2					*2*
ANNELIDA	22	43			170	*235*
CRUSTACEA		IUF	110			*110*
Copepoda		4				*4*
Cirripedia			10			*10*
Malacostraca					3	*3*
Isopoda	100				942	*1042*
Amphipoda	4					*4*
MYRIAPODA	115		3			*118*
Chilopoda					605	*605*
Diplopoda					1230	*1230*
INSECTA						
Orthoptera	120	30	100		138	*388*
Coleoptera	650	4370	1890		10422	*17332*
Lepidoptera	4800	16545	2000		5200	*28545*
Diptera	2400	90	10		14591	*17091*
Hymenoptera	990	410	300		5884	*7584*
Collembola						*0*
Ephemeroptera					240	*240*
Odonata					20	*20*
Isoptera						*0*
Plecoptera					270	*270*
Dermaptera						*0*
Neuroptera					1	*1*
Trichoptera					580	*580*
Siphonaptera						*0*

PHYLA	County	British	Foreign	Figured & types	Additions since 1977	Total
Mallophaga						*0*
Hemiptera					1654	*1654*
Total "other orders"	380	170	310		476	*1336*
ARACHNIDA						
Opilliones					1080	*1080*
Araneae	155	311	53		9660	*10179*
MOLLUSCA (Boxes or tubes)	156	850	4000		640	*5646*
Amphineura						*0*
Gasteropoda						*0*
Lamellibranchiata						*0*
Cephalopoda						*0*
BRACHIOPODA			10			*10*
ECHINODERMATA						
Asteroidea						*0*
Ophiuroidea						*0*
Echinoidea						*0*
Holothuroidea						*0*
UROCHORDATA		10				*10*
VERTEBRATES						
PISCES	IUB	117	18		2	*137*
AMPHIBIA	IUB					
Anura		14	11		1	*26*
Urodela		12	3		1	*16*
REPTILIA						
Squamata	IUB					*0*
Lacertilia		8	59		8	*75*
Ophidia		32	103		16	*151*
Crocodylia			13			*13*
Chelonia			33		3	*36*
AVES Specimens etc.	IUB	1737	1263		672	*3672*
Eggs (Clutches)		2160	10		425	*2595*

PHYLA	County	British	Foreign	Figured & types	Additions since 1977	Total
MAMMALIA	IUB					
Monotremata			4			*4*
Marsupialia			18			*18*
Insectivora		61	4		59	*124*
Chiroptera		81	3		92	*176*
Primates			30			*30*
Carnivora		90	29		95	*214*
Cetacea		4				*4*
Edentata			16			*16*
Perissodactyla			2			*2*
Artiodactyla		32	46		6	*84*
Rodentia		158	32		78	*268*
Lagomorpha		21			29	*50*
TOTAL ZOOLOGY						**104458**
HERBARIA (No of packets or sheets)						
FUNGI	64				10	*74*
ALGAE		406	257	Possibly		*663*
LICHENS	114				208	*322*
CHAROPHYTA	3					*3*
BRYOPHYTA	375					*375*
PTERIDOPHYTA	90	178	243		20	*531*
SPERMATOPHYTA	1744	2621	1913		1475	*7753*
TOTAL BOTANY						**9721**
Column Total	**12287**	**30691**	**14193**	**57171**	**57006**	
TOTAL BIOLOGY						**114179**

published by the Biology Curator's Group (Hancock and Morgan, 1980). The report stated that the collection of Natural History specimens at Sheffield City Museum was 16th largest in Britain, containing over 70,000 specimens. In fact, this figure was something of an exaggeration, due to a simple mathematical error that had occurred somewhere between sending in the correct values and final publication. The actual figures were closer to 56,000, ranking it 18th, just above Stoke on Trent City (The Potteries) Museum.

The figures presented give a good idea of the scope of the collections and areas of recent growth but can only be considered as good estimates. The taxonomic categories reflect those of the Hancock & Morgan report. It would have been impractical to count every specimen and therefore in some cases averages were taken of store box, drawer and specimen tube contents. Some of the pre-77 figures were very rough estimates and these have been given more accurate figures where the information is available. For this reason, therefore, the figures shown below may not match those in the original report. A summary of the information shows that in the last 23 years, additions to the collection have been considerable. Where the last audit gave a figure of **56,652** specimens, the new pre-77 figure is 57171. The 2000 audit gives figures of **114,179**, an increase of 49.9%. The collection, which was started in 1880, has nearly doubled over the last 20 years.

94.4% of the additions to the collection since 1977 have been invertebrates.

69.3% of additions were insects

65.7% of the collection is now made up of insects. (62.2% of the collection belonged to insect groups prior to 1977)

Other ongoing curatorial work is currently focusing on the re-organisation of the invertebrate collections, conservation and storage improvements on the bird collection, replacing and freshening up of permanent displays and preparing for a major hands-on natural history centre to open in January 2002. In between, we are maintaining and developing our partnerships with external organisations, including the local Universities and Natural History societies and collecting data and preparing a publication on local Dragonflies. Above all, 2 remaining part-time staff have still been maintaining an active public enquiry service, answering 540 biology enquiries (+ 2,400 in Geology/Met.) in the last 12 months. We have come through a difficult transitionary period with the added pressures of staffing reductions. Now, with several major projects on the horizon and the move towards previous staffing levels, we can look forward to the future with more optimism than we have allowed ourselves for a number of years.

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Paul Richards, Curator of Natural History, Sheffield Galleries & Museums Trust

Alistair McLean, Temporary Curatorial Assistant, Natural History Section,

Sheffield Galleries & Museums Trust July 2001

Conservation of Flood Damaged Birdwing Butterflies.

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Background

During the summer of 2000, a water pipe running above Harrow School's Lepidoptera collection burst and led to flooding. Four drawers of post-display Oriental/Australian butterflies that were waiting to be put away, were exposed to the full effects of the downpour; the drawers were completely saturated. Fortunately, the wooden cabinets that housed the rest of the collection prevented more widespread damage. The damage was discovered within 2 days of the incident and dehumidifiers were installed within the following 36 hours. Mould began appearing on the specimens after about a week. Once the specimens and drawers had dried out, they were presented for conservation.

Introduction

The damaged specimens belong to the butterfly family Papilionidae, genus Ornithoptera (Birdwings) and are approximately 80 years old. These large robust butterflies vary in wingspan from 17cm down to 9cm. In total 22 specimens were affected, ranging from those where the wings had just 'relaxed' to specimens that had become stuck to the base of the drawer. This adhesion was due to the reactivation of glue used to affix the lining paper, or in some instances the gumming effect of re-softened paint that had been applied to the drawer bases in the past. Mould that had grown on both the specimens and their labels was a further problem. A few specimens also had structural damage, for instance a detached wing or abdomen (Fig. 1).

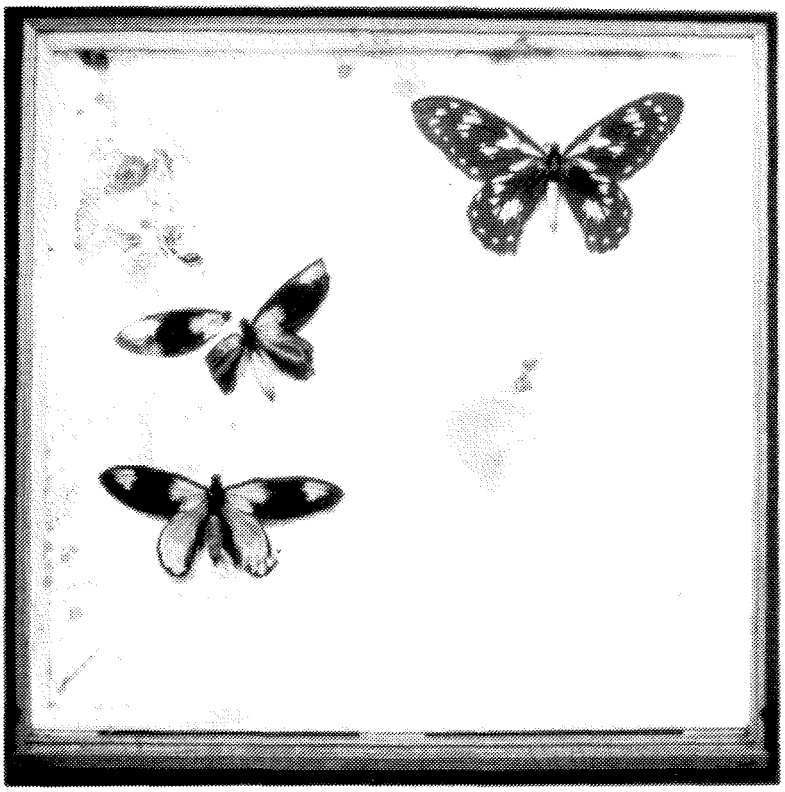


Figure 1. Drawer in original state before conservation.

Closer examination revealed that some of the specimens had been conserved in the past. Earlier remedial measures had involved either re-pinning or wing repair accompanied by painting to conceal damage.

All the specimens had to be taken from the drawers, cleaned to remove the mould, re-pinned, re-set and repaired, before they could be correctly identified and re-curated back into the refurbished drawers.

Conservation Strategy

All the drawers were bagged and frozen for 72 hours at -30 °C. This was done for two reasons - firstly to kill any insect pests that might be present, and secondly to help kill off the active mould. Freezing can kill off some of dormant conidia but not all. Only when the drawers had returned to room temperature was it safe to remove them from the bags. The specimens were then extracted. In some cases this involved dampening those parts, usually the wing tips, that had adhered to the base of the drawer. Dampening was achieved using distilled water and a fine paintbrush, size 00, and then using the same brush, easing the wing away from the base. In a couple of instances the adhesion was so great that the top layer of the base had to be carefully cut away from the drawer. This layer was then soaked with water and gently peeled away from the specimen piece by piece, using a pair of fine forceps and the paintbrush for support. Moisture application was kept to a minimum, particularly in areas that had mould, as it may become activated.

One set of data labels was also stuck to the base. Again these were moistened (checking first that the ink was waterproof) and gently lifted. These were dried out between two pieces of mounting board interleaved with pieces of Glassine paper to prevent adhesion, this was all held together with bulldog clips. Through all stages, great care was taken to ensure that specimens did not become disassociated from any data labels. The drawers were then free to be refurbished.

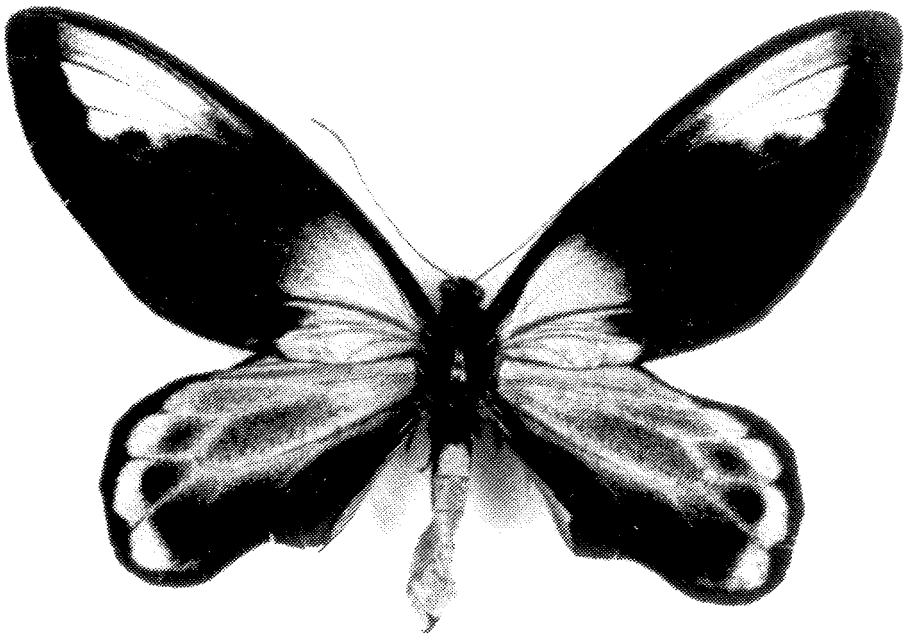
Mould

In elementary terms, the visible mould seen on the surface of an object consists of a mass of hyphae that cover and penetrate the object; this mass is called the mycelium or vegetative body. The hyphae produce enzymes that digest complex proteins, carbohydrates and fats from the object and turn them into simple amino acids, simple sugars and fatty acids. The dusty surface of the mycelia consists of conidia or spores which lie dormant awaiting a suitable environment, usually a damp or wet surface, so that they can germinate and produce new mycelia. Although the mycelia can be killed using a variety of methods, the dormant conidia are very difficult to kill and can easily become airborne so contaminating the surrounding area.

The task of removing mould should be carried out using a positive-pressure fume hood and should not be done by anyone who suffers from allergies or asthma. After treatment the area should be sterilised by swabbing down using 70% alcohol; the used swabs should be disposed of carefully (Florian 1997).

In removing the mould, the use of chemicals was kept to a minimum. The dry mould was removed from the wings by gentle brushing with a dry fine sable paintbrush size 00. A worn brush, which had shorter bristles, was the most effective. The initial strokes of the brush were in the direction of the scales with subsequent strokes gently across the scales, while gently blowing the mould away. Brushing had to be done very carefully so that the actual scales themselves were not damaged or loosened; this was checked using a microscope or hand lens (x10). The mould was removed from the long hair-like scales on the thorax and abdomen by agitating them with the brush and gently blowing, to lift the mould away. The legs and antenna required slightly different treatment. Where there were no scales, the mould tended to adhere more firmly to the cuticle. These areas were treated with the same brush, which had been dipped into 95% alcohol, and slightly more pressure was applied while brushing. In this way most of the mould was removed from the specimens. Although there were a couple of areas where staining had occurred at least most of the dead mycelia and as many dormant conidia as possible had been removed

Figure 2. Specimen coverd with mould
Figure 3. Specimen from Figure 2 after cleaning



(Figs 2 & 3).

Re-pinning and setting
Due to the distorted and unstable condition of the old pins, it was decided to re-pin all the specimens with new stainless steel pins. Most of the old pins had corroded producing either rust or verdigris and some were broken or bent. The specimens were relaxed by pinning them in an airtight box, with an absorbent material in the base to hold water; thymol crystals were used as an antifungal agent. The specimens were left in this box for between 48 and 72 hours depending on their size. The specimens had to relax sufficiently to restore movement in the basal wing joints and for thoracic muscles adhering to the pin to be softened. Specimens must not be allowed to become waterlogged. Not only does this damage the wing scales, in extreme cases the whole specimen can disintegrate due to the breakdown of tissue fibres. Each old pin was then carefully removed by slowly twisting as it was pulled upwards out of the thorax. In one or two cases the pins were so bent, it was necessary to remove the head by clipping so that the pin could be pulled through from below. To prevent further damage the new pins were placed in the original holes in the specimens. In some cases were the new pins where slightly loose, a small drop of glue was used to prevent the specimen spinning.

The specimens were then placed on to setting boards; these are made from a softwood and have a grove down the centre to take the abdomen. Once the wings had been positioned, they were held in place with glassine paper strips and pins (see Dickson, 1976, for full explanation of setting). In the case of specimens with particularly large wings, additional paper braces were used to re-enforce the glassine strips. The most difficult specimens to re-set were those that had been repaired with glue in the past; this prevented a full range of movement so the wings could not be placed in the correct position but as near to it as possible. The specimens dried quickly in about a week at room temperature as the RH was low (about 35%).

Repairs
Once the specimens were quite dry, it was safe to remove them from the setting boards for any necessary repairs. Seccotine glue was used as it dries clear and is soluble in water. This enables it to be thinned and also re-dissolved at any future date. Any legs or abdomens that had broken off were glued back on, as were the wings that had become detached. Either a setting board or additional strips of plastazote were used to support the wings in the correct position while the glue dried (Figs 4 & 5).

Traditionally, damaged wings are repaired with pieces of wing from other discarded specimens (not always of the same species). Indeed, this method had already been used on a number of these specimens. The damaged area had been trimmed back and an additional piece of wing glued in place. The disadvantage of this is the extra weight it produces particularly if the repair is at the tip of the wing; this causes extra stress to the wing attachments and to the area immediately surrounding the repair. Also getting hold of 'discarded' birdwings is not that easy! L2S Lens tissue (9 gsm) was used to give support to any large tears in the wings. This very light paper has long fibres that give it extra strength. The nature of the paper is such that when torn it forms a jagged edge that not only 'blends in' better but produces a stronger joint than would be formed by a straight edge. The lens tissue was secured using Secottine glue that had been greatly thinned down with distilled water (approximately 1 part glue to 6 parts water). Using a diluted solution of glue enables the tissue paper to absorb it more readily, forming a thinner bond in contact with the wing. The glue soaked tissue paper is applied to the damaged area ensuring that all the edges of the tissue paper are smoothed out and are in contact with the wing. The lens tissue was placed on the surface facing the base of the drawer, even on those specimens that had been set ventral side uppermost. No effort was made to conceal the repairs other than by using the minimum quantities of materials needed.

Curation
The final task was to lay out and label the

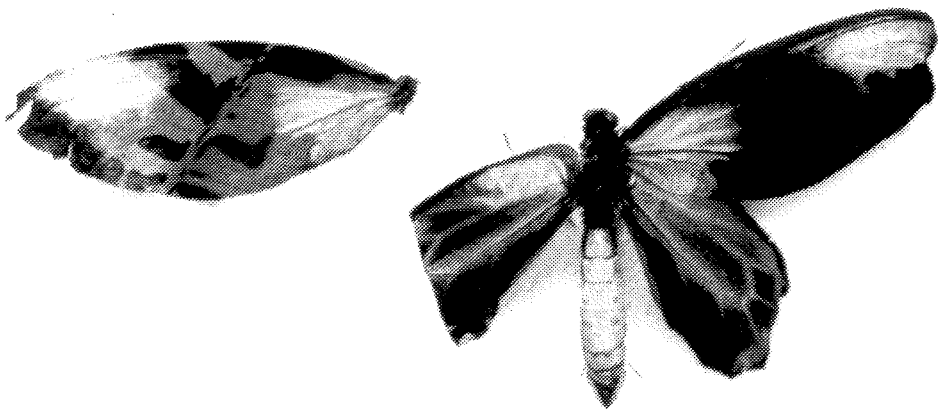
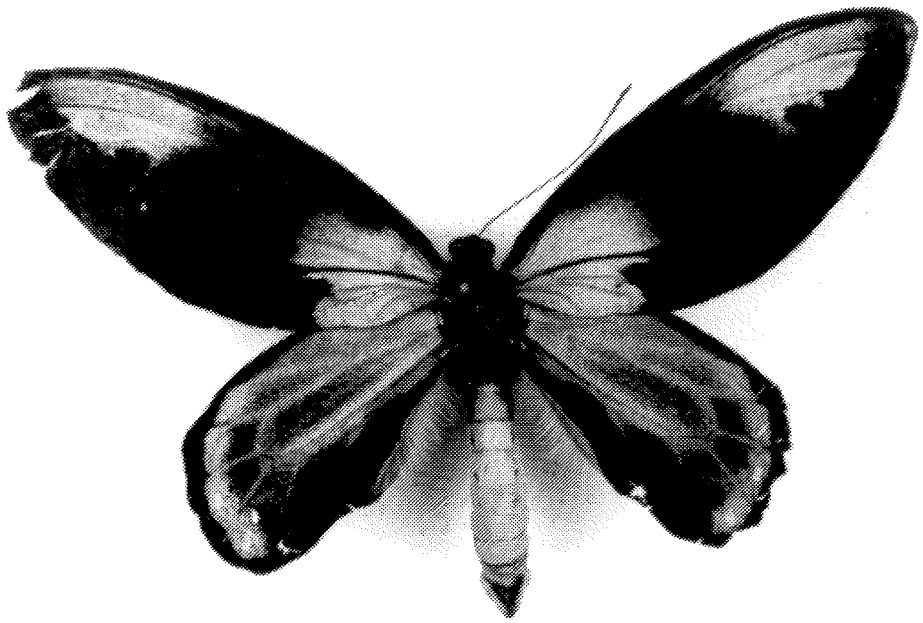


Figure 4. Specimen with damaged wings

Figure 5. Same specimen as in figure 4 after repairs



specimens following current nomenclature (d'Abrera 1990). This required determination of current names as many of the original labels within the drawers were out of date. Only a few of the specimens had locality data and most of that was insufficient to permit confident identification below species-level (Fig. 6).

Conclusion

These large birdwing butterflies withstood water damage quite well. Smaller, more delicate specimens would probably have disintegrated before any action could have been taken. The fact that they were fairly robust specimens also meant that handling and remedial work was relatively straightforward.

Freezing, once the specimens have dried out to reduce the risk of ice crystals forming, will kill hydrated or germinating conidia and vegetative growth but may not kill all dormant conidia. Removal of the visible mycelia helps to reduce the conidia population, it is impossible to remove them all and the dormant conidia can be easily activated by increases in humidity (60 - 70 %) and temperature (Florian 1997). The effects of fumigation usually only lasts about a month and many of the chemicals used are toxic and have to be used with care.

During the conservation work, the specimens were monitored regularly to check for re-growth of any mould. At the end of conservation, which was carried over a period of about 2 months there was no sign of any germination or vegetative growth. To prevent activation of the conidia in the future the specimens need to be kept in an environment that has a low RH and low temperature.

Materials used.

Glassine envelopes - BioQuip Products, Inc.

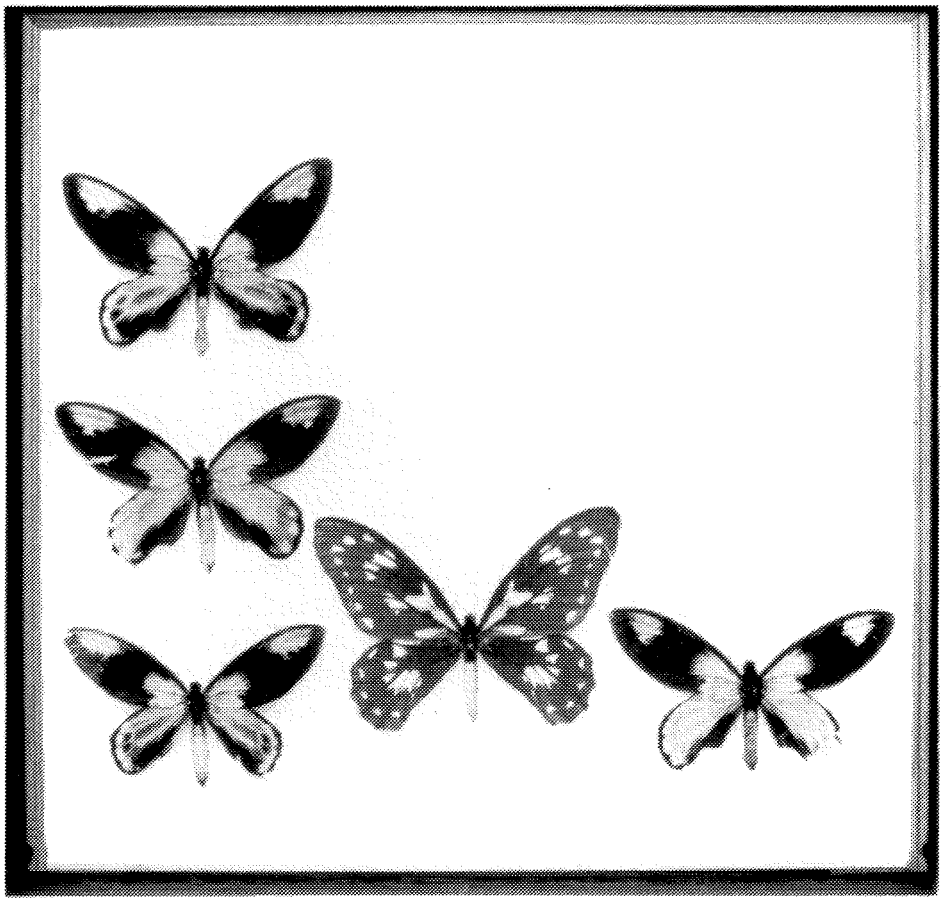


Figure 6. Drawer after conservation work completed

Digital Learning

Biology Collections and New Technologies

Department of Museum Studies, Leicester University, 30th January 2001

IT usage has moved far beyond using computers simply for documentation purposes. Digital technologies are reshaping how we use, interact with and display biological collections. They offer new ways of communicating and affording access to the huge resource and potential contained within biological collections. This meeting looked at some of the ways digital technologies are being used and at their potential for providing access, information and new ways of using and interpreting collections.
This was a very well attended meeting, with over 70 delegates, this perhaps reflecting interest in and opportunities afforded through IT usage. The day included demonstrations of the pilot NBN Gateway, virtual reality technology, and the Virtual Store project created by Stoke on Trent Museums.

Overcoming the Shock of the New

Changing the agenda for digital learning

Ross Parry - New Technologies Lecturer,
Department of Museum Studies

There's more to IT then word processing and collections databasing. Isn't there? Ross Parry from the Museum Studies Department at Leicester University discussed the wider usage of IT and how it can be effectively utilised to communicate with our audiences.

Late Victorian Cambridge – exclusive, hierarchical, conservative. Not, perhaps, the place where we would today (with our inclusive and progressive outlooks) expect to find a key moment in the history of collections and new technology. And yet on 13 June 1894, J.W. Clark (historian of library classification) delivered a paper as that year's prestigious Rede Lecture, which was just that. Through a meticulous piece of scholarly work, Clark placed the University libraries that surrounded him and his audience into the context of a sweeping story of civilisation. From Sir Christopher Wren to St. Benedict, and from Sir Robert Cotton (one of the benefactors of the British Museum), to Bishop Alexander of Jerusalem, this was nineteenth-century narrative history at its most introspective and self-congratulatory. It was, however, his comments on the current state of archiving and librarianship that contribute to the history of museums collections and media technology. Clark concluded that: 'common sense urges that mechanical ingenuity, which had gone so much in other directions, should be employed in making the acquisition of knowledge less cumbrous and less tedious'. His recommendation, therefore, was a simple one: 'that as we travel by steam, so we should also read by steam, and be helped in our studies by the varied resources of modern invention.' In short, writing at the twilight of the Victorian age of expansion and mechanization, Clark saw his culture's new technologies as having a role (a significant role) in the organization of his society's, libraries, archives and museums. To him, it was 'the varied resources of modern invention' that had a active and unavoidable part to play in the future of memory institutions. I doubt he could have guessed how true his words would prove to be.

In particular, it is in the last twenty-five years that the 'resources of modern invention' (our new technologies) have become increasingly more conspicuous within the modern museum. By the end of the 1970s IT projects were emergent in museums – if weighed down by the weight of expense and labour-intensive

data entry that they (invariably) needed. And yet, working in the early 1980s, a team on Merseyside bucked this trend and used (in contrast) some of early microcomputers within their exhibitions. Engaging with the subject of insects, growth and habitat, simple programs allowed visitors to build creatures on the screen (formed from the letters and characters on the keyboard). This proved to be both an early and enduring in-gallery digital interactive - the machine and the program defending their place in the museum into the 1990s. By the end of the decade the computer was established both in front of and behind the scenes of the UK museum. In 1989, two years after MODES had appeared for the first time on registrar's desks, an exhibition of the drawings of Leonardo da Vinci, at the Hayward Gallery in London, used a series of computer models to support its scholarly commentary on the collection. (Interestingly, for curators of biological collections, these were drawings that made anatomical studies of the heart, the cranium and spine proximate with those of architecture and mechanics.) For the first time, the sketches and jottings of the Windsor Codex were realised as three-dimensional objects

By the early 1990s (when *A Hard Day's Night* had become the first full-length feature film in hypermedia, and when, for the first time, sales in hypermedia encyclopaedias had exceeded those for conventional print encyclopaedias) there was a clearer sense of how new media could be used in museums. (We think here primarily of the document published by the MDA in 1991: *Who's Using What Software for Documentation Where*? But, perhaps, we also think of the British Library's 'Initiatives for Access' programme begun in 1993, investigating the technical requirements (both hardware and software) for digitisation and networking of library materials. Also, in the same year Bibliotheque Nationale de France began a programme for digitisation, storage and public-access retrieval system for 300,00 scanned documents, books, periodicals, images and sound.) Some curators now felt confident to let visitors commune - *unsupervised* - with the new technology. It was, significantly, just at this time that the 'Micro-Gallery' was opened in the new wing of the National Gallery, London. With its digital tours, 12,000 high quality images and 4,500 pages of art historical information stored on Apple Mac computers, the Micro Gallery signalled a (high-profile) enhancement in the capability of multimedia software, an increase in the power of digital processing, and a reduction in the cost of computer hardware. And yet, from another perspective, the Micro Gallery might be viewed as a muted revolution, being somewhat marginalised within the space of the museum – a basement ghetto, anything but 'in-gallery'. Moreover, in terms of the profession countrywide, it stood as a privileged provision of a national institution – rather than the paragon of curatorial best practice.

In fact, it was not until the late 1990s (in the UK at least) that the axis of digital change finally moved both into the galleries and into the localities. To use the words of Wendy Sudbury in 1996 (then Chief Executive of the MDA) advances in new media (especially networked media) meant things were 'growing fast'. (Indeed, that same year the MDA produced its first published report, by Sue Gordon, on the role and impact of the Internet in museums). In 1995 (in her paper on 'New technologies for museum communication') Anne Fahy left little doubt that the advent of new media presented museums: 'with the opportunity to develop new ways of communication which allow the visitor to explore the richness and diversity of collections at their own pace and to their own requirements'. In the same year, the *International Council Of Museums* was more proscriptive: 'ICOM encourages museums' a policy statement from the executive council announced, 'to be active contributors of information to the Internet about their programmes and collections in order to fully play their role "in the service of society".' Allied to this has come the new Cultural Heritage Training Organisation (CHNTO) guidelines for heritage training providers that has stipulated that the use and knowledge of information management media is now a clear part of any validated training curriculum.

Consequently, today, in the face of this new professional responsibility to engage with new media (J. W. Clark's *'resources of modern invention'*) we are now perhaps used to seeing in

typical city museum services such as Leicester CD ROM terminals providing the sounds and contextual information to support the surrounding objects (as happened with last year's 'Sikh' exhibition at New Walk, and the 'Suffering for Style' interactive at Jewry Wall's Leicester millennium exhibition). We are not even surprised (as happened at Leicester's recent centenary celebrations) when we are given an opportunity to put on a headset and walk with a virtual reality Teranasarus Rex. In short, in those twenty years (from the Merseyside keyboard characters, to the Leicester virtual Dinosaur) we may still be using computers to make digital creatures. But, crucially, the resolution, the location, the intention and cultural condition has changed beyond recognition. Less of a mainframe curiosity, or privileged gimmick, Digital Communication Technology (New Media, ICT, IT - call it what you will) is now an established curatorial medium and tool to which we are now beginning to turn with comfort and confidence.

And yet, despite these myriad initiatives, and irrespective of the decades of development, there is much for all of us (as professionals working in or with museums) still to learn about using new media. Or to put it another way: we might want to read the title *Digital Learning* – our subject for all these discussion – as a reference to the learning *we* need to embark upon; and not just the learning our audiences will engage with once our collections and interpretations are digitised.

Consequently, when we consider David Dawson's reflections on the 'Networking Collections' (and the new potentials for information management within some of our collections) let us also think about how much we can *learn* from others who have undertaken such work. Already (with respect to New Media) it is, for instance, becoming clear that it is, in fact, evaluation that is the key to successful, deliverable, sustainable projects. It is evaluation that helps us confront key questions about why we are embarking on a particular initiative or project. It is evaluation that provides context for the work we are about to undertake; and that provides direction for the work ahead. It is evaluation that helps a project fulfil the needs of its intended audience; that maintains a focus for a project; that allows a project to respond to change; and that can help ensure an end product is successful and effective against the project's original criteria. Moreover, it is evaluation that helps us understand how we might develop our provision in the future, as well as providing us with the means to see how we (personally) operate as individuals within a team dynamic. It can help us play to our strengths in future projects, and plan our continuing professional development. In short, when approached appropriately, project evaluation (front end, formative, summative, on-going) can be a positive and productive agent for our audiences, our projects ... *and* ourselves. Undoubtedly, part of our *Digital Learning*, relates to *learning* how we evaluate *digital* projects

However, there is another aspect of *Digital Learning* which involves *learning* how digital media is used. These are lessons (aspects of which the contributions from the Potteries Museum and Art Gallery, and Leeds City Museums will remind us of) in *learning* both the nature and limits of the technology's potential. Why, for instance, do we persist in allowing the Internet to remain synonymous with 'accessibility' and 'inclusion' when, in actuality, in Britain today some three-quarters of the Adult population do not have access to the web at home? Why do we continue to fanfare the audio-visual wonderland (and interactive eye-candy) of the web when, in fact, the realities of a design rationale that is responsible, browser-independent, client-side-application-based, access-technology-sensitive, W3C top level complient ... in most cases generates products that are far short of this. Though I appreciate that we are future proofing ourselves and our collections for a cultural moment in which society is fully networked with blue tooth technology (a web-compatible playstation in every teenage bedroom, a WAP phone in every pocket, a broad band online connection into every home, classroom and library) we should, nevertheless, strive to be more critical of this media and of these visions of how it may be used. We should perhaps develop a more nuanced appreciation of what networked hypermedia is, and what it can do for us. The sound-bitery and simplifications

that marked our initial 'shock of the new' should perhaps be behind us. After all, this new technology is now not so new. Therefore, our *Digital Learning* needs to confront and critique (with alacrity and acuity) the very nature and communicative culture of the World Wide Web and its hypermedia discourses. Is the Web empowering - a mass communication for the masses? Or, is it just the means to a new social underclass? Is it a confusing, unsettling juxtaposition of dismembered data? Or, is it in fact – for this very reason – the perfect medium for the post-modern generation? Does the web present a new mode of dialogue for the museum - a private form of public communication? And what happens to the value of the published word on the web (the notion of the authentic) when publishing is itself so democratised? As difficult as they may be, it is time to answer questions like these. It is time to ask ourselves if we really know *why* we are putting things online. And it is definitely time – likewise – that we become more aware of the different abilities of our online users. After all, the diversity of users and usage of our online (and in-gallery) digital media is invariably characterised by more than just differences in equipment used. When engaging with the technical specifications of building our websites, we can all too easily forget how we are not just connecting computer with computer, but also person with person. Web designers and museum professionals alike may want to bear in mind that people are just as diverse in their abilities as the computers they use. Our 'Digital Learning', therefore, is also about *learning* about people, their abilities, their expectations, and their preferences.

However, what Nick Gordon's paper on the Termlists project does is open up another vista of debate, and another set of new lessons for our *Digital Learning*. Lessons to do with what happens to information when we structure it (or relate it) using a computer. And, again, we are perhaps here at an important moment of transition within the development in museum computing - a transition to do with the structure and taxonomies of our information management systems. Consider for instance MODES. The development of the MODES products from 1987 onwards is representative, we could say not too controversially, of an approach to digital collections that is orientated around the curator and registrar as principal users. These products (and many like them that followed) located informed registration and expert documentation as their main objectives. Within them, intuitive front ends for public access have only developed as something of an after thought. However, in the new generation of products (of which, say, MUSIMS stands out as a prime example), the approach is, instead, to provide a computerised system for the flow of information *right through the museum*. Therefore, in contrast, in the computerised information management system of *today,* information retrieval by *all* users (whether inside or outside the museum) is now paramount. As such, we detect a shift in the use of Database Management Systems, from a guarded provision (a registration tool) to a mechanism (dare one say 'a culture') for information presentation and access. Our museums' 'Collections Databases' are, it seems, now evolving into 'Information Exchanges'. Moreover, the very theoretical principles (semiotic frameworks) of these databases and exchanges are, in many cases, shifting as well: from a system-orientated to an object-orientated paradigm, where multiple meanings and varied interpretations take precedence over (or, at the very least *hold equal status with*) controlled classifications and universal standards.

Allied with this paradigmatic shift is the new culture of interoperability, yet another area of our new *Digital Learning*. Through Malcolm Scoble's description of a project that is looking to facilitate access to specimen databases across the European Community, let us think on about what interoperability will mean for the museum. Interoperability is an example of New Technology (in this case *networked information management technology*) synchronising with the social and political aspirations of some of our modern cultures. (In short, because of what information management technology can now do, we are now able to think through some aspects of social change). Therefore, in one respect, interoperability is the point at which information management becomes conspicuously semantic, legal, political, and cultural. Moreover, interoperability

marks the point at which technology and museums, (computers and society) connect in a mutually transforming way.

Finally, John Hopwood's presentation of new Virtual Reality technologies will reminds of yet more lessons we need to have as part of our on-going *Digital Learning*. For what the innovative work of Education City is doing (in Leicester) in its interactive, low-cost experiences for lifelong learners (what elsewhere has been called its '*Knowledge Space*') is quite literally rethinking the space of the museum. The thought processes at the kernel of the creative networked virtual reality products that John Hopwood's team are building, raise questions about the very essence of what museums are, and what the are trying to do.

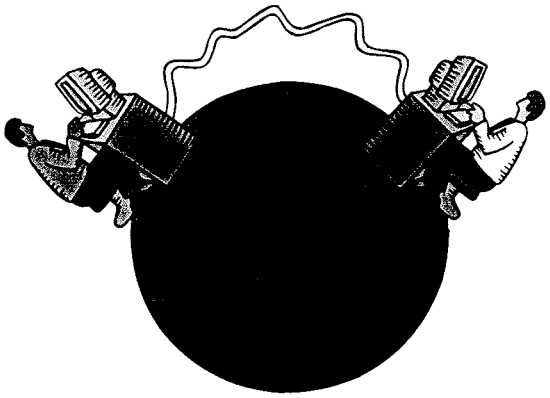
Museums have always been associated with Technology. After all, in one sense, they are themselves a technology of sorts; a medium, a physical form of communication. Indeed, over the centuries our museums, libraries and archives (our 'memory institutions') have found their beginnings and shaped their changing roles at the same time as they also found new ways to present, process and protect their objects and ideas. From the cabinet of curiosity to the tableaux diorama, and from the glass-fronted display case to the hands-on interactive, and from the punch card catalogue to the database management system ... communication technology continues to inform and support the purpose and practice of the museum world. The histories of museums, and the histories of their mediating technologies are inextricably linked. To tell a story of museums is to tell a story (also) of the technologies they contain. This has certainly been the case (at least) for the technology that is the subject of these discussions - *digital information technology*. It is the proximity of this digital technology to the construction and representation of knowledge, which is the theme that sits at the very heart of these papers here. Within this theme are fundamental issues for museums today: who they are for, what they contain, what form they take? We cannot avoid the series of questions and issues centred upon the role of new technology - in particular those challenges centred upon the portable, programmable, automated, digital-processing machines we call computers. How and why may we talk about a 'virtual museum'? To whom would it serve, and in what way? How do the processes, roles and skills of curatorship change in such a setting? Who should fund such innovation? For what benefit, as museum professionals, do we enter the digital age? It is to these questions, these issues and these challenges that this discussion looks. It is a discussion about new beginnings; new approaches to the way we work, and new approaches to the way we sustain this work. It is about new standards, new protocols and new partnerships. It is a discussion about new potentials, new visions, and even, perhaps, new museums.

Networking Collections Can we make it work?

David Dawson -
Senior ICT Advisor, Re:source

Much is talked about the power of IT to unlock the huge potential of natural history collections, but is it possible? David Dawson discussed the issues and some of the projects that are attempting to make this a reality.

True to the spirit of this meeting David's talk is available online both in HTML and as a Powerpoint presentation. It can be accessed at www.peoplesnetwork.gov.uk/team/dawson/present.html.



ENHSIN Remote Access to European Natural History Databases

Malcolm Scoble – Natural History Museum

ENHSIN - European Natural History Specimen Information System is a network supported by the European Commission under its Improving Human Potential Programme of Framework V. The aim is to create an institutional and computerised network across the Community to deal with remote access to specimen databases, examine data standards and sources, look at IP issues (which restrict the free flow of information), assess user needs, and organise a management model for the system.

ENHSIN stands for the European Natural History Specimen Information Network funded under the Improving Human Potential programme of the EU Framework Programme V. Its purpose is to enable the development of a shared interoperable European network of specimen databases. Further information can be found on the web-site dedicated to the Network: http://www.nhm.ac.uk/science/rco/enhsin

Background

The Network is an initiative arising from CETAF, the Consortium of European Taxonomic Facilities - a body created to promote research in systematic biology and access to collections, information and expertise. The Consortium includes several major European natural history museums, herbaria and botanic gardens. With the growing enthusiasm for databasing material in collections across Europe, it was clear that enormous value would be added if a system could be developed to network relatively uncoordinated efforts across a diverse continent. There are two fundamental aims in ENHSIN. One is to provide a means of allowing remote access to specimen databases across the Internet. ENHSIN, however, is also a network of people and institutions. Professional interaction between systematists has existed from the very dawn of the process of documenting and classifying organisms; but with an increase in the number of collections-based institutions and curators, a more formal means of facilitating contact is highly desirable. If better organization can be combined with the power of the Internet, enormous potential exists for providing access to information about biological collections. A successful outcome of the project will depend both on the extent to which collections data become digitised and the effectiveness of the system by which remote access across the Internet is achieved.

Natural history collections are a valuable part of the European infrastructure. They can be perceived as physical databases (West & Nielsen, 1992) holding information on specimens. Their value increases over time because the temporal details they contain provides us with at least some guide to the changing distributions of species. Although older specimens rarely have associated co-ordinate detail, access to what is admittedly patchy, qualitative data can help. Collections, therefore, are a source of information for environmental research, including that on the impact of changing patterns of land use on the distribution of organisms and their conservation. They also hold data relevant to health issues, such as the distribution, current and past, of vectors of disease. And finally, specimens, their acquisition and their collectors are part of the rich European history of natural history and they form part of our European cultural heritage.

The partners Seven European organizations comprise the ENHSIN partnership. They are: the Natural History Museum, London, which is the co-ordinating institution; the Royal Botanic Gardens, Kew; the Zoological Museum, University of Copenhagen; Museo Nacional de Ciencias Naturales, Madrid; Muséum national d'Histoire naturelle, Paris; Botanischer Garten und Botanisches Museum, Berlin-Dahlem; and the Zoölogisch Museum, Universiteit van Amsterdam. It is essential to appreciate that the Network is not a closed club. Its purpose is to create a system to which institutions will wish to communicate.

The use of collections

Although care is needed before attempting to extrapolate across Europe, figures from the Natural History Museum, London, give some idea of the magnitude of usage of natural history collections. About 9000 researchers visited the collections in the financial year 1999/2000 for a total of 18,000 days. Museum collections also inform public displays, and there were 1.9 million gallery visitors to the Natural History Museum over the course of the year. The fact that the museum's web-site received over one million hits each month from the public and researchers, gives a dramatic indication of the growing importance of the Internet to collections-based institutions.

Access and adding value

Access to collections has traditionally been gained almost exclusively by visiting institutions or by receiving specimens on loan by post. While personal visits will remain essential, gaining access to data via the Internet has the potential to broaden the users base. It will also enable direct users of collections to undertake background work prior to making expensive visits to institutions, so allowing valuable time to be spent working on the collections to maximum effect. The effectiveness of the Internet as a means of delivering access will depend largely on the number of collections that become digitised and the quality of software enabling users to interoperate across a variety of sites.

The ENHSIN partners aim to create an operational system for what is intended to become a pan-European network. Over the duration of the project, which is supported by the Commission for three years, a variety of issues will be addressed. These include user needs, data standards and sources, intellectual property issues, and network management. Central to the project is achieving interoperability across specimen databases. The partners are aware of existing interoperability software, notably 'Species Analyst', which has been developed at the University of Kansas (http://habanero.nhm.ukans.edu/TSA/) and which provides simultaneous access to multiple biological collection databases from a web browser. An experimental interface providing common access to distributed specimen data has also been developed within the partnership to facilitate a pilot network for the ENHSIN project (for details see http://www.bgbm.fu-berlin.de/BioDivInf/projects/ENHSIN/XMLClient.htm/). Already, four specimen databases have been identified and made accessible (lichens, fruits and seeds, Homoptera insects, fishes). Further data sources suitable for linking in the pilot are being sought. Implementation of the pilot network will provide the opportunity to evaluate its effectiveness both in terms of technical development and by allowing priorities identified by users to be addressed.

Associated tasks

To gain a better understanding of European user needs, in both scientific and other sectors, a questionnaire was constructed and mailed to 2287 institutions or individuals. The results are in the process of being analysed. The questionnaire has also been placed on the ENHSIN web-site and, to encourage responses, is available in five European languages. This task emphasizes the fundamental importance that the partners and the European Commission place on addressing users in the development of the infrastructure.

Since specimen databasing is at a relatively early stage in its development, it is possible to gain a reasonable degree of agreement over standards and protocols for data access and quality and for the exchange of specimen information. To lay the foundation for data exchange, it is important to agree the core information to be searched and shared within the infrastructure collaboration. Since Europe is an area of great cultural diversity, this is a demanding task.

A potential barrier to Internet access to data exists in restrictions imposed by the protection of intellectual property. This field is complex and IP issues are being identified and addressed. Complete open access to geographical information will inevitably and rightly be restricted where threatened and protected species are involved.

A management model is being constructed both to track and guide the course of the project and also to sustain the network for the future. Certainly forming policy and frameworks to implement and bind a pan-European infrastructure will be critical if, as is intended, the network is to be sustained and expanded after completion of the ENHSIN initiative.

Complementary initiatives ENHSIN, clearly, should not be seen in isolation. A particularly notable initiative, which is intended to provide access to the wider content of European natural history collections is the BioCISE (the Biological Collection Information Service in Europe (http://www.bgbm.fu-berlin.de/biocise/). BioCISE deals with collections metadata above the level of the specimen. The system enables questions to be asked such as "in which European collections can I find specimens of a particular taxon or from a particular geographic region?". ENHSIN, by contrast, is creating a system to enable users to gain access to unit data - information pertaining to actual specimens such as geographical co-ordinates or observations. Related to these two initiatives is 'Species 2000' (http://www.sp2000.org), the purpose of which is a to enable interoperability across global species databases. If links can be established to other databases, species names are a major means of access to collection metadata (at or above the level of the specimen). There exist many other initiatives from the global to the local, but those mentioned here have a particularly close association.

Hopes, reality and the future

Although there exists a wave of enthusiasm for creating specimen databases, we are far from the goal of access to full, standardized, digitised data of high quality for the vast number of natural history specimens housed in European collections. By developing systems such as BioCISE and ENHSIN, however, a means of gaining remote access to data in collections is, at least, rendered possible. Furthermore, it is hoped that these networks will provide a focus and serve as an encouragement for the digitisation of specimen metadata and encourage ways of improving data standards and systems of access.

Natural history collections are housed largely in what Lorcan Dempsey termed "memory institutions" (museums, libraries and archives) (http://www.ariadne.ac.uk/issue22/dempsey). Such institutions hold a wealth of information on the distribution of organisms through time across vast geographical areas: collections held in many European institutions span the globe in their representation. Although much of the data within these collections is (inevitably) uneven and qualitative, we have nothing to equal it. Modern samples lack the time dimension, are often restricted to one or a few species, and, typically, are focused on narrow geographical areas. Bioinformatics has changed profoundly the science of genomics. Informatics may not have had quite the same impact within biodiversity, but it is making great strides and shows every sign of developing much further.

Acknowledgements

I thank my colleagues in the ENHSIN partnership and in the Research and Consulting Office of the Natural History Museum, London, for the work on which this article is substantially based.

Reference

West, J.G. & Nielsen, E.S. 1992. Management and accessibility of biological collections. *Australian Biologist* **5**: 68-75.

The Virtual Store

Natural History Collections at Stoke Museum

Keith Bloor Senior Museum Officer, The Potteries Museum & Art Gallery

Introduction

The award of designation was made because of the strengths of all collections, the Natural History collections are of local and regional importance and is the only major collection of its kind in the County. The designation application identified a number of weaknesses in the section:

1. "most groups of invertebrates are poorly represented except mollusca."
2. "storage space is now greater than 80% utilised"
3. "little time is available to adequately research and document collections at item level, which in turn has decreased oppor-

tunities for publication"

The required amount matching funding to address 1 and 2 above is not available in this financial year but need addressing in future projects. However, item 3 could be addressed by implementing the following project.

The 'virtual store' project

Since 1988 the Natural History section has been the leading light in the computerisation of the 130,000 objects in its care, with now well over 30,000 items computerised and a complete *meta-database* (summary information) of all collection holdings. From the outset, the aim has always been to make this information available to the general public both on-line and in the public galleries, however this ambition has always suffered through lack of access to funds. Indeed, 1994 the section represented one of the first n the Country to pioneer trials in the emerging multimedia and internet Web technologies, and more recently digital mapping (GIS), to deliver the information in galleries and on-line with accompanying images and video. Work on creating a digital library of images on Photo CD was started in 1996 and has been continually developed. However, it has never had access to the funding required to implement the knowledge investment, consequently the wealth of information now digitised is accessible to curatorial staff members only.

Museum management has identified the need to open up museum stores to make them more accessible to the public. This is very difficult to do with the Natural History stores which, as identified above and following further important acquisitions, are now overcrowded and consequently unsafe for the public to occupy. One solution to this, which builds on the past work achieved, is to make the collection available on

Equipment and Costs (first phase 1999/2000)	
Hardware and cabinet already exists specifically for this project.	£0.00
All software required is already available, however the upgrade of one copy of Modes for Windows would be required to integrate data and images.	£75.00
Database design and implementation (£250.00 per day 4 days work)	£1,000.00
Browser/GIS programming	£500.00
GIS development (training already received by curatorial staff for creation of public access point)	£0.00
Total Cost	£1,575.00
Matching funding at 20 % would be available from the sectional budget.	£315.00
Equipment and Costs (second phase 2000/2001)	
Hardware upgrade (PC and touch screen)	£2000
Workstation unit in shape of a 'leaf'	£1000
Image digitisation (20 days) of external staff time	£1137
Matching funding at 20%	£827.40 (To be identified eg COPUS, Curry, Conhological Society) – also see * below)

line in the form of a 'virtual store' both in the galleries and on the existing web site. The project would concentrate on the general collections using existing computerised information, digital images and GIS mapping. More detailed information would be available for two specific, important collections. John Ward (fossil fish) and the William Hill (molluscs), are examples of local collectors who have made important contributions to our understanding of the natural history of the Potteries area. Their collections are already documented to a detailed level on computer but would need complimenting with digital images as part of a second phase. Gallery computer hardware already exists and a customised storage unit is in place to display a selection of the objects from the collection. Upgrading of the hardware and a workstation table (in the form of a leaf) would form the second phase when matching funding has been identified. The project would benefit the rest of the service by acting as a **model and stimulus** in putting collections databases **directly on-line** using what is now tried and tested technology and demonstrate the use of digital map-based information to all disciplines.

Products, Problems, Pictures & Priorities

Using computers to support Natural History Collections in Leeds Museums & Galleries

Adrian Norris and Maggie Pedley
Leeds City Museums

How Leeds Museums have responded to pressures to make information accessible to public through use of IT and look at local and National initiatives which provide opportunities to get collection information

Introduction

Over the last seven years the acquisition and use of ICT to support collections management in Leeds Museums and Galleries has at last started to quicken its pace from a gentle stroll to a steady jog. The races we prepare ourselves for, offer many cash prizes - However our strategy is to ensure that we don't run off in different directions - to coin a phrase "cheque chasing" which at present can be difficult. We are driven by the need to ensure that any investment of time and resources continues to deliver on the aims of the service and the wider objectives of the City Council.

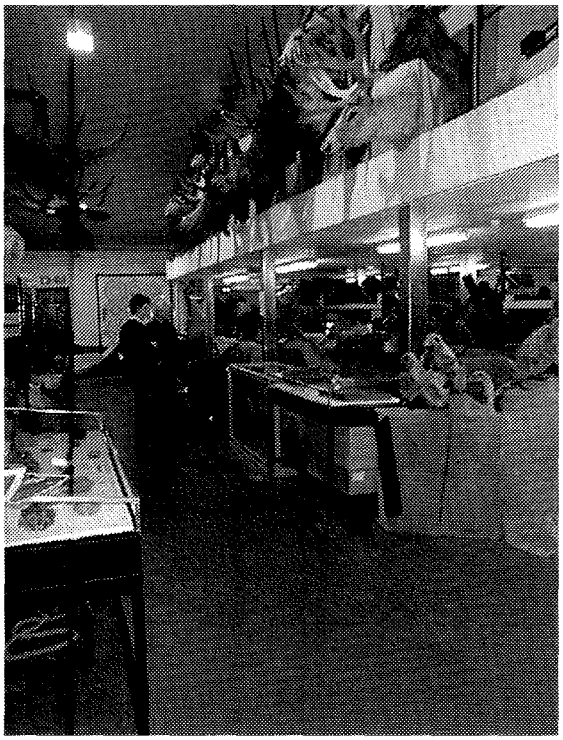
In 1993 like many museums responding to the requirements of MGC Registration, Leeds Museums Service acquired hardware and software to help improve its collections documentation. A Museums Council Grant provided a budget of 15K and three months for the selection process. (January to end March 1993).

The Museum Service documented its collections using a variety of card cataloguing systems including **mda** cards and colour coding. It soon became very apparent that the system would have to accommodate all these differences.

Many of the software products available did not allow for this. Our attraction to Advanced Revelation centred around the fact that we could build the screens to mirror the existing index cards and manual systems– even their colour. We purchased nine PCs and dot matrix printers. In 1995 the Museum Service merged with the Galleries Service and the system was extended to support the documentation of the Galleries collections. Between 1993 and 1996 twenty one data entry screens have been developed using Advanced Revelation. A stand alone DOS based system, it continues to be used for the recording of Biological Material at the Leeds Museum Resource Centre.

Advanced Revelation & Natural History Collections

Many of you may be familiar with Advanced Revelation through Recorder, and has been used for many years by the various Biological Record Centres. The system was adapted for us for museum documentation purposes complete with the species lists found within Recorder, and has been a remarkable success to date.



Open access area, Leeds Museum resource Centre

However things have moved on dramatically over the past years, and "Advanced Revelation" has been superseded by other products

Responding to external pressures
The closure of the City Museum in 1998 and our relocation to a Resource Centre along with the entire Natural History Collection gave us a unique opportunity to reconsider our needs regarding ICT.

Many new software products are now on the market, some of which are designed for the small museum and others specifically aimed at the large museum services.

During 1999 we have written a detailed specification that describes the new collections management system we require, along with assessment criteria. We are very hopeful that we will be able to start the formal procurement process in April this year. Formal approaches to software providers will enable us to confirm the potential and possibilities and move away from the "it will do anything you want" and "we can make it do that if you want". Words welcomed by museums but frowned upon by Council IT and Procurement departments. This will take time and we need to be aware of the impact the introduction of a large system will have on us.

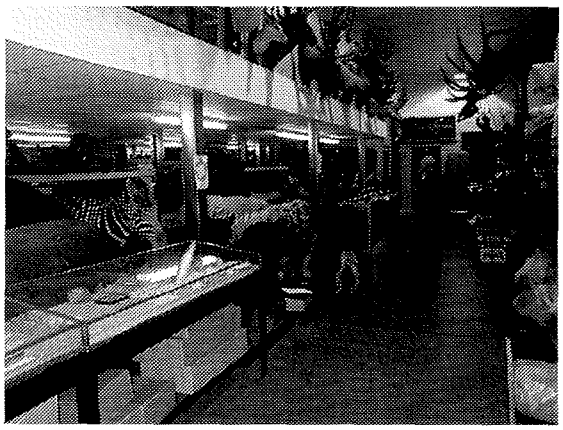
In the meantime we have had to respond to local and national initiatives. New Opportunity Fund projects in partnerships with other Leisure Service Departments are making a start putting our collections on the world wide web. A major development in Leeds is the Leeds Learning Network. that provides Leeds schools with a learning resources. As a key partner and content provider a DfEE funded project called "Making Connections" which draws from our collections to provide schools with unique learning materials, chat rooms and bulletin boards. All these projects have been test beds – with massive learning curves for us all.

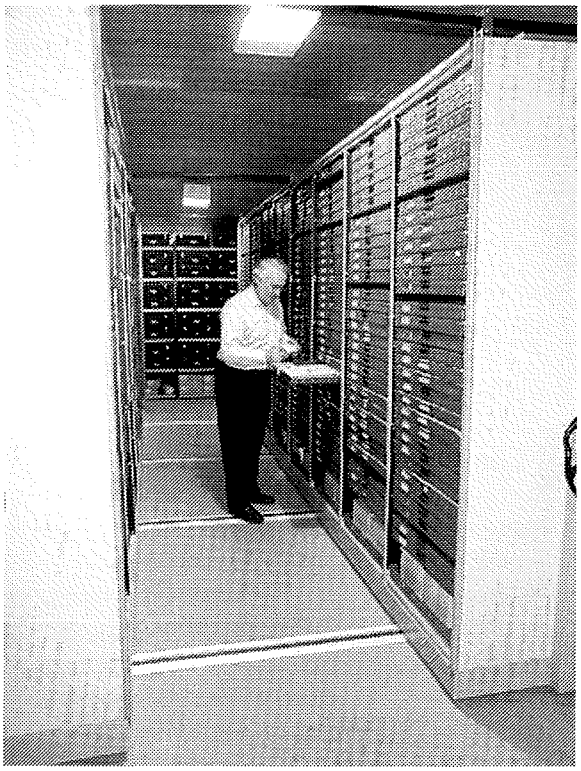
Designation Challenge Fund

The development of the Internet as one of the main avenues for disseminating information has placed new demands, and expectations on museums. We are now expected to deliver information electronically by e-mail and via the world-wide web. A few museums in Britain, such as the National Museum of Wales, have already been able to spend the time and money required to establish direct links from the web into their own institutional databases.

Within the council environment restrictions apply. We have had to work closely with them to ensure that they understand what our requirements.
We have also had to be clear about our inten-

Open access area, Leeds Museum resource Centre





Roller racking for designated mollusc collection, paid for by Designation Challenge

tions. Are we really going to give public access to our data base? – all 100,000 records? We have had to responded to this debate and the pressures of providing information electronically.

During 1999 we agreed to run a project that concentrated on improving the collections database and to look at ways of promoting the Natural History Collection via the web. It also provided the Service with a pilot for networking. Providing real data on the resources required – from additional power supply to staff training.

As we speak a network is being installed at the Resource Centre to provide the staff team with access to the City Council network and all that that provides. It will also enable the Natural History data base to be networked providing multiple data entry and access by staff.

But even this work causes problems. Recently the **mda** has carried out a research project looking at what has been made available by museums and it is clear that there are important questions to be considered. Not just those of confidentiality and security but those regarding the real the value of the information and images.

There are many other considerations, some of which will be familiar to you all. The problem that is often quoted first is the cost of such a service. Yes it does cost money, and does seem to be an extravagance, particularly when services are being threatened with cuts, or we have other priorities, such as a leaky roof.

Money is not usually the main factor preventing us placing our collections on the web. Information is usually the main problem, or should I say the lack of available information within our databases.

The following are just some of the main problems we face.

- **The size of the collection** – The Leeds shell collections for example have at the moment about 24,000 molluscan records on the museums database. This represents about 8 percent of the collection. We estimate that the total number of entries will be circa 300,000.
- **Incomplete records** - Of these 24,000, about 8,000, or one-third of the records, are incomplete. By this I mean, grid references, county names, vice-county numbers, sea-area's etc are missing from the full record.
- **The time scale required** - The time taken to input records can easily be worked out. Over the past six months this has worked out as an average of 2,000 records per month. We have an estimated 276,000 records to be computerized; at 2,000 per month this will take an estimated 138 months, or 11.5 years. As you can see from these figures, it will be many years before we can even think about linking the system in full to the world-wide web.

Pictures

- **Photography** – has been a standard tool for the recording of museum objects, for at least 100 years. The written and photographic records, however, are often stored separately, and

in some extreme cases by different curators in different departments.

- **Digital cameras** - and the data packages to manipulate the digital images have come down in price dramatically, over the past few years.
- **Modern computer and digital technology**, allows us, if not to store the image and the written record together, than to access both at the same time, through electronic links. This allows us to use the information and the images much more constructively, through the use of other media.

Priorities

We as custodians of natural science collections have a duty to make available information on our holdings, to the best of our abilities.

Many larger museums, The National Museum of Wales and the Royal Scottish Museum for example, have in the past published hand-lists of particular sections of their collections. This was always far to expensive for many of us, but the internet has opened a door into a world of cheap publications, which also have the advantage of being flexible and capable of being updated as further material and information becomes available.

We have identified a number of practical priorities for our own collections as follows:

- **Electronic Publications** - The production of selected and illustrated hand-lists, to be published on the WWW. These will highlight certain aspects of our holdings, such as our large international collection of freshwater bivalves, many of which are type of figured specimens.
- **Scientific Papers** – On the people who built and acquired the collections, and objects held within them
- **Exhibitions** – A series of exhibitions highlighting the collections as a whole and not just a few selected items. These can be standard three-dimensional exhibitions or
- **Electronic or Virtual Exhibitions** – Such as the two which are in production now with the aid of students from Leicester University Department of Museum Studies.
    - o **White Gold** – A virtual exhibition on ivory, its uses and conservation, aimed at all ages and for use over the web.
    - o **Going, Going Gone** – A virtual exhibition on some of our rare and extinct animals.

Edinburgh AGM 1998

Legal Eagles — Wildlife Collections and the Law

Day 2

The Extraction of DNA from Old material

Alan Cooper, Oxford University Museum

What I would like to talk about this morning is everything we would do to a specimen after we have got permission from you lot to actually destroy it. So we will determine it is legal, you've got your Article 30 certificate and you have gone through the process of working out whether the destruction is going to be worthwhile, i.e. the information we are going to get from the specimen is going to be useful enough to justify it. I think Richard Thomas will be talking a little bit more later on how you might go about doing that. To give you a quick overview of the field of ancient DNA. This is the quagga, or was the quagga, an extinct zebra like species from South Africa and in 1985 this was the first extinct organism to have DNA recovered from it and analysed. From a fairly simple study, the quagga had only been extinct 60 or 70 years, the field jumped into the really big scheme of things, millions of years, with reports that DNA could be recovered from amber. The amber work has largely been discredited since that point.

These are the publications from 1984 on the left to 1998. We started of with the quagga, the Egyptian mummy, a human brain from Florida, everything was fine and dandy, we are looking only at specimens, we are back about a 1,000 to 3,000 years in age. Things went berserk about 1990. We had reports of around the 100 million year mark that DNA could survive that long, from Miocene leaves, termites, weevils, dinosaur bones, even bacteria. Basically I don't think any of those discoveries are believed in any more – I'll talk a little bit more about the problems a little later on. Then you have a range of other material, moas, that I have been working on in New Zealand, mammoths, cave bears, etc. The interesting thing is that all the reports which have been replicated or authenticated in some way go back in time to about this point. There is actually a theoretical limit based on the decay rate of DNA at about a 100,000 years and I suspect that that is how far we are able to go back with ancient DNA and optimal conditions. Optimal means deep frozen for a lot of these things i.e. permafrost.

What type of DNA are we looking for? You might think there is only one type of DNA and technically speaking you are probably right. We tend to talk about DNA from two different sources from within the cell. We have a nucleus in the middle which contains the genome. The little blue dots are mitochondria and these are what we call organelles, an analogy would be an organ in your own body. They are small semi-autonomous organs within the cell. They actually have their own genome and we tend to use those for ancient DNA studies because there are many mitochondria per cell, somewhere between a 1,000 and 5,000. Each mitochondria has, in itself, five to ten copies of it's own DNA. So, you are talking rather a large number of mitochondria copies of DNA in a cell. The nuclear DNA on the other hand – if you are after a gene which is present only as a single copy and most of the genes that really do anything particularly serious are present as single copies you are talking two copies in the entire cell. So if you had an ancient specimen and it only had one cell left in it and you are after a gene to study if you chose a nuclear single copy gene you have two chances in that whole cell of ever finding it whereas if you chose mitochondrial DNA you would have close to 50, 000 chances of finding it so you can see why mitochondrial DNA has been the gene of choice. There are multi-copy nuclear genes. They tend to be not too informative for phylogenetic studies or evolution. There is poten-

tial there for perhaps looking at individual identification but that is still largely unexplored.

So the mitochondrial DNA would be at least 90 – 95 per cent of the ancient DNA studies so far. The nuclear DNA has been used very rarely and I think no one is quite sure whether it has actually been successfully retrieved in anything older than about 60 to 80 years. The character we measure in mitochondrial DNA is generally the sequence of a small section or piece of the gene, whereas in the nuclear DNA, if you were doing something like micro-sattelite work you can either use the sequence or just the size of the product. Often that is variable enough between individuals to be used as a character worthy of study. Mitochondrial DNA is generally useful for studies in populations or particularly between species and above.

In the best case scenario when we are working with mitochondria DNA how much is actually present in an ancient specimen? If we look at some of the studies that have been done with Neanderthals or human remains where quantifying the amount of DNA is quite important in terms of proving what you are getting is the real thing. The estimate, I think, is about 200 copies for a 100mg bone and that seems to be both true for both Neanderthals and things more recent like the Anastasia remains. I suspect, however, that museum specimens may actually have a lot higher concentrations of DNA depending on how they are actually being prepared – I'll talk about the preservation in a minute. If you can imagine 200 to 300 copies of mitochondrial DNA and 100mg of bone and then the people who have been handling that bone, the curatorial staff, the people that are preparing it, the archaeologists the sweat on your hands or the breath that you are breathing all over the bone contain numerous fragments of cells that you have just shed. Each one of those cells has about 5,000 copies of your mitochondrial DNA so you can see that trying to work with some of the ancient specimens is going to be difficult. It is going to be a very small amount of the original DNA covered in masses of modern contamination and that is one of the harder problems with working with human remains. It is a little bit easier when doing studies on fauna, birds in particular, which is what I specialise in. But still it is important to realise how much DNA museums and archaeologists contribute to a specimen. Even in tissue or bone there are pores in the surface and basically you just get capillary action. The sweat is greased with bits of cell debris and that stuff is whipped up into these pores and your DNA shoots inside the specimen.

Where is the DNA preserved? There are a variety of sources of material. I prefer bone for several reasons. Firstly, you can clean the outside of a bone off with sandpaper and a drill and that will remove quite a bit of contamination. The DNA in a bone is largely protected from some of the processes that go on after death. If you consider DNA that is stuck in tissue, once the organism has died there are many enzymes floating around in your body mopping up anything that is foreign, viruses etc or enzymes which are contained within cells to do their jobs properly. After death a lot of that stuff is let lose and there is a massive period of what we call cortilitic damage when your own enzymes are chopping everything in sight. DNA in tissues is subject to that sort of action for quite some time, there is quite a lot of moisture in there and that is basically all the enzymes need and they are off chewing everything, DNA in bone, particularly in osteocytes (cells that are actually entombed in the bone)

[Slide]. – This is a cross section of a rhino femur from under Lloyds Bank in Trafalgar Square. It is about 30, 000 years old and has been preserved in the cold mud and clay of the Thames. Basically you can see after about 30,000 years enormous detail in the bone structure, the original (?) canals, interesting little flecks all over the cells. Particularly, within this structure you have osteocytes which are cells which are there to secrete calcium or reabsorb calcium in response to stress. So those cells are entombed in the bone and after death and not bathed in blood or liquid for the days or weeks it takes for the body to decompose so the DNA tends to survive a lot better. You may think that bone sample are going to be hard to come by, particularly from bird skins, for example, but quite often we find that the tops of the humerus are left in

prepared skins, you'll find fragments here and there or perhaps even toe bones (removed by a little incision from under the foot). If you can't get bone there are many tissues which will work reasonably well. It is best to sample from the extremities where this period of automatic digestion has been fairly limited just because it dries out faster. I find a particularly good source is from the thick skin on toe pads on birds but I suspect it will work equally well for mammals. No one has told me yet that it is a phylogenetic character so I have kept on using that and found it to be one of the better sources. The body skin on birds tends to be very thin and not contain a lot of cells and if you sample anywhere around the neck or the chest area both sites are going to be very close to the gut and there is a lot of bacteria in there which is basically going to go haywire after death so you find that a lot of that material has been quite damaged.

This is another specimen from New Zealand which is what I did part of my thesis on. It has fallen into a gap between two cave systems and basically got freeze-dried. It is between two large caves. They have a shared entrance and the caves have exits at different heights of the mountains creating a pressure difference which causes a draft to flow through the cave so there is normally a constant 30 mph wind going across this site at about 8 degrees C so effectively you've got a freeze-dried specimen. So what I did with this was to compare the various bits of tissue for DNA sources. You have bits of tendon hanging on the leg, dried muscle block on the pelvis, the bone. I figured we could actually have a look at some of this stuff and see what the DNA content was. Here are some of the pieces here, tendon fragment, skin, the rib which I have actually shattered with a hammer. What we found when we looked at it – this is a slide of an agrose gel which basically if you just think of it as a sieve that we are running DNA through. The larger the piece of DNA the slower it will progress through the sieve and we are starting at the top and we are coming to the bottom, we are using electricity to drive this. What I have done here is amplified a small piece of DNA, actually three different pieces of DNA. I've tried to amplify one a 147 base pairs, 200 and 400. The bone sample gave a very strong amplification when we tried to find a 150 base pair piece of DNA. The flesh didn't give us a very strong amplification. When we go to 265 base pairs the bone is still working well, the flesh – there doesn't seem to be much DNA of around 265 base pairs left in that specimen and by the time we go to 400 base pairs the bone is still looking very strong, there is nothing for the flesh. We did this in 1991. There had been a couple of reports that you could get DNA from a bone but they had all used human skeletons and when you get human DNA from a human skeleton, particularly when you use a technique that no one thinks should work everyone basically says it's your DNA. So this was authentic moa DNA which we had got from the bone and by that stage we started getting very excited about the whole potential of bone as a potential source of DNA. Excited because museums are full of bones! The tendon had a fairly low amount of DNA, the muscle was similar or slightly less than the skin. I suspect that you can correlate the amount of DNA in an ancient specimen with what was there originally i.e. tendon doesn't really have a lot of cells it's mainly elastic, strong helical structures, and the amount of liquid around the site and in the days after death how much damage would have been done by that. Feathers, the quill tip itself, analogous to a hair or a hair root, seems to contain all the DNA. Normally if I was studying a feather I would take off the first 2mm/3mm of the quill and that's all I would use for analysis, the rest of the feather doesn't really seem to contain very much at all. It's possible if you go right down the shaft you might find something but I think about 80 or 90 percent of the DNA is going to be in that first couple of millimetres and that's analogous to a hair root. You can get DNA from quite a long way from down a hair but again it's a very small amount, almost all of it is in the actual root.

Then there is the environment in which the specimen has been preserved. The best environment we find is cold, dry conditions e.g. alpine caves, technically permafrost is actually the best and there you can go back 30-40,000 years and get DNA out. That preserves DNA better than cold and wet which makes sense as the water is allowing degradation to occur, which is better than hot and dry, which is bet-

ter than the worst scenario of all which is hot and wet. So basically, bones from sand dunes on beaches are about the worst and bones from alpine caves are the best. The museum specimens which have been dried fairly quickly after death, haven't been treated with nasty things like varnish etc and then stored in a climate-controlled environment are very good. Not as good as the permafrost but getting there. The amount of time since death is relevant. I am not sure whether that is true due to enzymatic decay or just curatorial practice.

As a first approximation, the macroscopic structure the tissue or the bone is probably going to tell you how much DNA is going to be there as a rough guide. For a bone sample I am looking for a smooth, unglazed and uncracked surface preferably with some sort of greasy tone to it, a yellow, creamy sort of colour rather than a white, bleached sort of thing but you have really got to sample it to see if that is going to be backed up.

To sample a specimen and this is really of a lot of relevance to you. If you are working on human DNA this is the sort of stuff that we have to do. Your looking into a sealed laboratory that has got high-pressure air in there so that nothing from the environment can go in. You will be wearing a complete body suit, masks. The only bit of skin that is going to be exposed is your forehead and we are working on covering that up, we haven't come up with a solution for that yet. You've got little booties on. That's the sort of high tech approach when you are worried about contamination. What we would ask for museum curators doing sampling is, if possible, latex gloves and a breathing mask and that is going to stop two of the main ways in which you are going to contribute your DNA to the specimen. We would try and sample the interior of the specimen to avoid surface contamination. Particularly with bone I would abrade the outside with some sort of sanding disc. For bone, depending on the specimen, I maintain that about 3 – 5 mm cubed is sufficient for DNA analysis. It will depend on how your specimen has been preserved but I think as a general rule that's not too bad. When I'm sampling I try and avoid building up any excess heat because that will destroy DNA so if you are using a drill that will concentrate the heat at the point at which you are cutting so I tend to use a carborundum disc, a round disc about an inch in diameter spinning at high revolutions. That, because of the large surface area, will tend to cool as it goes around. It doesn't build up much heat at the cutting point. In studies that people were doing on teeth for example where they are drilling into a tooth there was so much heat building up that you couldn't touch the tooth, it was way too hot. The DNA recovery from that sort of technique is minimal and that's due to the actual drilling technique, not the amount of actual DNA that's present in the tooth. For tissue we routinely recommend about 2-3 mm cubed again is probably sufficient for most ancient DNA studies. In both of these cases we appreciate more if you can spare it but this is about the minimum we can get away with. You would remove that with a sterile scalpel, changing gloves between specimens and try to minimise the amount of dust or transfer from one specimen to another. You would avoid curatorial materials such as dyes and shellac.

What do you do once you have got the sample? The first thing is to work in a very isolated environment because, as I've outlined already, the amount of DNA in a specimen is minimal while the amount of DNA around is very large. That problem gets worse when your anywhere near a biology department because they are working with masses of DNA. Basically you can regard the floors of any modern molecular department as just a sea of amplified DNA products. Basically there are aerosol droplets going all over the place when people are doing pipetting or other actions within the lab, these things are floating around, dropping on the floor, drying out and becoming dust, everybody walks backwards and forwards picks these things up on their shoes and tracks them everywhere. So, to do ancient DNA work – to give you an example, when I was working in the Smithsonian, this is the National Zoological Park where I was working. Our lab was somewhere around here. That's were all the modern biology went on. To do the ancient DNA work I had to drive all the way up of the page here for about quarter of an hour to get to the lab where I do the ancient DNA work. That's the sort of separation

I regard as being practical. I would also, only do the work first thing in the morning, or in my case, first thing in the afternoon when you have just come in from home and you are wearing clean clothes, new shoes, you've had a shower. All the pieces of DNA that you have picked up from your modern DNA laboratory the day before have basically been shed at home, you've cleaned off and when you come in your not allowed to go to any area involving DNA work before you go to the Ancient DNA Lab and that applies for the whole day. Once you've been into any hot area your not allowed back to the ancient DNA lab. That's just trying to minimise the flow of contaminating DNA into your work area.

The laboratory requirements. Physical separation. Temporal is quite a good one if you can do the work on the ancient specimen before you do the work on the modern species your chance of contamination are reduced. You use dedicated tools. This whole laboratory would have completely separate equipment, protective clothing and routinely using bleach to try and get rid of anything that has managed get into the room. Also controls through every step of the process is very important.

How do we go about getting DNA out. You can use several techniques because certain specimens will present certain problems. Insects seem to have a large amount of strange polysaccharides in their skin and other areas which will get in the way of DNA but behave a little bit like DNA and tend to be isolated with it and then get in the way of all your enzymatic processes later on. You have to use a certain process, C tab(?) is the name of it, to get DNA out of insects. C tab (?) is used commonly in plant material as well. In general for vertebrate specimens I would mechanically chop the specimen. If it was tissue I would chop it up with a scalpel, try and use low heat. This is a parrot sternum from the four-corners area of New Mexico and this is a technique I use. I'd break it down to bone powder and place it in a chemical called EDTA – it's a chemical that likes calcium and will pull calcium out of that bone matrix, leave that overnight mixing well so by the next day a lot of calcium has been pulled out of the bone is starting to look quite gooey. At that stage I would treat the bone just like I would treat tissue – you digest the specimen, you stick in the proteinase which is just an enzyme (I think they're putting it in detergents for washing machines these days), a strong detergent and then you would gently mix it at a reasonably high temperature. What is going to happen is a proteinase is going to chop down those cellular components releasing the DNA and also fats and carbohydrates and anything else that was left behind in the cell. You then extract the DNA from that mix using, commonly, what we call an organic solvent method. Basically you use phenol and then chloroform and what happens is you mix the phenol with your mixture of x cell and centrifuge it and you have an aqueous and non-aqueous layer. The protein products shoot down into the non-aqueous layer, the DNA tends to hang around in the aqueous layer. So if you wash it twice with phenol and then once with chloroform your DNA will be in water reasonably dilute. There are another couple of techniques that you might hear. One is a silica method which basically exploit the fact that DNA will bind to silica in conditions of high salt concentration. That's a technique that is good if you are worried about other components present in your specimen which are going to inhibit your ability to grow DNA later on – things like arsenic, lead, various salts that have been rubbed into specimens. I find, however, it doesn't give me nearly as much DNA as my organic solvent mix so I tend not to use it so much. The last method is a very quick and dirty thing called KX (????), you might hear about. This is basically just a compound that collates, i.e. it binds cations, things like calcium, magnesium, positively charged ions. Wnzymes that digest DNA (called DNA-ases generally) very commonly require magnesium or calcium to be activated, so all your doing with keelex (??) you boil the specimen with these beads and they bind all the magnesium and calcium around preventing the enzymes from chopping anything up. Unfortunately you haven't removed the enzymes you haven't removed anything at all, you've just stopped them working temporarily, so you find many people that do keelex preps very quick, very easy just takes 15/20 minutes, find that in 6 months time that they have no DNA left at all. Basically what's happened is at some stage they've opened the

tube or somehow, a little bit of calcium or a little bit of magnesium has got back into that system and bumph! Everything's off again. And your DNA will get broken down over time. So this is really only if you're not particularly worried about your specimens a lot more than you just want something quick and dirty.

In all three methods you'd have your DNA isolated,. You can recover it with alcohol precipitation either for centrifugal dialysis, especially if it is through membrane and you centrifuge it, the DNA can't fit through the membrane but everything else can, it just sits on top, so you just spin everything else away and just concentrate your DNA. When you extract your DNA you must carry out control extractions. This is very important because of the risk of contamination from modern DNA everywhere. You must extract nothing i.e. stick two blank reactions in there and do all this stuff and try and isolate DNA even though you haven't put any actual material in at the start of the experiment. That's very important to find out how many of your components, your phenol, your chloroform or anything else might have DNA in them, which would give you anonymous readings. To do the extraction you should be using hi-tech safe equipment, I worked in New Zealand where we don't have COSHH standards and this is a converted chart recorded and all I doing there is spinning the bone powder in EDTA overnight just at slow speed. You can see the sort of colour of dirt and gunge you're getting out of the bone material.

So now we've got the trace amounts of DNA back from the ancient specimen, how do we turn that into something that we can use? The whole field of ancient DNA is basically revolutionised by the concept of PCR. PCR is Polymerase Chain Reaction. Polymerase is basically just an enzyme that copies DNA and Chain Reaction is referring to the iterative process that is used. It's fairly clever but relatively simple. There's two pieces of DNA here or if you consider a gene that you're interested in and there is the DNA the two strands are bound together in the normal DNA structure. Now you're interested in this little highlighted area here that you know already exists because someone has already found it in a frog, for example. What you do is design a little synthetic piece of DNA, which you'll get made in a chemical company called a 'primer', a PCR primer, and that's this little short piece here. What you've done when you've designed that is made sure that it will match a little piece here and here of your existing gene. What it is going to do is it is going to stick to it, it is going to recognise what it has been designed for and it will locate it amongst the entire mish mash of DNA and find just that spot and join onto it. So what we do is take the original piece of DNA, you heat it up to about 90 degrees at which stage it will separate. The two strands can't hold themselves together at that temperature and now you've got this piece here and this piece here. You then cool it down, as you cool it down the DNA will want to join together. If you put enough primer, in the primer is going to get to the strands of DNA before those two find one another, so the primer is going to join on here and join on here. What happens then is the polymerase, it's job in life is basically to recognise a double stranded piece of DNA, that becomes single stranded DNA and fill that hole. It's there to repair damage from UV light or errors in your own copying when your cells are dividing. It's there to fill in holes and prevent errors. So it sees this nice double stranded piece here and it sees the single stranded stretch and it thinks, right better fill that in, that's going to be dangerous, so it copies this strand all the way down, filling in the appropriate piece of DNA that is complimentary to it, i.e. A, T and G will bind with C, copies it all the way down there and copies it all the way down here. You've now got one, two, three, four pieces of DNA, whereas before you only had one, two and they will be the same sequence, this sequence here will be the same as the original one there, and that is going to be the same as this. You then heat it up to 90 degrees again, and separate it and now each of those four strands becomes a template, one, two, three, four, you cool it down the primers join back on and you go through the process again, they copy each of those four strands and you now have eight. You do that about 40 times and you end up with many hundreds of millions of copies of that one short piece of that DNA you've been inter-

ested in. That is important in all sorts of stuff, forensics, medicine anything involving DNA, but it really enabled ancient DNA to become a technique that was relatively easy, because you could take the one or two copies of DNA that were left in a very old specimen and turn them into many hundred million copies which you could then use to study.

To give you an idea of how you build a large piece of DNA, this is the moa mitochondrian genome that I've been working on at Oxford. The genome means in the mitochondrion the entire section of DNA that the mitochondrion uses is about 16,000 base pairs this is 16 and that's zero. What I've done is design lots of little primers, these little things here to amplify small, short regions of that lower DNA and by doing this on and that one and that one and this one, I'm actually building up the entire sequence, I've just overlapped them and this is the sequence that has been generated so far, here to here, got a gap there, something didn't work, and then here to here and then here to here. So while ancient DNA has traditionally used only very short pieces of genes, maybe 200, 300 base pairs, people consider that's so difficult, that's going to be enough, unfortunately it may not be enough data. It might be enough work but it's not going to be enough data to make any real conclusions. So what I'm saying here is we'll just ignore all the dogma, and what we're going to do is to sequence the entire thing. I've designed primers right the way across, there is a gap here, I haven't gone between 9 and 14 yet so I've still got about half of it to do, but this has taken about three months, to do those three sections, so I should be able to knock it off before August. That would be the first mitochondrian genome of an extinct species. Technically, if you're really interested, you could then synthesise this protein, knowing the sequence and find out if it worked. That would tell you if we are accurately recording information from the past because if it didn't work you'd know there was a problem, the bird certainly lived at some stage, the proteins had to work. You could synthesise the whole thing too but it would cost a lot of money and I couldn't see the point of it. Those are fun things you could do if you had too much cash. I'm referring obliquely to a couple of Japanese scientists that are thinking of doing this sort of stuff.

So, PCR is very powerful. You take one copy of DNA and you turn it into a hundred, million copies or so. But it's very, very sensitive and that's because of contamination. While I've got one copy of moa DNA, I might have had a hundred copies of human DNA sitting around it. I got to make sure I get the right thing and not human sequences right throughout. So that's one big concern. People take that far too lightly when they do ancient DNA studies in general. You find people working in the same lab as modern PCR experiments. They'll be sitting in one corner trying to study one copy of DNA, a guy three feet away has generated a hundred million and is just spilling them over the bench and people think this is acceptable. You must do a control PCR reaction, probably more important than the extraction control because here you know that anything is going to be amplified and this is how you get results from amber insects and everything else. Basically it is very powerful and therefore you have to do preferably two controls for each time you try and amplify something to make sure there is no DNA in the system. To authenticate it when you do get a DNA sequence e.g. out of a dinosaur bone, the first thing you've got to do is check the sequence of DNA makes sense. This is the first thing the people in America didn't do, well I suspect they did and it didn't make sense, and didn't report it in their paper, because when you analyse a sequence it came out next to humans and cows I think, so fairly obviously that was mammalian contamination. It should be ideally a novel sequence particularly if your specimen is extinct, i.e. there shouldn't be any DNA from a quagga floating around in the world today, so the sequence you get from a quagga should look different from anything before, although preferably closely related to a zebra, and you should have blank controls, that's very important. These were the criteria that we used to use until about the early '90's when some of the amber stuff started coming up. At that stage people started demanding replication. If I say I've got dinosaur DNA, I'm not allowed to publish that until I get another laboratory to independently sample that specimen and also get dinosaur DNA and have the same sequence that I've

got. Once that criteria came in in about 1993 there have been no more reports of million year old DNA.

Then you've got things like histology. This is where you've still got a DNA sequence. It seems to make sense, you can't disprove it that way. It's a good idea to go and look at the specimen. Work out, for example, if it's bone? Is there any macrostructure? Can you see collagen fibres in there. Does it have good histology? Can you see the cells that I showed you before? There is a scale of one to five which some people on Oxford Archaeology Group have come up with to grade how well bone is preserved. Anything greater than two is generally accepted as being possible for DNA analysis. You can see how much nitrogen is left. The percentage of nitrogen in living organisms is about four to five percent. Anything over three percent in an ancient organism is encouraging. Then you can study things like rasamisation which is how proteins have decayed through time. If there are minimal amounts of decay you might be excited. You can do things like carbon dating. Basically, if the specimen is older than 11,000 years and it hasn't been preserved in ice or very cold conditions I think you're going to be very suspicious if you got DNA out of it.

Now you have got your sequence, you've authenticated it as much as possible. What can you actually do with it? Originally it was all phylogenetic studies or anthropology, e.g. the quagga – how would that fit within zebras? How are these ancient humans related to modern humans? The million year plus club turned up and they all tried to study evolution over a very long time span. You've got the saber tooth cat, how that fitted in with the cat family? Moas, cave bears, ground sloths, mastodons. Those projects are much easier are going to be a lot easier because your risk of contamination from modern humans is going to be minimised. Things like Neanderthals, the iceman are much more difficult but have still been done.

I want to talk about the study on the Laysan duck which is one that I have been involved in because that had some legal implications which were slightly interesting. The Laysan duck is a threatened species that has varied between 20 individuals and about 500 in the last 60 years. It wanders around, amongst the sand dunes on a remote atoll of the Hawaiian island chain called Laysan Island. Very small, it's about 270 hectares. This atoll is basically a large lagoon surrounded by a thin strip of coast with very little height. It's very isolated, small population and one disease or hurricane is probably going to remove the species completely from the wild. You think that there would be a desire to set up another population so that you have an insurance policy for that species but the politics of introducing things to Hawaii are very sensitive because so many of them have been done badly and have gone completely wrong like the mongoose. So, at the moment, the Fish and Wildlife Department couldn't do this, there would have been a legal challenge and therefore, the conservation management of the Laysan Duck has remained in limbo.

This is what the Laysan Duck largely does. It feeds on the flies that live on the lagoon and people thought that this was a fairly specialised ecology, you don't see that too often. A lot of the conservation plans have been based on this behaviour of these ducks. On the main islands of Hawaii I've been working with Helen James and Sors (?) Olsen doing a lot of caving there, finding old bird bones. What I did notice was that there was a duck, particularly from high altitude lava flows where you have caves. That duck didn't seem to fit anything else that was known from Hawaii today. It was a little bit larger than the modern ducks – the mallards and co. Ecologically it didn't make sense. What sort of duck lives in very dry lava fields? They couldn't identify it so they suggested that perhaps it is something related to the Laysan duck and that we might want to have a look at it from a DNA perspective. We extracted DNA from bones that were 1,000 – 2,000 years old. Quite poor condition in general, they were fairly fragmentary. We extracted DNA after a bit of effort and found, interestingly enough the DNA from bones fit right in with the modern Laysan duck population where there is no mitochondrial DNA variation whatsoever. These are the places in the sequence where you get variation between the Laysan duck and other possible out-groups

and these guys match up. A phylogenetic tree based on that shows you the bones grouped very tightly with the Laysan duck and actually revealed that there was a little bit more variation on the paths, just different form of DNA which is now not seen in the modern population – they're down to one form. It is quite separate to all the other ducks on Hawaii. Because we can show that the Laysan duck was formerly distributed all over Hawaii at high altitude the Fish and Wildlife Department now has some sort of defence to say that we can actually reintroduce this bird to Hawaii. It was there formally. The Hawaiian natives had exterminated it when they turned up but formally it was part of the ecology. You don't precisely know what it is going to do because the ecology has changed since it disappeared but you certainly know it had a role in the original one and one of the islands they are reclaiming from the military might be used as a source for setting the Laysan duck back up in Hawaii. I think most importantly, it showed that peoples views of how you should conserve an isolated island endemic by feeding it brine flies and keeping it on a little atoll had nothing really to do with what that duck was originally adapted for. It was a high altitude specialist ranging right up and down the Hawaiian island chain. It probably had quite a diverse set of ecological niches it could have exploited so basically when you come across small populations in the Pacific quite often they are remnants of a much larger widespread group and really you should take that into account when trying to plan what ecological climate they are going to have.

One last thing. I would just like to say from the ancient DNA perspective we are all very reliant on the museum curatorial staff to give us our samples and basically we can't do much more than acknowledge the museum in all the publications we get but without you guys we can't do our work. What I have done in a couple of cases is about the only thing I can contribute back is write letters of support and things like this during rounds of funding cuts and we've done this a couple of times in various museums but basically we will do what we can but in the mean time we are totally reliant on you guys.

DNA from Museum Specimens

Mark Wilcox
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The work I am going to present is work that has been done with Dr Malcolm Hall from Liverpool University, Dr David Mellor from Liverpool John Moores University, and I am grateful for the assistance of Dr Clem Fisher from Liverpool Museum and Dr Andrew Kitchener from the Museum here in Edinburgh.

We first became interested in what we could get from museums when we started to look at some bones that were collected from Furness Head. This [slide?] is a piece from a rib bone from an unknown species, although it was almost certainly a feline. These bones had been excavated from a small crevice that had possibly, in the past, been part of a cave system. The bone had been completely mineralised on the outside (ranging from about 0.1mm to 0.01mm). On closer examination of this bone we found a number of quite interesting objects, notably this cell here[slide]. This doughnut shape and characteristic size of about 10 microns made us think that these looked very similar to red blood cells.

We did some electron dispersive micro-X-ray analysis of the bone and found that the interior of the bone gave us readings which were very similar to contemporary bone in terms of the elemental composition, including calcium, magnesium and iron. When we scanned the cells themselves, we found a very high level of iron compared to the background and, again, this made us think that perhaps what we had were blood cells. If you look closely you can see that there is some damage to these cells. We were rather curious about this damage until we started to look at fresh blood cells, which we also scanned using EDXA. We found that the X-rays actually made a very similar damage pattern to those fresh blood cells, so we had another look at the bone. This time we didn't use EDXA, and found that some of these cells were completely

undamaged. This led us to the perhaps startling conclusion that from this bone, somewhere between 5 – 7,000 years old, we've got tissue in a very good state of preservation! In fact, we may even have tissue in a soft state, despite the hard, mineralised exterior. We became quite interested in this and decided to try and extract some DNA. This is a multiplex PCR to amplify DNA, using specific primers for feline cytochrome B. This [slide] is a fairly large fragment, about 400 base pairs, and a much shorter fragment of about 80 base pairs at the top. It appeared to us that we could actually get DNA from bones that were about 5,000 years old. This led us to start thinking that we could use museum collections.

I'd like to just summarise the procedures that are involved. One has a DNA extraction method which is dependent on the sort of source material that you are using, be it feather, tissue or bone. After you have got your extract, you then go on to the PCR step and then you do your double stranded sequencing, and finally down to your analysis. The two stages that I would like to concentrate on are the DNA extraction and the PCR stages. From the museum perspective these are the critical stages.

We were wanting to use DNA from museums for a couple of projects – Amazon parrots and Psyllids, a small insect which people are interested in terms of potential global warming and speciation questions. When we started to use these specimens, we found our task far from straightforward. Our hit rate, the chance of getting amplified product, was not 100 percent. After consultation with colleagues working in other labs, we found that this wasn't actually a problem specific to us and that a lot of people had problems getting DNA. We decided to take a very basic look at what was going on. We figured that there were two problems. The first one was the preservation of DNA and the second one was possible inhibition of DNA extraction or PCR steps by chemicals used in preservation of the sample.

There is probably little we can do about the preservation with the current technology. If the DNA hasn't been preserved particularly, then that's it, you've got to use another method to answer your question. There is some work going on with the use of lygases which actually repair DNA, although the likely results of those studies are going to be controversial if they are used for phylogenetics. There is also work using tunnelling electron microscopy where you actually look at the DNA directly, although the state that is at is far from being ready for use in widescale genetic projects.

There are other possible solutions to preservation problems. You can use mitochondrial DNA. The copy number of mitochondrial DNA far exceeds that of nuclear DNA and also, because it is a closed circular molecule, it's preservation is much better than nuclear DNA. Another method is to use overlapping contigs. These are essentially very small products that you amplify, typically of the order of a 100 or 200 base pairs. From fresh material, it is not unusual to be able to get 10,000 base pairs very easily and when we are talking about museum specimens we typically find that 100-200 base pairs is a fairly modest target.

Other alternatives include taking multiple samples from the same specimen or, if the specimen is well represented in a collection, from different specimens. This sometimes brings us into conflict with curators because there is obviously a great deal of emphasis on keeping samples for future studies and this sampling tends to be destructive. Taking multiple samples is actually quite important. This slide here shows some sequence from a Thayer's gull feather. The feather is about 60-70 years old and it is a single feather. What we find from this single feather, on a number of amplifications from different samples, we have got a conflict here. The sequence is very, very different at one point to that at another and you can see that in the alignment of the bases.

When DNA is damaged, and the damage is widespread, then at the PCR step you tend to get a complete failure. So those damaged DNA fragments fail to replicate. However, if the damage is actually quite slight, perhaps

just one or two missing bases, polymerase can still travel along that strand copying it and so you don't get a proper replacement of your damaged template from your final pool of PCR products. At the end of your PCR step, when you come to sequence and actually read that DNA, you can find that you have got these spurious sequences in your sample. You also have to be very careful with the polymerase, because there are different fidelities associated with different brands, as it were, of polymerase. The fidelity is the accuracy with which that polymerase copies the original target DNA.

Going on to the second problem with museum specimens. This is one of inhibition, and different preparation methods can result in inhibition of enzymes used in either the first step, the DNA extraction step, or in the second step, that of PCR amplification. And, of course, some preservation methods are actually detrimental to the survival of DNA for future studies. It looked like this was going to be the step that we could actually make some headway.

We got a supply of different samples of bird and mammal skins which had been treated in different ways. Using a control, which was simply a freeze-dried mouse skin, and using this EDXA technique, we started to have a look at what elements were present. We expected oxygen, phosphorous, sulphur, chlorine and potassium, because these are just normal elements that you would expect in skin samples. Anything that differs from that control is likely to have been introduced during the preservation technique. We found it quite difficult to relate preservation techniques of, say, arsenic treated skins with the final elements that we detected. Because so many museum skins don't have very good records about preservation, especially those preserved in the last century, this was a problem.

What we did was to take samples of those skins, duplicate them and cut them in half. Half went for EDXA treatment, looking at the elements. The other half we soaked in water for 48 hours to produce a rinse water, to look at the water-soluble compounds that were in those treated skins. We then took the water treated samples, removed the water and introduced a known amount of protein ova albumen together with protinase K, which is a typical enzyme used in DNA extraction, and looked at the action of protein hydrolysis over time.

Obviously, at the start of the experiment we had a 100 percent of protein and, as the experiment went on, some of that protein was digested [slide]. (These samples here relate to the samples on the previous slide with the different treatments). Using an unbuffered DNA extraction protocol which is not dissimilar to many which have been used in published papers, we found that there was very little digestion in some of these samples and more in others. This is the untreated sample [slide], so that you can see that in unbuffered conditions we've got about 20 percent digestion. There was a significant difference between two groups of skins. It looks like some of those treatments do prevent maximum utility of protinase K in the DNA extraction stage. We then used a buffered experiment using EDXA and kelax(?) and we found a tremendous improvement in the ability of protinase K to digest protein. As you can see [slide] we have got a great deal more digestion going on here. What we had was a picture where some of these preservative methods do actually hinder the DNA extraction stage, decreasing the effectiveness of some of the enzymes we might use to break down the sample to release that DNA.

The next stage of the experiment was to take some of the rinse water and introduce it into a PCR reaction. We took a known amount of DNA from a plasmid and tried to amplify a very small gene, the laxed(?) gene – about 370 base pairs, by using the rinse water on two different concentrations of target DNA, of the order of 10^5 and 10^8. That is to say, the first one has 10^5 copies of DNA and the second one has 10^8 copies of target DNA. We then performed the PCR experiment and found that there is a big gap where we are getting no product. We know that we have got good DNA and we know that our primers are a perfect match, but what we are finding is that there is some inhibition on the treated museum specimens that is preventing that DNA

polymerase working.

We are now trying to go on from this work, using an ion exchange resin to try and clean up the DNA from museum specimens prior to both the DNA extraction and the PCR stage. We are also using EDXA and mass spectrometry to try and fingerprint museum samples and this will give us an idea of the chemicals used in preservation. Then we will be able to relate that to possible inhibition effects and be able to try and solve that by different clean up methods.

We are also working on repeated, non-destructive sampling for DNA. One of the projects we are looking at involves bird skins. Many of these skins do not have bones and we have been using feather, with about a 30% hit rate in terms of amplifying the DNA. What we are now trying to do, rather than taking the feather off the skin, is to actually do the DNA extraction on the skin by introducing the extraction buffer through the shaft of the feather and incubating the skin at a slightly elevated temperature of about 35 degrees. By doing this, we can sample several feathers and only put a very small whole in the feather shaft. The results from this seem to be quite encouraging, but that is as far as we have got at the present time.

Guidelines for Destructive Use of Biological Material

Richard Thomas
Natural History Museum

I'm going to talk about guidelines for the destructive use of biological material. Effectively there are two versions of this talk I could give you. There's the short version. There is really no difference in principal between destructive sampling of specimens for molecular work and any other kind of destructive sampling. In fact, as you have probably gathered from some of the stuff that Alan was saying earlier, destructive sampling for molecular work is sometimes much less destructive than some of the techniques standardly used by morphologists when they are doing some of their techniques. I'll give you the slightly longer version of the talk which is derived from an article in a now extinct publication called 'The Ancient DNA Newsletter' six years ago, and written by ????? Havow (?), Bob Wayne and myself and much of the material in that article has subsequently been incorporated in the NHM's policy document on sampling for molecular purposes from the collections.

The somewhat longer version. I think we need the somewhat longer version because there is this cultural difference between molecular biologists and museum curators. Curators often see molecular biologists as sort of evil interlopers who soak up valuable resources and take up space that could be better used for storing collections. Some of the molecular biologists see curators as traditionalists who don't recognise or are incapable of recognising the path-breaking importance of their research. There needs to be some way of mediating between those two sorts of cartoon extremes. Specifically you need criteria for evaluating requests for the use of material and that pre-supposes having somebody around who is qualified to evaluate the requests. You also need to consider what a museum or holders of a collection should expect to get back from a loan of material.

In 1992 we came up with five criterior for evaluating requests for destructive sampling of specimens. The scientific value and the feasibility of the project, the qualifications of the investigator or the lab to do the work, could they possibly get this material some other way other than destroying specimens like from captive populations or wild populations. The volume of the material required relevant to what is in the collections, so if they are going to grind up half of the single existing individual of something it would probably not be a good thing. And finally, the staff effort required to fulfil the terms of the loan. I will go through all of these in slightly more detail.

Feasibility and scientific value. Is it of sufficient interest to justify the damage done

to the collections? A lot of ancient DNA work initially started out looking a little bit like stamp collecting, saying ooh, we got the oldest sequence and that is about as far as it went. If some question of general importance is not being asked you might ask yourself whether it is worth destroying the specimen. Is it technically feasible? We have heard a lot about what is and isn't feasible today. It is a rapidly moving field. Techniques are improving. I think PCR was probably the one big thing and there is not much we are going to be able to do with specimens where the DNA is just no longer there. Hence there are limits, and I would be extremely sceptical for requests for material over a few tens of thousands of years at the very outside. Also, be very sceptical of projects requiring intact DNA of more than, at the very outside, a few hundred base pairs. Evaluation of the scientific value and feasibility usually requires having somebody around with a little bit of experience in this and I realise that most smaller museums don't have any in-house experience. The NHM and some of the other larger museums that do have that type of experience are generally willing to help evaluate the requests for the use of material.

The qualifications of the investigating laboratory to do the research. Do they have the technical competence. You might ask if they have a relevant publication record or some other relevant experience that indicates that they have got the technical competence, the facilities and the ability to work carefully enough to maintain the sort of standards that we've heard from Alan. Working from ancient material or material out of collections is often a little bit hit and miss. The success rates are generally not anything like 100 percent and if somebody comes in and asks to have a sample of all 532 specimens from a particular family, you'd tell them that you could give them half a dozen or so and see how they get on before they come back and slash and burn there way through the rest of your collection.

Tape 1, side 2

Could they get this material some other way? Generally speaking, with the difficulties of working with material from collections people generally aren't going to treat your collection as a free candy store to go pick up anything they need rather than making a slightly greater effort to get it from a fresh source. There are quite a few situations in which sampling from a collection is definitely legitimate in my view, extinct and endangered taxa, increasingly in the world it is getting logistically or politically harder to sample from some groups of organisms in some places.

This might be a good point to bring up a point that I was hoping Alan would but didn't - Museums being repositories of specimens that maintain DNA in a very good state rather than in frozen tissue or other methods of preserving nucleic acids and other bio-molecules in a very high state of preservation. We maintain a small _____ point of frozen tissue collection at the museum which fairly opportunistically gets specimens from, for example collecting trips along the continental slope – fish that are fabulously expensive, each of these individual fish costs hundreds of pounds if you cost it out to collect. We take small samples of muscle tissue and freeze them at –80 degrees. Again, that not something a lot of museums are going to have the wherewithall in funds, space and expertise to do but there are places like our institution and a number in North America and increasingly some of them will be willing to take on specimens like that.

Volume of material relevant to what someone wants. I recall us having a request for somebody wanting a pretty sizeable fraction of a grasshopper that had been collected on one of the Cook voyages. That was a very unique and historically important specimen. Rightly in my mind the curators in the museum decided that they shouldn't really grind up most of this specimen for molecular purposes. But in many cases, like in our vertebrate collections, somebody wants a few square millimetres of hide or a few bits of muscle tissue it's not doing significant damage to the specimen. There is a huge grey area between these extremes and that's were the judgement of the curator comes in and consultation, where required, with people with the relevant molecular experience.

The staff effort required to fulfil the terms of the loan. Obviously you all work very hard and your funding is not adequate and you don't have time to do the basic stuff you need to do to maintain four collections so you don't have time to deal with molecular workers swanning in wanting huge amounts of your time and lop bits off your specimens. So molecular workers, in general should be willing to travel to collections and do the sampling themselves where that's appropriate under the eyes of the curator and at the convenience of the curatorial staff. I think fees for the loan requests and bench charges can be required where appropriate. I'm not suggesting they be required all the time but were appropriate it is a reasonable thing to ask. Molecular work tends to be regarded as expensive and is often supported by grants so it's a relevantly minor thing to include bench fees when processing fees for loans within a grant proposal.

What the museum or collection holder should get back from a destructive sample of a specimen. The NHM requires that people give back alloquots the extracted nucleic acids. We have a facility to store them, it's not a problem for us, some institutions it will be a problem and there needs to be more communication amongst curators about what to do with returns from molecular projects like this. We require, minimally, an electronic copy of any sequence data taken or derived from a specimen and hopefully the people that go to the trouble to do this are going to submit the information with a sequence data base where it will have a proper accession number and hopefully they will have included the specimen registration number in the record (in the sequence data bases there are facilities for that). Museums should get back copies of experimental protocols where they differ from already published protocols so that other people, if they are successful, can use them as well.

We are all trying to justify are existence to funding bodies. It is important that, where appropriate, museum staff are authors on publications or at bare minimum the use of the collections are acknowledged. Collections have to justify their existence in the eyes of funding bodies. Sampling for some of these molecular projects adds value to the collection. You should get back reprints, status reports on projects using material from the museum collection, keep track on people like Alan who sits on material for years without doing anything with it.

Classifieds

Items for Disposal

NMGM (Liverpool Museum) has a number of wooden herbarium cabinets (86) and large metal storage cabinets (13) available for sale. There are also Britannia bases for a mobile storage system, comprising of 1 single and 3 double sided units.
We intend to offer the wooden cabinets in lots of 8 (4 large and 4 small cabinets). This does not preclude bids for single or multiple purchases other than contained in the lots but preference will be given to offers for the lots as they stand. The door and seals are of varying quality. NMGM accepts no liability for the cabinets once the transaction has been completed and reserves the right to reject any bids without prejudice to further dealings.
For further information on any of these items please contact the Botany Section on 0151 955 0813. Details on measurements etc. will be posted out to interested parties.
Reasonable offers will be invited in a sealed bid by 31.08.2001 to *Botany Section, Liverpool Museum, William Brown Street, Liverpool, L3 8EN.* Please mark envelopes 'Cabinet Bid'.
We reserve the right to have a reserved price.
Please note: successful bidders will be responsible for the collection and delivery of the cabinets.

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