Editorial

Dear Members,

I hope in the next couple of issues to be able to update you on the progress of the Subject Specialist Network grant application that NatSCA have applied for from the MLA.

In the NatSCA response to the Museums Association consultation paper *Collections For The Future* it was agreed that a network of subject specialists would be of great benefit. It was noted that a diverse number of formal and informal Subject Specialist Networks such as NatSCA and the Geology Curators Group (GCG) as well as more specialist groups for Entomology, herbaria, vertebrate Palaeontology etc, already existed. There is however little co-ordination or linkage between these organisations at a national or regional level. It was also noted that the members run many of these groups on their own time or with goodwill of their employers.

The overall vision for the proposed SSN is that of a strategic national body for the natural sciences. It would be formed as a collegiate network based on museums, allied institutions and relevant special interest groups working at a regional level with a national steering group composed of representatives from the regions, national museums, museum organisations (NatSCA, GCG) and national bodies with a strong interest in natural science collections.

The SSN will function as a strategic administrative body to develop, organise and sustain projects on a national scale and promote collaborative effort at a regional and national level. It will focus on national priorities and projects with long-term objectives, which will enhance collections care, research, interpretation and public understanding and involvement with the natural sciences.

The initial funding has allowed us to set up a series of regional meetings and really get the opportunity to discuss what we would like to achieve from this sort of partnership. The general feeling was that we should come up with some very practical outcomes that will be of use to everyone in the network.

If you log on to the natsca website, you should see a link to the SSN section which will show you the original brief as well as notes from the various regional meetings. We would welcome your feedback on this, or any comments and suggestions that you might have if you weren't able to make the regional meetings.

- Victoria Papworth

Contributions for Issue 11, March 2007

All articles, letters, news, adverts and other items for inclusion for the next issue of the NatSCA Newsletter should be sent to the address below by February 1st:

Victoria Papworth [Editor, NatSCA]
Department of Botany, Natural History Museum, LONDON, SW7 5BD
email: V.Papworth@nhm.ac.uk
or
Jess Marsh [Assistant Editor, NatSCA]
email: brlsjm2@bristol-city.gov.uk

Letters

Burton Birds

Dear Editor,

Trying to find a home for a beautiful collection of historically important, provenanced, Indian bird
taxidermy shouldn't be that difficult. Surely. A museum or stately home would be delighted to take them on – wouldn't they? Three months, and several appeals later, the birds are still residing at Burton-on-Trent Leisure Centre, of all places, and appear to be going nowhere. The main problem is their size, the second problem is each specimen's lack of data and the last hurdle is their origin – many local museums have a strict 'we-only-collect-from-the-surrounding-area' policy (which is fair enough or where do you stop?). The National Trust and English Heritage are both looking into homing them but at the moment they remain unwanted.

So, what is going to happen to these birds? Is it reasonable to see them sold privately if all public avenues have been exhausted? Would it be more or less ethically sound to split the cases up and retrieve the individual specimens – losing the historical detail but at least keeping the birds in the public arena? A private collector might do this anyway. Should we approach the High Commission of India for
repatriation? Any ideas/offers would be very welcome!

NatSCA is still trying to find this collection a home, it sees campaigning for collections at risk as one of its many roles. How successful it is depends largely on its membership – well connected, interested people, willing to give their advice and rack their brains for solutions to these problems. It also falls to
NatSCA and its members to constantly shout, scream and wave about how wonderful the collections we look after are. Without keen advocates, non-museum and non-science decision makers often find it difficult to get excited about 'dusty taxidermy' or 'pickled fish'.

If you are concerned about any natural science collection then please bring it to NatSCA's attention. We will try our best to help. It would take something to beat a large Victorian case of Indian birds housed in a swimming pool … wouldn't it?

- Clare Stringer, Collections at Risk Officer, NatSCA Committee

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Curator at Bradford Museums

Dear Editor,

I was saddened to hear that the curator of natural history for Bradford Museums, Alison Armstrong, had decided to retire at the end of August. I was not sad for her – she goes on to a retirement of gardening, geology and time to enjoy God's own county – but I was sad for myself and the rest of the Yorkshire and Humberside Natural History Working Group as she has been as asset to us and will be missed. She leaves Cliffe Castle Museum in Keighley and its wonderful natural history collections.

However, this is not an obituary to Alison's career, I am writing to report how delighted I am to learn that Bradford are fully intending to fill the natural history post 'as soon as possible'. At a time when some local authority museums seem at best reluctant to employ natural historians, Bill Grange's post at Derby is a case in point, it is to Bradford's credit that they recognise the wonderful asset they care for and the value of employing a curator to exploit that asset.

- Clare Stringer
Curator of Natural Science
The Leeds Museum Resource Centre

Mounted Bird Collection from the old Burton Museum
- Bill Grange, Derby Museum and Art Gallery

Report on mounted bird collection from the old Burton Museum, now at Burton Meadowside Leisure Centre, Burton-upon-Trent, Staffs

On 9th January 2006, I examined the collection and spent about two hours photographing it and making notes.

There is a substantial amount of material, the birds and some historical items (of which more later) being displayed on a large landing as a remnant of the old Burton Museum.

The main part of the collection is a series of cases joined together as a single unit, 17 feet or so long, with the joints masked off by wide moulding strips. assume that this is how they were displayed in the old museum – but they must have been dismantled prior to being transferred to the leisure centre. I have no idea how easy they would be to take apart again, I attach a drawing, showing the separate case components and their measurements – each numbered to relate to the accompanying photographs.

All these cases are in the same style, including the written labels for each of the specimens, with common name and region of origin, as the other Moseley material transferred to Derby Museum in 1980 - so I can safely assume that they are part of the Moseley Collection of Rolleston Hall, mounted and set up by the famous taxidermist, A. S. Hutchinson of Derby (c. 1870). There are approximately 100 specimens of birds, most 'exotic', mainly from Asia and the Americas. The birds are mounted on modelled branches and rockwork, with added dried vegetation and with a plain painted background. There is no attempt to recreate the birds' original habitat, typical of Hutchinson's work. For a good illustrated account of the work of Hutchinson see the website at: http://www.taxidermy4cash.com/hutchinson.html

The quality of the material is generally good, with some good mounts, even by modern standards. In general the larger birds are better mounted than the smaller ones. Pest attack seems to have been confined to only one of the case units, with some damage to feathers of at least two specimens and tell tale dead bodies of moths immediately below. However, it appears that this is an old infestation. There has also been a little fading of some of the material.

The environmental conditions of storage are fairly satisfactory, being clean and apparently dry (though I didn't take any relative humidity readings). The birds do face towards some windows, approximately 20 feet away, which is far from ideal.

In addition to the main collection, there are three isolated cases, featuring respectively - an immature Mute Swan (42 x 19 x 43 in; A Flamingo (16 x 16 x 58 in.); Water Rail (14 x 14 x 6.5 in). These may also be by Hutchinson. Again, there appeared to be no taxidermist's labels, nor any information on where or when they were collected. These three items are good quality mounts and in good condition.
The quality and history of all of the bird material, not least as examples of the work of a renowned Victorian taxidermist, means that they should definitely be retained intact.

Other Items

There are two other items of social history on display in two separate island cases and I attach photographs of these, too.

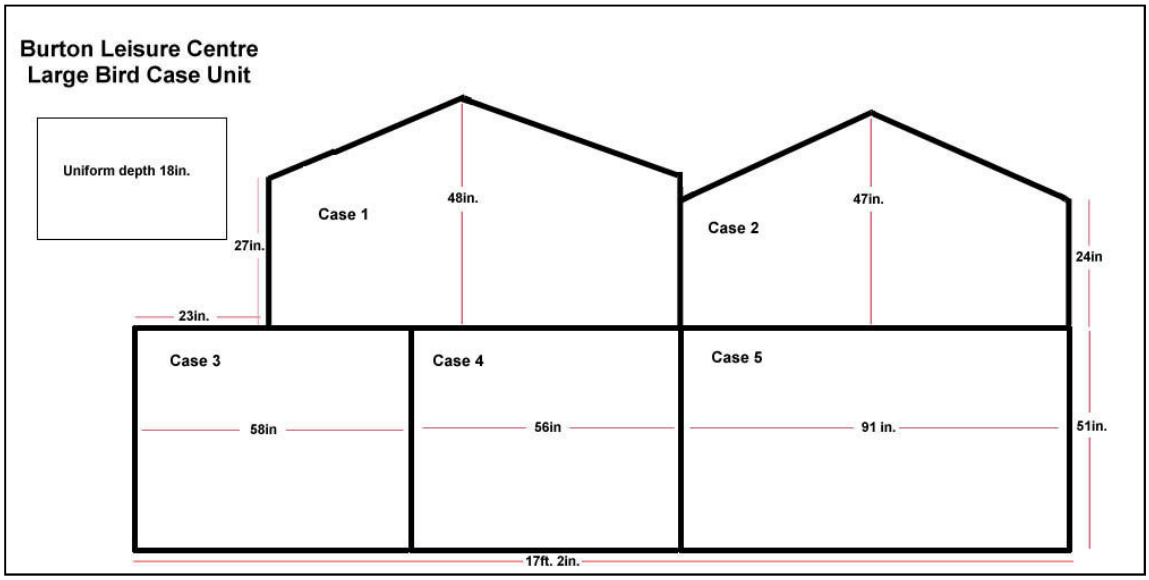
These are:

A metal model of the Ferrybridge, Burton, made in the 1890s by Herbert Lakin of Burton (approximately 4ft in length).

A doll's house, made by the Barton under Needwood W.I. in 1925 (approx. 3ft 3in long).

I was also shown two large model ships, a tea clipper and what appeared to be an early 19th century fighting ship. They appeared to be of very high quality and in excellent condition.

Both were in island cases in a storage area. The local significance of these was not apparent. It was not possible to photograph them at the time.



Stuffed animals are still in fashion! (Well for kids in museums anyway)
- Ed Drewitt, Bristol Museums, Galleries and Archives

It's true! While adults may be wary and sometimes pulsate or even scream at the sight of a stuffed animal, children can't get enough of them. And it is this wonderful fascination that they have for animals that enables me, in my job, to offer children the opportunity to learn more about British and Global wildlife, both past and present.

I have been at Bristol's Museums, Galleries and Archives now for two and a half years working as a museum learning officer specialising in natural history and geology. I have a degree in zoology and worked previously for the RSPB and the Recycling Consortium, delivering assemblies and workshops to schools in the Bristol region. As far as I am aware I am in a very unique position in the Southwest and across many parts of the country, working as a learning officer covering specifically natural science subjects.

My position here at Bristol City Museum and Art Gallery is dynamic and diverse and provides a very satisfying and enjoyable work life, one that I wouldn't swap for any other job. I use a vast handling collection of high quality taxidermied birds, mammals and reptiles as well as rocks, fossils and minerals for delivery of my work programme. Most of these artefacts are left over from the loan service that ceased to exist around 7 or 8 years ago. We are still adding to the collection and filling in gaps where older specimens have been damaged, faded or are absent. Latest additions include an otter and little egret.

I work with everyone from school groups to families visiting on Sunday Fundays and holiday activities, to the media and TV and other museum professionals. My latest project is developing new family trails based on recent evaluation I have done with our visitors. I am also involved with numerous other projects and initiatives that are helping to both increase awareness of natural sciences within the museum and link it with all the other subjects that are covered here such as Egyptology, archaeology, fine art, applied art, conservation, eastern art and much more.

To give you an idea of what I get up to, let's look at one week of my life at work earlier in May this year.

Monday

I was at a team working training course having an enjoyable time; the outcomes have put me in good stead for team projects coming up very soon.

Tuesday

On Tuesday I was at a primary school giving an assembly on Peregrine Falcons using images, taxidermy and someone dressed up as a Peregrine! This was followed by a workshop during the morning where the children handled, drew and measured birds of prey, as well as cutting out their flight silhouettes. This was then followed up by a visit to a local quarry to see the 'real' Peregrines. I had a quick drive back to the museum where I was then straight into facilitating two classes in our British Birds and Mammals Gallery, allowing them to learn about the animals for a project they are working on with ACTA, a community theatre group. We have a grant of £50, 000 to work with ACTA and schools to provide live interpretation (drama in costume) for a big day in July.

Wednesday

The next day I was working with another school, also related to ACTA, this time in our South West Natural History Gallery – their part of the project involved producing unusual sculptures and models of animals related to wetland habitats in the south-west. With a quick turn around I was then with another school for another part of the project, this time in our World Wildlife Gallery. Here I was helping the children to explore the senses, sounds and movements of animals from around the world. The children were pretending to be gorillas at one point (many imitating them very well!!!) and thinking about the sounds and movements of different animals that they could imitate for the project.

Thursday

On Thursday I was presenting a workshop about rocks to home-educated children who came along with their parents. They were discovering more about local rocks and minerals, taking observational drawings and looking at artefacts under microscopes. We then went up to the Severn Estuary to visit Aust Cliff and see rocks for 'real' and discover fossils and minerals. Some even found some coprolites and fish teeth as well as the snow-like gypsum scattered on the beach. It was then a quick journey to a City Learning Centre in Bristol where computers and other forms of ICT are available in suites for secondary and primary aged children. We were briefing teachers for fieldwork they are doing in June where their children are using laptops and data loggers to learn more about the stream, woodland and local history on Blaise Estate. This is where one of our museums, Blaise Castle House Museum is also based, which presents information about Blaise and the local area in a social history context to our visitors. I was then down to BBC Bristol to go on BBC Points West to talk about a blue tit nestbox linked up to a webcam that the BBC is showing viewers to help advertise the BBC's Springwatch campaign.

Friday

Finally, on Friday I was working with three classes from one school, giving workshops related to wildlife conservation and focussing on the Somerset Levels. This trip was complimented by a follow up trip to Ham Wall RSPB reserve on the Somerset Levels and is funded by the Heritage Lottery Fund for the RSPB. This was a great opportunity to use many of our handling objects such as Bittern, Hobby, Swallow, Barn Owl and Peregrine. A week or so later I took a different school group out to the Somerset Levels where they were able to experience the sights and sounds of the reed beds in between the rain showers! Highlights included discovering a water stick insect (a first for the field teachers!) and a brood of seven cygnets, some jostling to get on the back of the female swan. Interestingly, some of the children thought they would be coming to a place where the animals would be inside a dome rather like the Eden Project or @Bristol. They were taken aback when they realised the Somerset Levels was all for real and that the birds such as Swifts came all the way from Africa by themselves!

So, as you can probably see from this 'week in the life of…' my work is very varied and continually changing and dynamic, meeting new people and using different handling objects on a constant basis.

After having recently helped to complete a new family resource area in our World Wildlife Gallery, providing things for families to touch, play, match up and draw, with lots of ideas for thinking and playing creatively, I am now working on producing new family trails. After consultation with families that visit the museum we are in the process of producing coloured, user friendly trails that include notes for parents to help families make the most of all our galleries. Consultation with audiences, and evaluation of our work is integral to the planning and delivery. With this in mind we are using Inspiring Learning for All, a framework enabling us to evaluate and plan projects with greater accuracy and discover more about what our audiences are gaining from their museum experience.

Recently I have been working with Horfield Prison, Bristol, where we have the opportunity to be a larger part of the inmates' learning programme. On one occasion I took in a selection of common garden birds for two art workshops. The response was very encouraging and I must admit was one of the most amazing things I have ever done. With so many preconceptions of what prisons are like it was great to experience it for real! We had a meeting with the senior prison managers including the director who were very encouraging and supportive of our work.

Every two months or so I arrange a meeting with other learning officers from other organisations in Bristol such as Bristol Zoo, SS Great Britain, English Heritage, @Bristol, The Empire and Commonwealth Museum, the Arnolfini, and Clifton Suspension Bridge and meet as an education forum to help share ideas and good practise from evaluation to presentation. I am also a committee member for the South Western Federation of Museums and Art Galleries, organising bi-annual meetings for members of museums, art galleries, former museum staff and related organisations. This body helps to represent and support museums, etc. and enables me to relate better to the wider museum community and have a greater awareness of the projects, people, and issues concerning other parts of the region beyond Bristol.

As a museum we are heavily involved with projects related to the BBC's Natural History Unit and the Bristol Festival of Nature, an annual celebration of Britain's wildlife. It is a great opportunity for us meet the

public and put across important conservation messages both at the City Museum and at the festival itself. This year the BBC has been encouraging viewers to look out for frogspawn, swifts, hawthorn, 7-spot ladybirds, peacock butterflies and red-tailed bumblebees. We will be displaying some of these animals and providing the public with information on how to tell them apart from similar species, for example house martins, swallows and swifts will be on display for comparison. Meanwhile I will be giving two afternoon boat tours to visitors showing the wildlife around the Bristol Docks and making birdcake with BBC Points West viewers.

My job here at Bristol's Museums, Galleries and Archives has opened up huge opportunities for both myself and the service with museums in the country and many other organisations. Audiences are able to relate very easily to animals and indeed our natural science galleries are one of the most popular in the City Museum & Art Gallery. I hope that natural science subjects will become increasingly integrated with the other subjects represented at Bristol, and that people will continue to associate our service as a place to see, learn and become excited about local wildlife and fossils.

If you would like to know more about how the natural history and geology collections are used by our audiences or how integral my work is to Bristol's Museums, Galleries and Archives and the wider community, both museum and beyond, then please drop me a line on 0117 922 3016 or ed_drewitt@bristol-city.gov.uk.

Ed Drewitt and the Ivory-billed Woodpecker
Photo by Neil Phillips (2005)

How To Accommodate A Whale: Manx National Heritage's New Natural History Gallery

- Kate Hawkins, Manx National Heritage

Factors influencing the design

As the Isle of Man Government's statutory heritage agency, Manx National Heritage (MNH) has a wide range of responsibilities (see box), including running twelve museum sites. The Manx Museum is the nerve centre for this integrated service, and the starting point for exploration of the Isle of Man's cultural and natural landscape through a themed island-wide presentation called 'The Story of Mann'. As with our other museum displays, our philosophy for the new gallery has always been that we should attract visitors in to whet their appetite for more natural history, and then equip them with the confidence and practical information to go out and find it for themselves.

Of course there were other factors to consider. The Museum receives a very mixed audience through the year. Island residents, their families, school parties and students are joined in summer by tourists, including coach parties and bikers on wet days during the TT Festival. At 213 square metres the gallery space is not huge, but it has a high ceiling, with large roof lights. Over the 30 plus years that the old natural history displays were in this space, the roof lights caused fading in the specimens and large temperature fluctuations often made the gallery uncomfortable for staff, visitors and exhibits. This needed to be addressed in the redisplay project.

As the gallery design evolved, so did a strong desire to raise awareness of MNH's museum role, which came to gel nicely with the need to encourage appreciation of biodiversity. Amongst other things, this meant acquiring new specimens for display and finding ways to present awkward material. Major investment in new taxidermy over the five years leading up to installation enabled us to retire the ancient, faded and poor mounts which had served their time in the old gallery. We felt it was essential to display quality life-like taxidermy to engender curiosity and respect for the animals represented, rather than to distract visitors into disgust or ridicule for faded and poor specimens.

And last, but not least, there was the whale. A 13 metre long skeleton of a Sei whale Balaenoptera borealis hanging from steel roof beams dominated the old gallery, and at first seemed to constrain ideas for making full use of the height and domed roof shape in the new design. However, on discussing the prospect of removing the whale from display with museum staff, it became clear the skeleton was a popular exhibit and had its education uses. This, coupled with the sheer impracticability of removing it to storage, prompted the decision to keep the specimen where it is and to make a virtue out of a necessity with imaginative interpretation.

Bringing people into the gallery

Despite the very rich intertidal and inshore marine habitats around the Isle of Man, for practical and historical reasons marine life is poorly represented in the Museum collections. A previously uninspiring corridor between the Museum shop and the gallery provided an opportunity to extend the displays on a marine theme. By using ripple lighting and dark sea-green colour, we turned the corridor into an atmospheric backdrop for large dramatic images of sea animals, and projected a film about the transition between intertidal and subtidal habitats. The corridor space now suggests and underwater journey to the Isle of Man, and is an appropriate way to introduce visitors to a story about an island set in the Irish Sea.

Once inside the gallery, visitors can orientate themselves geographically with the help of a map of the Island's wildlife hot-spots , and get an idea of how the gallery works. The distinctiveness of the Island's natural history is emphasised with a simple taxidermy display representing animals which symbolise the Isle of Man (Loghtan sheep, chough, Manx cat), as opposed to animals which are not found here at all (badger, squirrel, snake, mole).

Interactive table projections

The main gallery space divides into an inner collections and biodiversity exploration area, and an outer habitat/place display. The inner exploration area is framed by six large showcases which form an aisle underneath the whale. To each is fixed a shaped MDF 'fin' with an illuminated edge. Together, the effect of the cases and their fins is to lead the eye upwards towards the skeleton, making the whale visually part of the displays and enhancing the sense of height in the gallery space.

In choosing specimens for the central cases, our idea was to exhibit a loosely classification-based cross-section of the Museum's natural history collections. As it has turned out, space is rather biased towards the birds. We make no apology for this; bird mounts make glamorous exhibits and the Isle of Man is well known for its avian fauna, particularly its choughs and birds of prey. The other cases present mammals, plants, lower vertebrates (fish, amphibians, reptiles), and some of the larger invertebrates (especially molluscs). One case is devoted to fossils, as illustrations of past life and habitats in the Isle of Man.

Each of three pairs of case arrangements is replicated as a digital image, projected from above onto a white table. Visitors can use a roller ball and click device mounted on each of the tables to choose a case arrangement, and then to select a specimen that they want to know more about. Choosing a specimen takes them to an information screen, where they can click on-screen 'buttons' to call up more text, a film extract or a sound recording if available. Clicking the 'draw' button here takes them to a screen where they can trace on paper around images of the specimens, an activity that has proved to be particularly popular with children.

The table projection technique derives from an idea pioneered by the Horniman Museum in its musical instruments gallery. It has been modified and expanded upon in the Manx Museum display, largely by the use of different media .One of our main objectives was to provide to all our visitors, even those with only a mild interest in wildlife, the means to recognise at least some of the species they might encounter in the countryside. We felt this could be much more effective with a full range of media, and quite a large part of the budget was spent on acquiring library film footage, still photographs and sound recordings to enrich the interactive table experience.

Interactive drawers

At one end of each of the three tables is a set of four drawers which link to a touch screen. On opening each of the drawers, an image of the contents is displayed on screen, with buttons to activate layers of information and related still images, working in much the same way as the interactive table projections. The drawers are useful for showing smaller specimens, such as insects, and for exploring the history and function of the natural history collections, for example changing attitudes to egg collecting and bird conservation (yes, we are displaying birds' eggs).

The Tale of the Whale

Interpretation of the Sei whale skeleton needed a more individual approach as there was a good story attached to its acquisition by the Museum. The whale was stranded on the south coast of the Isle of Man in 1925. News of its demise spread quickly, and attracted crowds of sightseers, who all seemed eager to have their photograph taken next to the whale, posh hats and all. Bags of carrots were stuffed into the unfortunate creature's mouth to see how many would fit inside, and baleen plates were removed as souvenirs. The carcase was hauled onto trailers and pulled back to the knacker's yard outside Douglas by two traction engines, providing a spectacle to onlookers along the route. Policemen travelled ahead of the party, advising residents to close their windows against the terrible smell from the corpse. It was buried (with more photographs) and the skeleton was eventually recovered for mounting and display in the Manx Museum in the early1930s.

This story says as much about the reaction of the local people to the stranding as it does about the whale, and encapsulates an instance of social history meeting natural history. Our solution to its display was to use some of the old photographs of the incident to make a short sub-titled animation sequence as a screen saver on the table interactives and drawer touch screens. The screens automatically default to the animation after a few minutes if the interactives are not being used. In addition, a souvenir baleen plate is displayed in one of the drawers underneath the whale, together with a pigmy shrew mount and skeleton, as a graphic exam-

ple of the extremes of size in the mammalian body plan.

The habitat/place displays

Encircling the collections and biodiversity exploration area are six modular displays about the Isle of Man's main wildlife habitats. Each of these displays represents a specific named place which exemplifies one or more habitat types, eg. Snaefell Mountain representing upland moor, bog and conifer plantation; the Ayres representing coastal dune and heath.

The six displays are arranged around the gallery roughly in order of the geographical relationship of the named places. Each consists of a large curved wall-mounted image of the landscape or habitat, a small display case with six to eight 'key species' for the habitats featured, a digital screen showing a short, specially commissioned film about the place and its wildlife, and one or two hanging banner graphics. Three of the displays include children's interactive exhibits which relate in some way to the places represented.
For each display, one of the banners carries an 'orientation' graphic, which consists of a stylised map of the Island, with summarised information about the featured place, including where to find it, traveller's tips, similar places to see and habitat characteristics.

Achievements of the gallery project

From so far informal comments, the new gallery seems to be well received, and is certainly very popular during the school holidays. Its family-friendly, interactive approach is balanced with availability of more in-depth information, should people want it, and the Museum's Education Service successfully uses the displays to compliment its curriculum sessions. Promotion of Manx identity is at the core of Manx National Heritage's work, and the 'local angle' is emphasised in the natural history gallery by weaving folklore and the Manx language into species names and accounts.

In terms of museum conservation, specimens are now displayed in sealed, dust- and pest-proof, humidity controlled cases. Light falling on sensitive objects is much reduced with the help of a false ceiling installed between the roof lights and display space. The gallery offers a window on the reference collections and their role in the Museum, hopefully winning us more friends and stimulating welcome interest in Manx National Heritage's work behind the scenes.

Manx National Heritage is the national heritage organisation for the Isle of Man, and combines a range of statutory responsibilities. These include:
The National Museums Service
The National Monuments Service
The National Trust Service
The National Library and Archive
The National Art Gallery
Education Service.

See website at www.gov.im/mnh
E-mail: enquiries@mnh.gov.im

The Interpretation of Botany at Haslemere Educational Museum
- Julia Tanner

The Botanical Challenge

The particular challenge of displaying botany collections first became apparent to the current curatorial team at Haslemere Museum whilst undertaking a Heritage Lottery funded gallery refurbishment programme, which was completed in 2003. The galleries had last had a makeover in the 1950s and no current member of staff had experience of formally presenting botany to the public. Without doubt it proved to be the most challenging section to re-develop.

The NatSCA 2006 presentation, "Interpreting the Undisplayable" by Leander Wolstenholme, Curator of Botany at The Manchester Museum, struck an immediate chord with our experiences at Haslemere and raised many interesting issues relating to the interpretation and display of botanical collections. The discussion provided valuable points of reference for reviewing botany at Haslemere Museum and examining some common challenges.

The Founding of the Museum

Haslemere Educational Museum was founded in 1888 by Sir Jonathan Hutchinson (1828-1913), an eminent surgeon whose practice was based in London. In the 1860s Hutchinson built a country home in Haslemere, where he had the space to indulge his delight in collecting. This passion was based on his deep conviction that an education could be acquired through the study of objects.

His original museum was opened in the grounds of his home until its success led to its establishment at more central site on the south side of the town in 1895. It was conceived as a museum *for* Haslemere, not simply *of* Haslemere. At its inception it pioneered innovative ideas of museum education and interactivity which were influential at the time and which anticipated many ideas current today.

After his death in 1913, Hutchinson's circle of like-minded friends and scholars were determined to keep his museum going. They convened a new board of trustees that, in 1926, established the museum on its present site.

Haslemere Educational Museum is an independent museum, a charitable trust and a company limited by guarantee. Throughout its history it has been privately financed through its earned income, donations and bequests, with only limited recourse to public funds.

Botany at Haslemere Museum

The Museum has about 400,000 objects in its collections, broadly relating to the subjects of Natural History, Geology and Human History. Natural History specimens account for about two thirds of the entire collections. Botany is the second largest collection (after shells) with approximately 65,000 specimens, primarily from British sources. Most of these, about 80%, consist of pressed herbarium specimens of flowering and non-flowering plants. Other specimens include plant galls, seeds, liverworts, mosses, conifers and wood sample blocks. Of all the collections, botany has the richest field collection data and well recorded donor details. Much of this material's primary value is as a research resource.

Amongst the named collections is the G.J Lyon Collection of all known species of mosses in Great Britain up to 1849. The hard-bound volume is beautifully preserved and includes many rare species. The Colonel Lionel Messel (1899-1971) Collection was donated in the 1950s and consists of wood block samples from around the world. The Joshua Lamb (1856-1943) Collection of British wild flowers was collected in the late 1800s. The more unusual Lightfoot Collection comprises a large selection of vascular plants collected in the 1860s-1870s by a Miss Lightfoot, with each specimen accompanied by a poem. These named collections provide a brief insight into the scope of the botany collection and reflect a concentration of collecting from the 1800s to the mid-twentieth century.

Two-doubled sided display cases and three text panels make up the formal botany display in the Natural

History Gallery. These new displays were developed as part of the Heritage Lottery funded gallery refurbishment programme that was completed in 2003. Living plants can also be found on display in the museum, but not in the main galleries. A permanent display of common wild plants in our reception hall has been a popular feature of the Museum since 1893. 'The Flower Table' gives visitors an opportunity to see a wide range of live species at close quarters and encourages an interest in native plants, some of which are often thought of as weeds. During the winter months few wild flowers are available, so we take the opportunity to stage special interest displays with themes such as 'Herbs and Spices', 'Medicinal Plants', 'Poisonous Plants' or 'Shakespeare's Flowers'. These displays always receive a great deal of interest from our visitors and there is probably much greater scope for development.

A number of Haslemere Museum staff have also committed their botanical expertise to print over the years. At least two previous curators have published books in the field. Ernest William Swanton (1870-1958) was curator for over 50 years from 1897-1948 and took an active role in many fields of natural history, but had a particular interest in plant galls. In 1912 he published *British Plant Galls*, detailing all the gall-inducing species in Britain at that time. Arthur Jewell (1921-2004), curator from 1962-1988, was also an impressive polymath but his particular interest was reflected in his publication of, *The Observer's Book of Mosses and Liverworts*. Although no member of the curatorial team presently has a background in botany (or natural history for that matter), we can nevertheless call upon the expertise of our Honorary Botanist, Laura Ponsonby, who worked for many years at the Royal Botanic Gardens, Kew. She, likewise, has published on botany, including *A List of the Ferns and Flowering Plants of the Haslemere District* (1978) and *Marianne North at Kew Gardens*.

Displaying the Undisplayable

The presentation, "Displaying the Undisplayable", by Leander Wolstenholme indicated some common features and challenges in the display and interpretation of botany collections. In a survey of museum botany displays, Wolstenholme found a commonality of elements within the presentations. The Top Five display items were listed as: 1. Plant Models, 2. Big Seeds, 3. Living Plants, 4. Illustrations, 5. Photo-graphs. The truth of this assessment could be immediately gauged by the knowing laughter from delegates. Haslemere's formal botany display in the Natural History Gallery also reflects the findings. This is interesting given that the curatorial team involved (including myself) had no background in botany, and no specialist scientific or historical basis on which to base display decisions. This suggests that a common set of challenges using this particular resource generally produces a common set of adaptations. Furthermore, apart from the priority to present a valid 'scientific' botanical message, there is a strong 'aesthetic' impulse, which also drives display presentations.

During the Redevelopment Project at Haslemere, the selection process of objects for these new displays soon exhibited a tension between providing a valid botanical message and the availability of a limited number of "displayable" specimens to illustrate that message. Given that about 80% of our collection consists of pressed herbarium specimens, only a tiny proportion of these (four herbaria sheets) are displayed. In considering the use of more herbaria sheets, it was decided that the visual impact was unlikely to engage visitors to take an interest in the botany display. The rest of the plant world is therefore represented by specimens from the remaining 20% of the collection, i.e. those that are deemed as more "displayable". Where this is not possible (and limits are reached with what can be achieved with Big Seeds!), then the other usual suspects of Wolstenholme's Top Five are employed. In the case of Haslemere, this particularly means photographs and plant models. Overall, less than 1% of the botany collection is on display and it could be argued that the display presents a skewed impression of the botany collections as a whole. In order to counter this sort of criticism the museum is planning to provide further information at the display area

with a more detailed description of the botany collection, its contents and proportions. This may also include a discussion of the choice of objects on display.

The Haslemere display consists of two double-sided display cases and three large text panels. The three text panels rely on the presentation of written information illustrated with numerous photographs. These relate to *Plants and People: Food and Drink*, *Plants and People: Medicines and Materials*, and *British Plants: Places Where Plants Live*. The display cases also employ the latter elements, along with other members of the Top Five, particularly plant models and seeds (big and small). The display cases are thematically divided into four main categories. The types of items displayed in *Seed Plants: Cycads, Ginkgo and Conifers* include a cross-section of a Yew tree, but mainly numerous large pine-cones and seeds. Four drawers below display further pine-cones and photographs of local trees. *Seed Plants: Flowering Plants,* includes the only section where four pressed herbarium sheets are displayed, along with four trays of different types of seeds based upon dispersal techniques. *Plants Without Flowers: Mosses, Liverworts, Horsetails and Ferns*, relies on plant models but also loose dried specimens. *Fungi, Lichens and Algae: These Are Not Plants*, similarly includes plant models, but a little more variety is provided by dried bracket fungus, lichens on wood samples, seaweeds mounted on card and spore prints of fungi mounted on glass. An exception to the Top Five at Haslemere is that there are no botanical illustrations in the displays. Otherwise, the Top Five are well represented, with living plants being found as part of the separate "Flower Table" display.

In terms of alternative means of interpretation, Wolstenholme showed that it is possible to engage the interest of the general public with botany, especially using links to popular culture. This was apparent in the botanical events and workshops that were provided at Manchester, under themes like "Harry Potter" and "Narnia". These hooks can capture the imagination and foster further interest. However, as Wolstenholme made clear, these events were time consuming and labour intensive for a limited increase in access. In twelve busy months of concerted effort to broaden access to the botany collections only 0.0398% of the collection was used (originally stated as 0.038% but since revised). That would mean that only 3.98% of the collection would be accessed in 100 years (if you assume that none of the specimens are re-used or re-displayed in more than one event or display). Moreover, this level of interpretation would surely not be sustainable over a long period of time given the other pressures on limited staff numbers. Wolstenholme's findings serve as a pertinent reminder of the challenges of current collections management and the imperative to increase access.

The Future for Botany at Haslemere

Given the above, Haslemere Museum is also working on further means of interpreting botany other than the formal gallery display and the Flower Table, although most of these options will be self-led due to the aforementioned problems of limited staff numbers and current workload demands. These will chiefly consist of information leaflets and trails of the garden and grounds, though some events and workshops will be tailored to botany as part of regular programming. Further descriptive analysis of the botany collection will also be made available through our website in later 2006.

The Museum's garden and grounds has been a particularly under-interpreted resource of 'living botany'. However, a number of recent developments have begun to remedy this issue and are inspiring ideas for further interpretation. The Museum's original herb garden was lost many years ago when the building was extended. In 2001 we built a new Victorian style herb garden and have more recently developed a Herb Garden Booklet for visitors which contains information about the history of herbs, a summary of uses and an identification chart. Last year we also produced a Ten Tree Trail leaflet, which takes visitors on a guided tour of ten trees in the museum grounds and provides brief notes about identification, geographical origins, practical uses and associated folklore. A Garden Moss Trail identifies different types of mosses and locates them in the museum garden. Workshops for children such as, "Natures Colours and Patterns" and "Be A Nature Detective", already engage with our living resource and encourage observational skills and an appreciation of the variety of plant life. Other related workshops are being considered for all ages. Links are also made between the garden or "live specimens" and the museum galleries, in order to make the visitor/user experience more holistic. For example, a living gingko tree in the museum grounds is linked to a fossil gingko leaf from the Jurassic Period on display in the Geology Gallery. This facilitates discussion of other topics such as evolution, extinction of species and biodiversity, making links between different themes in order to indicate the inter-relatedness of subjects.

Furthermore, the history of our landscaped garden and grounds is interesting in its own right. The museum was relocated to its current site in the High Street in 1926. The original building dates back to an ancient burgage house of the 16th century, but over the years the building has been rebuilt and extended. From 1798 the Rev. Robert Price lived at what was then known as Burgage House. His brother was Sir Uvedale Price (1747-1829), the champion of rational landscape gardening and author of, *An Essay on the Picturesque*. It is assumed that Uvedale assisted his brother in planning the layout of the grounds. The plan included a ha-ha between the lawn and the field, the planting of numerous trees, and a pond with a gazebo above it commanding a view of the Weald, features which still exist today. The Museum has plans to usefully employ this history as a tool for the further interpretation of our living botany collection. Plans include a booklet about the early history of scientific collecting and the associated introduction of non-indigenous species to British gardens e.g. with reference to specimens like the monkey puzzle trees in the museum grounds. The booklet will also provide information about the botany collection held by the museum, thereby encouraging further access by appointment to the reserve collections.

A number of other information leaflets relating to botany are currently in production. These will be made available in "Want to Know More" files displayed in the Natural History Gallery. Titles include "Ferns", "Flowers and Trees", "Grasses, Sedges and Rushes", "Seed Dispersal" and "Understanding Flowers By Families", amongst others. These leaflets will explicitly relate to specimens on display or in the museum grounds. Readers will be alerted to further specimens in the reserve collections, therefore encouraging increased access by appointment. Further sources of information will be provided in terms of references to botanical publications, sites of interest (e.g. RHS Wisley in the local area) and options for further study (e.g. Field Studies Council).

Every year the Museum undertakes a number of temporary exhibitions of items from the reserve collections. A botany display is overdue and therefore part of current programming. The rotation of objects in the permanent gallery cases is also being considered as part of the imperative to broaden access. The Museum also provides a joint lecture series throughout the year with the local Haslemere Natural History Society. The subject of these lectures sometimes relates to botany and in the future the museum would like to provide small temporary displays to illustrate the lectures. Another regular feature may also benefit from further development, and taking inspiration from Wolstenholme's paper there is scope to broaden the displays of the traditional Flower Table with links into popular culture. This may take the form of films such as 'Jurassic Park', but also making links to regular high-profile events such as Springwatch and the Chelsea Flower Show.

About 40% of the botany collections remains un-catalogued. Over the next few years the museum will be tackling this backlog as part of a Collections Management Project and as an objective of Accreditation. This will provide a greater understanding of the collection and therefore facilitate access. Plans for the more distant future will hopefully result in an online catalogue of the collection, which will enable extensive access to detailed information.

Conclusion

Wolstenholme's finding with regard to the Top Five botanical display items is well reflected at Haslemere. This suggests that common challenges of display produce a common set of results, given the nature of the botanical collections.

Challenging though it may be at times, Wolstenholme showed that it is possible to interpret our botany collections for the general public and make that interpretation interesting and engaging.

The challenge to increase access to the reserve collections should not be underestimated and any directives calling for even greater access to these collections must be reasonable, given current staffing levels and responsibilities.

The ideas raised in Wolstenholme's presentation have encouraged further ideas for display and interpretation of botany at Haslemere, as part of an ongoing process of improvements.

Perhaps botany as a subject of learning and enjoyment would benefit from the establishment of a dedicated organisation to engage with the general public and encourage participation, much as Rockwatch does for geology.

Bags of Fun – Sachau o Hwyl
'Family activity bags to help you explore The National Museum Cardiff'
- Annette Townsend

Bags of Fun were introduced at The National Museum Cardiff in the Easter holidays 2006, by the Education team. They are free to use and are financially supported by visitor donations and The Basic Skills Strategy for Wales. When entering the Main Hall, families can now pick up a rucksack which contains equipment and an ideas sheet to help you discover more about a particular area or Gallery in the Museum. There are a total of 24 bags to choose from with many different themes covering both Art and Science.

One Sunday morning I decided conduct my own visitor research and brought my seven year old son along to the Museum to try it out!
When we arrived we were warmly greeted by the front of house staff who recommended to us, as inexperienced bag users, that we try out Science 'Seashore 1' as a good introduction. The laminated card in the front pocket of the rucksack told us to find the right part of the Gallery, ask for some comfy cushions to sit on if we needed them and look at the equipment in the bag. Inside we found a pair of binoculars, a magnifying glass, and a torch which we could use to explore.

We then sat down to have a go at the activities. We were encouraged to draw pictures, identify and match images, describe and write what we could see using words provided, make a model and complete a jigsaw.

The Seashore 1 backpack and contents

Firstly we used the information panels to find the names of all our favourite seaside birds, which we could see with the binoculars even though they were positioned high on the cliff face. Then we matched all our cut out rock pool creatures, and went on to do the jigsaw. It was a photo jigsaw of the huge basking shark which was hanging high above our heads in the gallery, a particular favourite of my son.

We watched the video footage about the basking shark to answer the questions on the sheet and we were soon inspired to make a drawing of our own to take home.

We saved the best till last and modelled a fish from the rock pool out of soft dough, all whilst learning about the need for the soft sea creatures to stay wet when the tide has gone out.

You are told that you can keep the bag for as long as you like during your visit, but you must place the items back in the correct packets and return the bag to the main desk when you leave. A register is taken of your name and address when you first collect the bag and you are signed out when it is returned. The visitor figures for the two week Easter period show that 372 bags were taken out and used by an estimated 1500 individuals. So far only one bag has been stolen from the Museum.

As we had the opportunity to use the items for as long as we liked, we then dashed off to visit the dinosaurs, a priority for any respectable seven year old. On the way we bumped into 'Bertie the Bison' and gave him the once over with the magnifying glass!

This is even better than just getting nose to nose with the animals!

The out come of my visitor survey was that my son thought the bag was 'brilliant', and he wants a return visit to try out another one, the dinosaur bag of course. We've heard it's got real dinosaur bones in it!

Inspiring Secondary Science Students

Andrew Lee, the Natural History Museum, London

'Real World Science' is a partnership project funded by the Department for Culture, Media and Sport, and the Department for Education and Skills through their Strategic Commissioning Education programme. This Natural History Museum led partnership has been in place since April 2004 and includes the Manchester Museum, the Oxford University Museum of Natural History and the Hancock Museum (Tyne & Wear).

The partnership has developed a powerful and engaging learning programme for secondary science students. This age group was prioritised in order to address a significant gap in museum education provision for secondary science. The partners initiated the project in the conviction that high quality learning programmes at natural history museums could raise aspirations and counter the lack of science uptake post-16. A key aim of the partnership is to inspire students to continue their scientific studies to A-level and university, and further to take up scientific careers.

The programme has attracted 5,985 secondary science students in its first two years (April 2004 – March 2006) and is targeted to reach 8,750 students in the current project year (April 2006 – March 2007).

The key aims of the project are to:

- inspire secondary science students to continue their scientific study to AS/A2 Level, and further to undergraduate level, through vibrant and compelling museum-based activities, including encounters with world-class practising scientists
- enable students to understand the impact that science has on their lives and to make informed decisions based on analysis of scientific evidence
- increase the number of secondary science students and teachers using natural history museums to support their science teaching and learning.

The partnership has recently published the results of a consultation with science teachers undertaken in 2005; *How can natural history museums support secondary science teaching and learning?* The results of this research confirmed the partnership's conviction that the out-of-classroom learning experience of a structured visit to a natural history museum, including encounters with practising scientists and curators, was highly valued by secondary science teachers. The consultation report shows overwhelmingly that natural history museums can have a substantial role to play in supporting science curriculum delivery, particularly in hard to teach areas such as Taxonomy and Earth Science, and in bringing science and its applications to life. The teachers felt that the museums provide unparalleled resources that are rarely available in school to support the teaching of challenging scientific concepts.

The top four themes to emerge from the research were that natural history museums can play a vital role in:

- providing opportunities for students to meet practising scientists who can positively influence attitudes to learning science, career choices and can support teaching the new science curricula
- offering fun and engaging workshops, debates and shows with a strong practical element
- engendering, through their collections and galleries, a sense of awe and wonder about the natural world
- supporting the course work elements of new GCSE's and AS/A2 exams such as Twenty First Century Science, Salters-Nuffield Advanced Biology and Perspectives on Science, all of which have an emphasis on the application of scientific research.

The next phase for the partnership is to build capacity in natural history museums and museums with natural history collection to use their resources to support secondary science students and inspire them to study science further.

If you would like to receive a copy of the report or would like further information on the 'Real World Science' project, please contact Andy Lee, Project Co-ordinator at Andrew.Lee@nhm.ac.uk.

Overcoming Problems With Polyester Resin Blocks

- Simon Moore, Hampshire CC Museums Service

Abstract

The problems associated with 'plastic embedding' are many, not least air bubble formation during hardening of polyester resin embedments and the clearing and loss of iridescence of lepidopteran wings. These and other associated problems are discussed, with effective solutions for removing some of these disfiguring problems.

Introduction

My heart always sinks slightly when asked to make a series of polyester resin blocks, normally for education purposes so that smaller children can handle delicate biological objects without fear of damage. I think that the idea is good since it enables younger persons to look closely at tissues that would normally be much too delicate for handling. My own reasons are purely personal for disliking the process, especially as I loathe the smell of styrene and all the other methyl-benzene solvents since they tend to linger in the olfactory part of the brain for 12 hours even though I haven't actually inhaled any of the vapour thanks to my efficient fume-extraction bench.

Advantages of embedding

1. Easy handling of delicate objects, ideal for children (and who don't mind giving them back afterwards!)
2. Accidental/incidental scratches can be ground and polished out.
3. The resin does not darken or discolour and I still have perfect mounts from 1968.
4. Items with fugitive colours (UV or air-sensitive, once dried) can be preserved more successfully. This is particularly useful for pale-coloured fungi that quickly turn brown following air or freeze-drying: cf. *Marasmiellus ramealis, Hydnum repandum* and other members of the 'tooth fungi' family. Also for the UV-sensitive colour of the Fly Agaric *Amanita muscaria* whose scarlet colour quickly fades to a dull orange due to natural breakdown of the muscarubrin/purpurin pigments by about 100nm in wavelength.

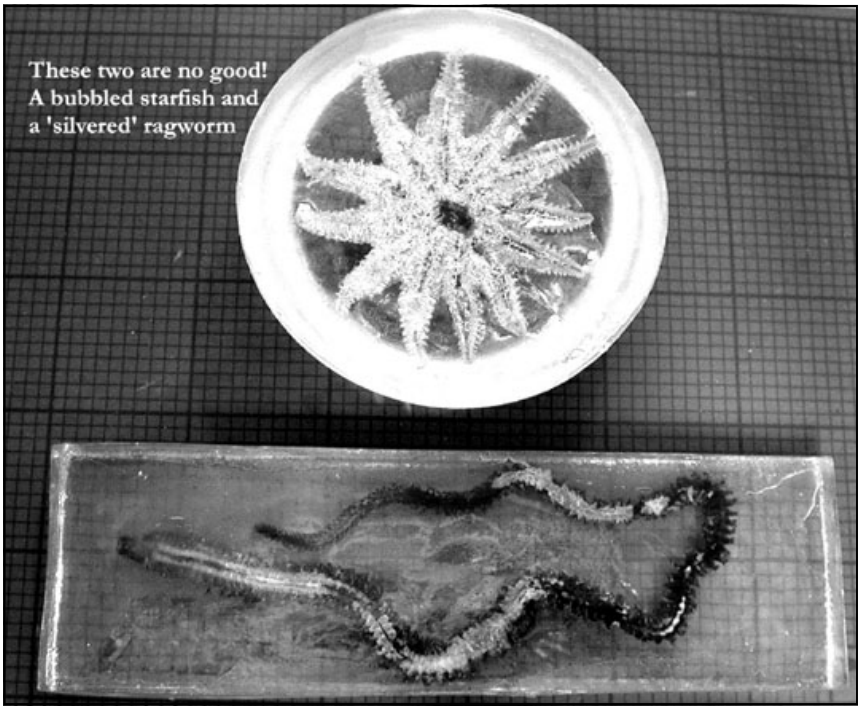


Figure 1: bubbled starfish and 'silvered' ragworm

Problems arising

I always warn anyone who wishes to have specimens embedded in resin that the process may fail for various reasons.

1. The resin may overheat during the curing process causing stress cracks in the resin.
2. The exothermic reaction may also cause air bubbles to be forced out of body cavities, disfiguring the final result (Fig. 1.upper).
3. A similar problem can be the gradual shrinkage of a dry specimen once the resin has hardened resulting in a silvering effect that masks the specimen (Fig. 1.lower).
4. If not totally dry, the specimen may form an emulsive mist around it as the trapped water in the specimen is drawn out into the resin.
5. Surface air bubbles can form on the resin but these can be subsequently ground away.
5. The specimen can become distorted by the process.
6. Although the process is reversible, dissolving out a fragile specimen will often result in its total disintegration due to internal or torsion stresses inside the block.
7. The resin and solvent have a clearing effect so that membranous tissues (e.g. lepidopteran wings) become transparent and blue (lycaenid) butterflies' wings lose their blue iridescence. The latter effect is due to the refractive index of the resin (1.5 – 1.75) being similar to that of the wing scales (see Table).
8. The blocks are fairly fragile: dropping onto a hard surface can easily result in chips and cracks.

Remedies

The main reason for a hyper-exothermic reaction is often due to the use of too much catalyst, especially in warmer weather. I always use the ratio of 1 drop per 10 grams of resin or 2 drops per 30 grams in warm weather. This ratio works well overall but there are still occasions when other (remediable) problems can occur.

1. If all else fails, the process is (slightly) reversible and the resin can be gradually dissolved in xylene. It starts to flake off in sticky lumps after a few days and you will end up with the specimen as before but if the resin has become stress cracked, it may have already broken the specimen. Be aware, however that physical forces are released during this reversing process: fragile specimens may end up completely fragmented! This should only be done for 'silvered' or 'misted' specimens that are sufficiently robust.
2. To avoid aqueous misting, the specimen must be absolutely dry. I usually freeze-dry specimens first to ensure absolute dryness is achieved. Always check that preserved specimens are freeze-dried from deionised water as formalin or IMS vapour are extremely damaging to the machinery of a freeze dryer, especially the vacuum pump! Deionised water must be used else the specimen will dry with a fine calcitic coating!
3. To prevent stress cracks from forming in the block, ensure that each layer of resin is no more than 40mm deep (Voss, c.1980).
4. More fragile specimens have to be dehydrated to acetone and then soaked in raw resin before embedding. This also helps to remove any air bubbles trapped in inner recesses (e.g. snail shells).
5. If the block starts to overheat, then immerse it in cool water, once it has gelled. Surface misting can always be removed by subsequent block grinding.
6. Always monitor the process and if air bubbles start emerging or forming, there will be more to come during the exothermic gelling stage, so beware. Use a mounted needle to tease them out; even if trapped in a lower and gelled layer of resin – push the needle through and move it about (rotate) to force the bubble/s out through the puncture hole which should be coated with fresh resin so that this flows down to fill the bubble's space (see also 10 below).
7. Surface bubbles can be removed by pipetting drops of acetone before the resin hardens.
8. Once the block has been ejected from the mould I always leave it for 24 hours to harden (else it will pick up your fingerprints during its final polymerisation) before grinding or administering any finishing treatment.
9. If the front of the block surface is disfigured by craters these can be filled in by pouring on a thin layer of resin and then grinding 48 hours or more later.
10. Trapped air bubbles inside the block: if the specimen is too fragile to reverse the process, trapped bubbles can be removed by careful drilling. Ensure that the drill bit makes a large enough hole

(5mm)*. The block must not allowed to heat up (1 second maximum for each application of the drill) or it will burn the resin or make it opaque. Also ensure that plastic swarf doesn't get into the block or it will have to be removed using a mounted needle.

10a. Mix up a small amount of resin and wait for the (stirred-in) air bubbles to disappear once it has been mixed with catalyst. Pipette it very slowly down the sides of the drilled holes. Tease out any trapped air bubbles using a mounted fine needle and top-up the levels of resin (Figs 2-4). Tiny craters can also be filled using cyanoacrylate (superglue) under a low-power microscope.

10b. Once hard, the holes may have slightly meniscoid dips which can either be removed by grinding or if the specimen is close to the surface, will require a top-up of fresh resin or adhesive.

*Sometimes the drilled hole will need to be narrower (to 1mm) and the rising air bubbles may be slow in exiting. To precipitate the exit of air bubbles insert a fine pin into the drilled out 'tube' and gently rotate the pin around the exterior of the slowly-rising air bubble. This rotation will help to lift out air bubbles.

11. To reduce or eliminate the transparency effect many sprays were tested but were found to be ineffective as they were dissolved by the styrene solvent: deodorant, photo matting spray (contains dispersed wax), hair lacquer, and even a 5% suspension of PVA in ethanol only gave a slightly improved result (Table 1 & Figs 6-8). Polyurethane resin gave no better result (Table 2).
12. To reduce or eliminate the loss of wing scale iridescence, the wing must first be coated with a substance outside the refractive index parameters of the resin and the wing scales (c. 1.50-1.56) and that will not be dissolved by the styrene. Aqueous, neutral pH PVA was found to work quite well but there were application problems (see below).

Associated Problems

The main problems with 11 & 12 are finding a similar coating that will isolate the wings from the transparency/dulling effect of the resin without forming a visible layer due to dissimilar refractive indices. Also of applying such a layer onto wings using an atomiser: water-based compounds (PVA) tend to coagulate on the wing surface rather than spread evenly, leading to a blotchy result, or require so much application pressure that the wings cannot take such a beating and disintegrate! Solvent-based compounds tend to be affected either by the styrene solvent in the resin or (for urethane-based resins) give rise to many air bubbles just as the resin is in the last stages of curing!

Brushed PVA (aqueously diluted to 50%) gave a fair result except that the careful brushing process, for full strength PVA, removed about c.30% of the wing scales, especially when spreading the PVA to prevent coalescence.

Conclusions

A variety of possible wing coatings for lepidopterans was tested to eliminate or reduce transparency and iridescence. Although some slight success with the former was noted, there was nothing noteworthy with the latter. Several persons connected with the retailing of these resins were contacted in the hope that there might have been a past technique to overcome these obstacles but it appears not. The author hopes that anyone who might know a technique or recipe for success might write it up as a sequel. On a more positive note, the removal of air bubbles and 'silvering' has now been improved.

Table : efficacy for coating agents to reduce lepidopteran wing transparency and loss of iridescence in clear polyester resin.

Coating agent	Transparency	Blue wing iri-descence	Colour change?
[Control]	0	0	complete initial loss of iridescence
Hair lacquer	1	0	10% initial loss of iridescence
Photo matting spray	0	0	10% initial loss of iridescence
Spray deodorant	1	0	5% initial loss of iridescence
Spray acrylic lacquer	1	0	20% initial loss of iridescence
Dilute PVA (5% in ethanol)	1	1	slight purpling of blue colour
50% PVA in IMS	2	0.5	80% initial loss of iridescence
50% aqueous PVA (brushed)	3	2	no fall-off, result patchy
50% PVA aqueous (atomised)	2	1	50% initial loss of iridescence, result patchy
PVA aqueous adhesive (brushed)	4	3	30% scales detached, no fall-off, result patchy
10% brown shellac in IPA	1	0	10 % initial loss of iridescence
10% colourless shellac in EtAc	1	0	no fall-off but final result poor
20% colourless shellac in EtAc	1	0	no fall-off but final result poor
50% colourless shellac in EtAc	2	0	80% initial loss of iridescence
100% colourless shellac in EtAc	2	0	90% initial loss of iridescence
50% glycerol in IMS	2	0	90% initial loss of iridescence
50% polypropylene glycol in IMS	1	0	90% initial loss of iridescence
20% Mowital B30H in IPA	2	1	60% initial loss of iridescence
Superglue (α-cyanoacrylate)	1	0	85% initial loss of iridescence
20% Paraloid B72 in acetone	2	0	50% initial loss of iridescence

EtAc = Ethyl Acetate
IMS = Industrial Methylated Spirit
IPA = Iso-propyl alcohol
PVA = Polyvinyl acetate

Colour change and initial loss of iridescence refers to blue wings after spraying or dipping in coating agent and subsequent drying, prior to embedding.

Table 2: efficacy for coating agents to reduce lepidopteran wing transparency and loss of iridescence in clear polyurethane resin.

Coating agent	Transparency	Blue wing irides-cence	Colour change?
control	1	0	70% initial loss of iridescence
Hair lacquer	4	0	50% initial loss of iridescence
50% PVA aqueous (atomised)	2	0	60% initial loss of iridescence

Both coating reagents reacted with resin at final stages of curing producing obscuring layers of air bubbles.

Two types of butterfly wing were used: pale/orange brown with darker spots and male blue butterfly.
Lined paper was viewed through a low-power microscope using the darker spots on the wing to test for transparency vs. opacity:
Transparency is rated for 0 to 5.
0 for total transparency.
1 slight fall-off in transparency.
2 lines on paper still just visible.
3 (acceptable): lines barely visible.
4 for the lines on the paper being barely visible (only under microscope).
5 for total opacity.

Iridescence was tested by tilting the finished block in incident light and is also rated at 0 to 5:
0 no iridescence – wing totally dull.
1 a slight blue flash (from small patches of wing).
2 shows the slightest sheen (result slightly patchy).
3 (acceptable) a noticeable blue flash and a reasonable sheen (over entire wing).
4 only a very slight dulling.
5 normal iridescence.

Reference
Voss, Klaus-W. *Casting with polyester.* Uetersen, Germany, c.1980.

Biological Recording and Natural Science Collection Workshops Yorkshire, Summer 2006

- Kate Measures, Heritage Learning Consultant

This summer, Creative Minds, (a Science, Technology, Engineering and Maths project run by MLA Yorkshire and funded by Yorkshire Forward) took a walk on the wild side with a series of wildlife identification workshops for adults. Each workshop equipped delegates with the skills and confidence to identify and record wildlife. They were open to people who are enthusiastic about wildlife and want to pass their skills on to others, for example, museum staff and volunteers, teachers and higher education students.

The workshops were based in local museums and were delivered by an expert from the Yorkshire Naturalist Union, with whom the programme was run in partnership. There was also a workshop specifically about biological recording. Workshop themes included:

- Dragonflies
- British Birds
- Bats
- Bumblebees
- Snails
- Hedgerows

Bumblebee workshop

When people think of museum natural science collections, images of dark rows of dusty taxidermy and 'things' in murky spirit often spring to mind. Collections are often seen as the last stronghold of a slightly tasteless, best-forgotten Victorian pastime.

Dragonfly workshop

Luckily, we've come a long way. Museum collections are inspirational, colourful, invaluable information banks, bursting with possibilities, intrigue and tangible data. The programme gave an excellent opportunity to look at some of Yorkshire's natural science specimens for reference. This not only enabled delegates to see more species than we would be able to spot in the wild during the workshop but also had the added advantage that the museum specimens don't move as fast as the ones in the wild!

But the work doesn't stop here……

Every delegate had the opportunity to join the Yorkshire Naturalists Union for a year to help develop their skills further.

The workshops have helped museum, library, heritage and environmental professionals within the region to develop their identification skills. Some have then gone on to pass on their new skills through their work, teaching or volunteering whilst others have started to record wildlife and send the data into the local biological recording centre to be added to the national records.

Investigate Your Natural World toolkit

This September, Creative Minds is launching a brand new toolkit. It provides practical guidance and help on planning and running wildlife identification workshops for museums. Wildlife identification workshops provide an exciting opportunity to use museum natural sciences collections in new ways and to build the skills of adult.

The toolkit includes help on choosing a workshop theme and the best times of year to run workshops, making use of natural science collections, help on finding workshop leaders and equipment and materials and a handy planning checklist. Also included are useful Yorkshire contacts and resources, a list of recommended wildlife identification guides and an information sheet for delegates on museum collecting.

The toolkit is free and is available on CD or can be downloaded from www.creativeminds.org.uk.

There is also a box of equipment available for museums in Yorkshire to borrow if they are intending to run a natural science event. The equipment, available for free, includes bat detectors, field guides, a GPS system, butterfly nets etc.

Contact Cliffe Castle Museum in Keighley (01535 618231) if you're interested.

NatSCA Annual Conference & AGM 2007
Theme: Collections Development

Sheffield Museums and Galleries Trust

Does Collections Development include disposal?

Need to consider:
Collecting
- fieldwork, consultancy and developing partnerships
- relationships with donors
- purchases

Added value
- loans
- research

Developing collections management strategies and policies

De-accession / disposal

Conservation
- the role of conservation in collection development
- how conservation practice uncovers hidden information

Realising the potential of collections – examples of good practice

Anyone wishing to present a paper on any of these, or any areas relevant to the theme, contact Jo Hatton.

Please note: we ask speakers to submit written versions of papers for publication in the conference issue of NatSCA News.

www.natsca.org

Bursaries for 2007 Conference

NatSCA would like to offer a number of bursaries for members towards the cost of the annual conference. There is a limited amount of money and the committee has decided that the following division best represents a fair dispersal of funds enabling the most members to attend.

- 90% of cost of reasonable travel and accommodation for those living more than 3 hours away
- 50% of conference fees for those living within 3 hours travel.

- All successful applicants *must* agree to provide a paper for the Newsletter before the bursary will be paid – this can be either an article on a suitable topic, or a personal view on the course or conference attended. (Content and style etc should be discussed with the Editor, when the bursary is approved). This paper must be submitted to the Editor within 1 month of the conference.
- 90% of accommodation costs up to £50 per night will be repaid only with a receipt.
- Travel costs to be agreed with the Bursary Committee at the earliest possible date.
- International applications will be considered at the discretion of the Committee.
- ALL bursaries are given at the discretion of the Committee and require proof of payment.

All applications must be sent to the Bursary Committee by the end of March. Successful applicants will be notified in time to qualify for the early-bird discount rate. Application should be by sending name, address and brief statement of interest (no more than 200 words) to any one of the bursary committee.

Bursary Committee:

Editor: Victoria Papworth	Treasurer: Kate Andrew	Events Organiser: Jo Hatton
Department of Botany The Natural History Museum London, SW7 5BD	Hereford Museum & Art Gallery Broad Street Hereford, HR4 9AU	Horniman Museum London Road Forest Hill, SE23 3PQ
V.Papworth@nhm.ac.uk	kandrew@herefordshire.gov.uk	jhatton@horniman.ac.uk

Museum Visitors & Dinosaurs

- G-Gina Koutsika, Audience Advocate, Natural History Museum, London

Those of us that work in a natural history museum with dinosaur fossils are not surprised that when our institutions are described as the *dinosaur museum*.

From various studies that have been undertaken with the Natural History Museum visitors, we have found out that many of our visitors specifically come to see the Museum's dinosaurs. The dinosaur gallery is particularly popular with younger children up to the age of eight.

Children usually become interested in dinosaurs between the ages of four to six and already possess related books and toys at home. It is difficult to generalize specific knowledge, but children, as young as five have background information of a concrete nature, often linked to their favourite dinosaurs. They are also able to recall basic characteristics of individual dinosaurs and use their name correctly.

The moving robotic dinosaurs (animatronics) that are displayed both in the permanent gallery and in the temporary exhibitions are for nearly all children the first on the list of favourites-*Tyrannosaurus rex* being a really captivating one. What attracts children to the animatronics is their life like size, the movement of the head and tails and the realistic qualities. Even though, some younger children find *Tyrannosaurus rex* and the other big animatronics frightening, they are still eager to see it. It was the size in particular that frightened children but also the blood, movement, the eyes and the lights. For most, the encounter remains positive, with fear heightening the experience.

'The first time my 5 year old went he was too scared –
but he went back up the path to look.
He was very pleased that he did' (mother, 2005)

It is only a small minority that remain in their guardians' arms and do not dare look.

Fossil digs also appear to be very popular with the process of *looking for* the replica dinosaur bones being the exciting aspect. Children Museums in the States that had developed dinosaur dig confirm that they are always very popular with both staff and visitors. During the *Gobi Desert* exhibition at the Natural History Museum, almost everybody (95%) enjoyed the dig because it involved dinosaurs; it was fun, was a practical activity and gave the opportunity to learn together. Children appreciated the combination of the prehistory of the dinosaurs and the history of the dinosaur expeditions.

Models of big dinosaurs and full size skeletons are also popular. The size of models is an attraction but also a source of fear. Visitors prefer specimens to casts, requesting a clear distinction between them. Where fossils are used, drawings of skeleton increase understanding and help appreciate them.

In the front-end evaluation for *Dino Jaws*, the current temporary exhibition, teachers visiting dinosaur displays appreciate the emphasis on scientific processes. Children were keen to learn more about what dinosaurs ate and how it compared to their food. Many also wanted to know about teeth and their shape and use. Several mothers mentioned that for their younger children, linking information to their own lives and bodies would help their understanding and interest.

The summative evaluation for *Dino Jaws* is currently taking place with internal staff from Learning and Interpretation. It is qualitative and complements the quantitative feedback (exit surveys) organised by the Marketing Department. It uses a combination of research methods, in order to increase validity, reliability and accuracy. A sample of 100 families is tracked and 50 interviewed. In addition, 10 schools are tracked and five are visited at schools. Further data is collected through email or web questionnaires and peer review discussion groups.

The aim is to assess the degree to which *Dino Jaws* meets the visitor outcomes and whether it is appealing and accessible to its target audience (families with children four to 11 and primary school groups). More about it …in another issue.

AGM MINUTES
Liverpool, 27.4.2006

1. Apologies for absence
Apologies were received from Wendy Atkinson, Louise Bacon, John Edmondson, Jane Mee, Clare Stringer & Graham Walley.

2. Minutes of AGM London June 2005
The minutes of the 2005 AGM held at the Natural History Museum, London on Thursday 16th June, 2005 were presented to the AGM. These were published in Issue 6 of NatSCA News in August 2005 and on the new NatSCA Website.

3. Matters arising from London AGM minutes
There were no matters arising from these minutes. The minutes were signed as a correct record by the Chair.

4. Chairman's Report: Nick Gordon
Nick Gordon reported on NatSCA's success at becoming the Special Subject Network (SSN) for Natural Sciences in the Museums sector. Nick will be posting a discussion paper to the membership in May 2006 with a Stamped addressed envelope for comments, to be returned to Nick Gordon. NatSCA will be a facilitator and will develop a collegiate approach with our many partners within the Natural Sciences collections industry. The MLA has provided a pot of money to spend in organising a series of area meetings across the country with NatSCA members, museums with natural Science collections and with other interested bodies invited to discuss what we would like the SSN to be. These areas will roughly reflect the Museum Hub local areas. Helen Fothergill asked about the SSN funding time scale and Nick replied that the MLA money given to NatSCA to effect the SSN is still available until spent.

Nick Gordon also discussed the perceived decline in Natural Science posts. There are two natural Scientists on the Leicester MSc course this year and Steve Garland reports that posts are frozen at Bolton. Any available Renaissance money cannot be utilised if there are no posts. There is a Geology curator post available at Scarborough and posts at Stoke and Cardiff for Conservators. There is also a Natural Science Conservator on the Royal College of Art Conservation Course at present.

5. Secretary's Report: Paul Brown
Attendance NatSCA committee 2005-2006

	16.vi.05	13.ix.05	21.xi.05		30.i.06	28.iii.06	26.iv.06
Nick Gordon	X			X	X	X	
Kate Andrew	X	X		X			
10 Paul Brown	X	X	X		X	X	X
Jo Hatton	X	X		X	X	X	
10 Jane Mee					X	X	
Simon Moore	X		X	X	X	X	
Vicki Papworth	X		X		X		X
Maggie Reilly	X	X			X	X	
Dominique Rogers		X					
Douglas Russell	X	X		X	X	X	
Sue Ryder	X	X		X	X	X	
Clare Stringer	X			X	X		
Steve Thompson	X	X	X	X	X		
Graham Walley	X	X					
Donna Young	X	X		X	X	X	

6. Treasurer's Report: Kate Andrew

Natsca accounts 1st Feb 2005 31st Jan 2006		
Income		
Subscriptions		
Personal 168 @£15.00		2520
Institutional 57 @ £30		1710
3 multi year and incorrect rates @ £8		76
1 @ 25 Euro rate		16.84
Other income		
sale of back issues		19.38
Interest (current & deposit account)		372.21
Meeting income		
Herbarium meeting fees		880
SPNHC meeting profit		3000
Total income		**8594.43**
Expenditure		
Subscriptions		
Data protection registration	35	
Bursaries and meeting costs		
SPNHC meeting bursaries	1885.6	
Herbarium meeting costs (room hire, catering etc)	546.2	
Committee expenses		
Insurance	687.45	
Travel to meetings	866.14	
Postage		
Committee related postage	145.92	
Newsletter postage	672.33	
Newsletter and publicity		
Printing newsletter	2436.53	
Misc outputs		
Web site	2100	
Leaflets and poster	345.63	
membership cards	55.81	
Total expenditure	**9776.61**	
deficit for 2005-2006 financial year	**-1182.18**	

Bank balances		
Deposit account 41653636		
Opening balance, 24th Jan 2005	20206.72	
Bank interest	373.96	
SPNHC meeting profit	3000	
Total and actual balance, 24th Jan 2006	**23580.68**	
Current account 91645722		
Opening balance, 24th Jan 2005	5344.85	
Income paid in	5225.47	
Expenditure on account		9776.61
Late clearing cheques from 04/05		63.45
Totals	**10570.32**	**9840.06**
Income less expenditure	730.26	
Add uncleared 05/06 cheques	1348.17	
Total and actual balance, 24th Jan 2006	**2078.43**	

Notes on the accounts
The committee took the decision that the society needed to spend some of its reserves on promoting its charitable objects and so this year have commissioned a web site, a promotional leaflet and display.

Three newsletters have been paid for this financial year rather than four in the previous year.

The employers of committee members are no longer able to be as generous in their support and increasingly the society is meeting the costs of travel to meetings.

Support for the joint meeting with SPNHC was provided in the form of bursaries to a total of eighteen individual members. The society was re-imbursed with £3,000, our share of the profit. The Herbarium meeting made a small profit.

Overall, expenditure has exceeded income by £1,182.18, but there are sufficient reserves in the deposit account to sustain this level of expenditure.

Bank statements, account books and arithmetic checked independently by Velson Horie.

7. Membership secretary's Report for 1st February 2005 – 31st January 2006: Maggie Reilly
We ended the year with 225 members with 11 additional FOC mailings The 225 are categorised as follows: 167 Personal, 58 Institutional members or 199 UK members, 26 Overseas.

Renewal notices were issued at the end of January. We (K. Andrew and M. Reilly) decided to offer to the UK personal members the option of paying by standing order this year, so a standing order mandate has gone out with the renewal notice. Several members had asked to have this facility and it seems generally popular. Helen Fothergill asked whether reminder letters have been sent. These will go out in June as paper copy and /or email to those who have not renewed. If memberships are not renewed by June, then membership will cease then.

We had hope to introduce a web-based payment facility via 'Paypal' or similar to facilitate non-sterling payments but no progress has been made. It seems complicated to understand what to do. SHNH has introduced 'WorldPay' on-line payment facility for their membership and it is up and running. Advice from the SHNH web person was sought. We were told it was difficult and complicated, requiring a web designer to do it or at least considerable website production knowledge. We have decided to postpone this for the time being.

The complimentary mailing list lost 2 mailings - SSCR due to its dissolution and Jane Pickering due to she and Chris Norris sharing a mailing.

USA members
We would like to record our thanks to Chris Norris and Jane Pickering for collecting the few USA personal memberships that we have. They have agreed to continue with this arrangement this year. We could give them complimentary membership for their services.

Steve Thompson asked whether this Swedish contacts, who have helped organise the NatSCA Study Trip to Sweden, can be given complementary NatSCA membership for 1 or 2 years as a thank you for their help in organising the imminent study trip there. Steve Thompson to supply names to Maggie Reilly.

Back issues of Newsletter
We have been running out of back issues of the Newsletter, which has necessitated some reprinting in order to cover mailings due to late/newly joined members. Fortunately the price of re-printing seems to work out at around £3.50 an issue almost the same as the original printing cost. This seems to have been a tricky one to get right - either I am sitting on a mountain of spare copies or we have none. We get a few requests for full sets of back issues. Back issues will eventually be put up on the website obviating the need for paper copies.

New Scottish charity regulations
After changes in primary legislation. a new authority has come into being in Scotland to regulate charities – it is the Office of The Scottish Charity Regulator (http://www.oscr.org.uk/Index.stm). We had some concerns that NatSCA might have to register separately in Scotland but this is not the case as it operates technically from an English address. The only change we were required to make is to add the phrase 'registered in England and Wales, after our charity number on letterheads [see heading of these minutes].

Membership cards
Membership cards will be issued shortly to all members. They will bear your membership number, which members will need when the first log onto the new NatSCA website forum. Please keep a note of your number. If you lose it please contact Vicki Papworth or Maggie Reilly to be reminded. Anyone late in renewal will have a new membership number allotted to them, cancelling the old one.

Email addresses
We would like to be able to circulate group news by email and most members have supplied addresses. We have some gaps, usually for our institutional members but we will be trying over the next few months to contact people and fill the gaps. There are a few members who do not use email. For these, and for those whom we cannot identify an email address, paper mailing will be sent out as usual.

8. Editor's Report: Vicki Papworth
There have been three issues of NatSCA News published during the year, issue 6 in in August 2005, Issue 7 in December 2005 and Issue 8 in March 2006, the latter with some colour printing. Please can the membership send copy and news items to the Editor for inclusion in NatSCA news.

The New NatSCA Web Forum went live yesterday on Wednesday 26th April 2006! When you get your new membership number, you enter this into the webpage and can then chose a memory friendly password of your choice.

Vicky would like to have a document store on the website for policies, licences etc as a reference source for NatSCA membership.

9. Natural Science Conservation (& Institute of Conservation) Report: Simon Moore
Simon Moore reported on the need for NatSCA to maintain an influence with ICON on Natural Science Conservation. The ICON Chair wishes to see us become part of ICON again (Convergence) but NSCG (Natural Sciences Conservation Group) became independent of the old UKIC (United Kingdom Institute of Conservation when their fees were astronomically raised. Such an influence can be done through our 8-10 ICON members within our NatSCA membership. The Care of Collections Forum was assimilated into ICON in 2004 even though many of their members are not Conservators. Simon proposes to put out a discussion document on our website forum to start a debate on this subject and in NatSCA News.

10 Election of ordinary members of NatSCA committee :
Nominees for NatSCA committee two-year posts at AGM Liverpool 2006-2008.

Name	Proposed:	Seconded:	Institution:
1. Andrea Hallaway*	Victoria Papworth	Jenny Bryant	NHM Botany
2. Jo Hatton	Sherry Doyal	Louise Bacon	Horniman Museum
3. Guy Knight*	Donna Young	Wendy Atkinson	World Museum Liverpool
4. Nicola McNicholas*	Steve Minean	Paddy Cottam	Hancock Museum, Newcastle
5. Simon Moore	Christine Taylor	Jenny Bryant	Hants Museums Service
6. Victoria Papworth	Jenny Bryant	Paul A Brown	NHM Botany
7. Maggie Reilly	Jo Hatton	Douglas Russell	University of Glasgow Mus.
8. Douglas Russell	Clare Stringer	Jane Mee	NHM Tring
9. Clare Stringer	Douglas Russell	Jane Mee	Leeds Museums Service
10. Steve Thompson	Adrian Norris	Richard Comley	Humberside Museum service

* denotes new members of committee

As there are 12 vacant posts and ten candidates, AGM was asked to accept and elect the 10 names en block onto committee to serve for two years from this meeting. This was proposed by Steve Thompson and seconded by Peter Howlett and AGM voted yes to accept these 10 nem. con.

11 Seminars: Notice of building blocks of Natural Science Objects November 2006: Simon Moore
Simon Moore reported on the success of the Botany Seminar held at Kew Gardens and reported on the future seminar 'building blocks of Natural Science Objects' with talks and hands on sessions and demonstrations, probably to be held on Thursday 9th November. Any members who are interested can sign a list at the registration desk today. He also asked for a botanist to volunteer to cover this field of biochemistry.

12 Study Trips: Notice of trip to St Petersburg in 2007: John Edmondson
In John Edmondson's absence, Paul Brown read out the following communication….

"Next year's study trip to St. Petersburg is being co-ordinated by John Edmondson, National Museums Liverpool. The likely date is early June 2007, and expressions of interest would be welcome. Please email me at john.edmondson@liverpoolmuseums.org.uk and I will send further details, including cost and booking deadlines, in the autumn. A CD is available for loan, containing a Power-point show giving some background information on St. Petersburg's rich collection of museums." John already has 10 people interested, so the trip is likely to go ahead assuming we can find an economical travel package. Steve Thompson reported on the study trip to Stockholm and Uppsala, Sweden, which is happening from 18th to 21st May 2006. He asked if there were any members who would still like to attend.

13 Any Other Business

There were no items for AOB.

14 Date and Venue of Next Meeting.
Paul Richards invited the membership to Sheffield for our AGM and conference in April 2007. Helen Fothergill remarked that this should not happen adjacent to the Mayday bank holiday weekend as this might cause problems for transport for those in the far-flung corners of the UK, in her case Plymouth. We hope to have the conference/AGM at least a week before this weekend. Watch NatSCA News and our Website for future further details.

15 Vote of thanks
Nick Gordon proposed a vote of thanks to Dominique Rogers, Sue Ryder, Donna Young and Graham Walley who are standing down from committee. We hope to second Graham as our contact for natural science species records (Fenscore etc.). Also Jo Hatton and the following people from World Museum Liverpool, Guy Knight, Donna Young, Mo Smith and Alex Blakesborough were thanked for organising our conference, which has proven most successful, interesting and useful.

The Impact Of Frozen Tissue And Molecular Collections On Natural History Museum Collections

- Geoff Martin, The Natural History Museum, London

This was a dissertation submitted in partial fulfilment of the requirements for the degree of MA in Museum Studies of the University of London in 2003

Abstract
This paper examines the impact of frozen tissue and molecular collections on traditional natural history museum collections. This was carried out by an examination of current literature, by talking to people who work with frozen tissue and molecular collections and by input of my own views as a curator of Lepidoptera (butterflies and moths) at The Natural History Museum, London. The first part deals with definitions of natural history museum collections and what they are used for. Then there is an examination of the issues surrounding the storage facilities for tissues and molecules, deposition of molecular material and the suitability of current and future museum specimens for molecular work. A large part of the future of systematics and taxonomy lie with molecular studies. As one of the main purposes of natural history museums is the study of systematics and taxonomy then natural history museums have to embrace frozen tissue and molecular collections to survive. I conclude that molecular collections are an important part of the future of natural history collections.

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Plate II. The tank room at The Natural History Museum, London; a typical spirit collection area housing large specimens

Plate III. A typical cabinet containing dried specimens, in this case moths, from the Department of Entomology, The Natural History Museum, London

Plate IV. A typical cabinet containing specimens mounted on microscope slides, in this case Hemiptera (true bugs), from the Department of Entomology, The Natural History Museum, London

Plate V. A typical vial from Entomology Department Molecular Laboratory, The Natural History Museum; London; in this case containing moth legs in 100% ethanol awaiting DNA extraction

Plate VI. A typical rack for holding vials, from a –20ºC freezer from the Entomology Department Molecular Laboratory at The Natural History Museum, London

Plate VII. A storage rack containing the specimens in liquid nitrogen from the AM-CC at The American Museum of Natural History

Plate VIII. Cryovats containing liquid nitrogen at –155ºC, from the AM-CC at The American Museum of Natural History

Plate IX A –20ºC freezer in the Entomology Department Molecular Laboratory, The Natural History Museum, London

Plate X. A –80ºC (or ultra-low) freezer in the Entomology Department Molecular Laboratory, The Natural History Museum, London

Plate I. The herbarium at The Natural History Museum, London; a typical collection cabinet with a herbarium sheet (Photo G. Martin).

Plate II. The tank room at The Natural History Museum, London; a typical spirit collection area housing large specimens (Photo G. Martin).

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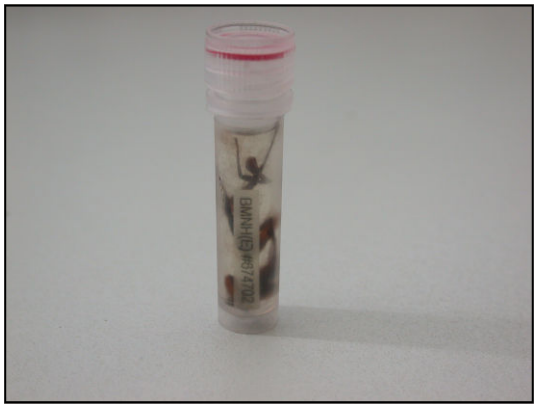

Plate V. A typical vial from Entomology Department Molecular Laboratory, The Natural History Museum; London; in this case containing moth legs in 100% ethanol awaiting DNA extraction (Photo G. Martin).

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ACKNOWLEDGEMENTS

I wish to thank the following: Suzanne Keene (Institute of Archaeology, University College, London) for helpful comments concerning this paper; Goulven Keineg (Entomology Library, The Natural History Museum) and Emma Bennett (General Library, The Natural History Museum), for help in locating hard to find references; Mike Fitton (Collections Manager, Department of Entomology) for information on size of the Entomology Building, The Natural History Museum; Kosmas Theodorides (Molecular Systematist, The Natural History Museum) for discussions on molecular biology and museums; Shazia Mahamdallie and Lejla Buza (Entomology Department Molecular Laboratory, The Natural History Museum) for information regarding the molecular laboratory; and Mark Wilkinson (Associate Keeper of Zoology, The Natural History Museum) for access to internal reports.

CHAPTER 1 - Introduction to natural history museums and their collections

"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." (Thomas, 2000)

1.1 Introduction

In the past 30 years the use of molecular techniques to answer questions of systematics and taxonomy has exploded. Although morphological studies have not been dismissed, the study of systematics increasingly relies on molecular data to confirm or challenge morphological studies. As natural history museums have traditionally been a depository for specimens and conducted systematic and taxonomic research into these specimens, it is reasonable that they are also going to embrace molecular studies. Some curators view these developments with suspicion particularly as many molecular studies cannot use traditional museum specimens for a number of reasons, generally due to the degradation of molecules over time. Although some molecules have been extracted from museum specimens, most molecular workers prefer fresh material and in some cases can only use fresh material. These frozen tissues and molecules also present unique storage problems. The use of freezers, cryogenics and molecular extraction equipment present museums with a further increase on ever tightening budgets. I will examine a number of issues concerning frozen tissue and molecular collections and their impact on natural history museum collections. These issues only affect the large national or university museums with encyclopaedic collections and staff that carry out research into taxonomy and systematics. The smaller local museum is not directly affected by these issues but may be affected if governmental resources are redirected to the larger national museums.

1.2 What are natural history museums and what is their purpose?

Natural history museums have been in existence for 250 years with the first natural history museum, the British Museum, opening in 1753 (Stearn, 1998:9). Other museums soon opened across Europe such as the Muséum national d'Histoire naturelle, Paris, founded in 1793 (Muséum national d'Histoire naturelle, 2003). In the following century natural history museums started to open in the USA. The Smithsonian (or National Museum of Natural History) in Washington D.C. opened in 1846 (Smithsonian Institute Libraries Online Exhibition, [No Date]) and the American Museum of Natural History, New York opened in 1869 (Kolb, 1999). These are probably the four most important natural history museums in the world due to the large encyclopaedic collections they house which includes a large proportion of the world's type material (see below for definition of type material). Many academic institutes also have natural history museums associated with their campus such as Oxford University Museum, England and Harvard Museum of Natural History, U.S.A.

Aside from public education and entertainment, natural history museums other role is the safeguarding of collections of specimens. These specimens are used in the study of taxonomy (i.e. scientific description and naming of living and fossil organisms; placing them within a system of classification; and developing systems for identification) and in the study of systematics (i.e. the naming and investigation of the characteristics and relationships of organisms), (The Natural History Museum, 2003a). Natural history museums are also depositories for type specimens. A type specimen is the unique representative of its particular species

and the specimen to which the scientific name is correlated, once defined a type specimen remains forever of key value, and will be required for study whenever that species comes under review (Thackray & Press, 2001:70).

1.2.1 Taxonomy, systematics and molecular biology

Taxonomy is based on the binomial system of classification first applied in 1758 when Carl Linnaeus published the tenth edition of *Systema naturae* (Koerner, 1999:199). However this was not totally accepted across the scientific community until 1867 in the case of plants and 1905 in the case of animals (Koerner, 1999:201). Systematics investigates the relationships between individuals, populations and species. One of the key tools for investigating systematics is that of phylogenetics. Phylogenetics attempts to recover genealogical relationships among groups of organisms and produces classifications that exactly reflect those genealogical relationships (Wiley, 1981:6). From this phylogenetic trees are produced which utilise hypotheses of character transformation to group taxa hierarchically into nested sets and then interpret these relationships (Kitching *et al.*, 1998:213).

Taxonomy and systematics were traditionally based on morphological characters to separate and classify organisms. Since the 1960's biological research including taxonomy and systematics has moved with ever increasing speed towards the molecular level (Dessauer & Hafner, 1984:1). The molecular level includes examination of proteins, DNA (deoxyribonucleic acid), and RNA (ribonucleic acid), although the vast majority of research at the present time involves DNA. The study of DNA really accelerated in the 1980's when the Polymerase Chain Reaction (PCR) was invented by Kary Mullis in 1983 (Mullis, 2002a). Mullis was awarded the Nobel Prize for Chemistry in 1993 for the invention of PCR (Mullis, 2002b). PCR enabled tiny fragments of DNA to be copied millions of times, cheaply, easily and in only a few hours. Tiny amounts of DNA could now be taken from a hair, a feather, blood or a museum specimen and amplified many times until useable quantities for study were obtained. PCR also revolutionised many other disciplines such as forensic science and medicine. Certainly systematics today relies heavily on molecular information to ascertain the relationships between species. Molecular information has provided many more characters for which the systematists can now use to build molecular phylogenies. Taxonomy generally does not make full use of molecular information at present as most species descriptions are still based on morphological characters. Although there is much heated debate as to whether this should remain the case (for more on this issue which is beyond the scope of this paper see Lipscomb *et al*., 2003; Seberg *et al*., 2003; Tautz *et al*., 2003).

Most major natural history museum collections are laid out systematically being sorted by order, family, genus and species. Without some kind of systematic system and some way of retrieving this information (i.e. a database, electronic or otherwise) then the collection would be unworkable. At the present time the systematic layout of most collections is usually based on morphological characters.

1.2.2 What are natural history collections?

Traditionally natural history collections consist of specimens preserved broadly in two ways: dry (i.e. pressed, pinned, boxed or mounted) or wet (i.e. preserved in alcohol or formalin), (Anon, 1998). Natural history collections tend to be divided into botanical and zoological collections.
For the most part botanical collections (which will include Fungi) consist of dried specimens (including seeds) on herbarium sheets and these sheets are ideally stored in pest proof steel or wooden cabinets (see Plate I). There will be collections of smaller specimens such as diatoms, microalgae and pollen which will be mounted on microscope slides. There will also be small amounts of plant material stored in spirit, usually 80% IMS (Industrial Methylated Spirit).

Zoological collections are usually divided into Vertebrates and Invertebrates. Vertebrate collections will include dried skins, skeletons and a large number of whole specimens in spirit, usually in formalin or 80% IMS (see Plate II). Invertebrates collections will include a large number of dried specimens such as pinned insect and shells (see Plate III). Very small specimens such as greenfly will be mounted on microscope slides (see Plate IV). Softer bodied invertebrates that do not dry well such as Jellyfish will be kept in spirit, again usually formalin or 80% IMS. The collection area will mostly contain collections storage furniture with areas set aside for research and curation of the collection. Most museums will also have extensive libraries associated with the collections.

1.3 What are frozen tissue and molecular collections

These collections consist of frozen tissues and molecules separated from specimens. Frozen tissues may include a whole organism (common in the case of insects, less common for larger vertebrates), parts of an organism (e.g. hair or feathers from vertebrates, legs from insects) and may include venom and blood samples. Molecules preserved will include extracted proteins, DNA, and RNA. It is usually the case that frozen tissues are collected first and then when time permits molecules are extracted from these tissues in the laboratory. The tissues and molecules will be stored in a variety of ways but generally in some kind of sealed tube (see Plate V), which will be placed in rack system (see Plate VI & VII). Within the tube the tissues or molecules may be kept dry, stored in 100% ethanol or stored with a buffer. All effort is made to prevent the degradation of the tissue/molecule concerned. The tubes containing the tissues or molecules are then stored in either cryovats which contain liquid nitrogen at –155ºC (see Plate VIII) or in a -20ºC or -80ºC freezer (see Plate IX & X).

Museums with large research collections have had to respond and adapt to molecular research. This has meant the building of molecular laboratories and molecular storage facilities within museums and the employment of specialised staff to conduct this research.

1.3.1 Examples of frozen tissue and molecular collections with facts and figures

The minimum requirement for a frozen tissue and molecular collection is a wet and a dry laboratory and a freezer or cryovat storage area. The wet laboratory will include equipment such as PCR machines, centrifuges, laminar flow hoods (similar to a fume cupboard but creates a sterile environment thereby avoiding contamination of isolated DNA) and a range of chemicals, glassware and other associated equipment. The dry laboratory would contain computer equipment associated with the collection inventory databases and would also be involved in the analyses of the molecular work carried out.

I will take the example of the molecular laboratory of the Entomology department at The Natural History Museum, London as a typical example of a museum molecular laboratory that does not utilise liquid nitrogen for storage of specimens. Facts and figures are supplied by Shazia Mahamdallie, the laboratory manager, Mike Fitton, entomology collections manager and Lejla Buza, assistant laboratory manager. The laboratory was started in 1989 and occupies space that was previously taken up by traditional natural history collections. The area covers approximately 250m^2 out of 6000m^2 for the entire entomology department, plus other office space required by researchers. Twenty staff are associated with the laboratory out of a total of 100 staff in the entire department. Only three of these staff have permanent contracts and the other 17 are a mixture of fixed term contracts, PhD and MSc students. Only permanent members of staff are funded by the museum, the rest of the staff are externally funded. The laboratory consists of two offices, a dry laboratory where the computer work is carried out, five wet laboratory which house four -20ºC freezers, two -80ºC freezers, five PCR machines, two lamina flow hoods and a whole hosts other associated laboratory equipment. The running costs of the laboratory in 2002/3 where in the region of £10,000 which £6,500 of this was spent on service contracts and equipment repairs and £3,500 on laboratory consumables. The approximate costs of equipment are as follows; -80ºC freezers cost £8,000 each, -20ºC freezers cost £2000 each, PCR machines £6000 each and the lamina flow hoods cost £4000 each. Around 20,000 specimens are stored here and they are accessed via the Freezerworks™ database, which cost £5,500 plus helpline/service contract. This approximates to start up costs of £67,500, and running costs of £10,000 per annum. Staffing and computer costs are not included.

The role model for all museum frozen tissue and molecular collections must be the Ambrose Monell Cryo Collection (AM-CC) at the American Museum of Natural History in New York, U.S.A. The collections at the AM-CC are stored in cryogenic vats, which contain liquid nitrogen that keeps the collection at around –155ºC (see Plate VIII). There are eight cryogenic vats in the storage area with space for another four; each cryovat contains enough space for 70,000 samples that are contained in racks (see Plate VII) (American Museum of Natural History, 2003a). There is potential at this facility to store nearly a million specimens. The specimens are fully databased using Freezerworks™ and this database is linked to the morphological collection in the main museum and is online (see http://research.amnh.org/amcc/database/) with images of the morphological specimen (American Museum of Natural History, 2002). The facility is fully alarmed in case of problems with the cryogenic vats or the atmospheric oxygen of the facility (American Museum of Natural History, 2003a). Wilkinson & Huxley (2002) report that it would cost in the region of £500,000 to set up and running costs (including staff) would be in the region of £200,000 per annum. The breakdown of

costs is as follows (from Wilkinson & Huxley, 2002). Infrastructure: Bulk tank (3,000 gallon) £30,000; Cryogenic vats (8 x £20,000) £160,000; Vacuum piping £60,000; Monitoring systems £20,000; Wet lab equipment, £80,000; Database /computer equipment £30,000. The recurrent costs for consumables (liquid nitrogen, cryotubes, etc.) are approximately £25,000 per annum. Overall running costs including staff costs are approximately £200,000 per annum. Building costs would of course be extra on top of this.

Although it is difficult to make exact comparisons if one compares number of specimens held by the Department of Entomology's Laboratory at The Natural History Museum (20,000 specimens, start up cost £67,500) and the AM-CC collection, (up to 1,000,000 specimens, start up cost £500,000), it is clear to see that a liquid nitrogen facility is much more cost effective. Although this is a considerable amount of money to find, molecular biology tends to have far more potential to attract sponsors than traditional natural history collections and grants have been obtained in the past for similar such projects from biotechnology and biomedical companies such as Wellcome or GlaxoSmithKleine. Without external funding it would seem unlikely that a museum is going to have the resources to run a molecular collection facility. One option for The Natural History Museum, London, would be to build this facility as part of Darwin Centre II, which is due to open in 2007 (Wilkinson & Huxley, 2002). It is the running costs of the molecular laboratory that causes most concern. Certainly grants are available to purchase capital equipment but rarely are running costs such as maintenance and replacement of equipment factored into these grants. There are conceivably a lot of problems ahead if running costs are not included and just to keep a molecular facility running may incur budget cuts on other parts of the museum particularly the traditional collection.

1.3.2 A short history of frozen tissue and molecular collections

It was the wide adaptation of protein electrophoresis in the 1960's and 70's that provided the impetus for assembling frozen tissue collections (Engstrom *et al*., 1999:316). The number of comparative molecular papers using collections and published in the Journal of Mammology increased from zero in 1954 to two in 1964, six in 1974, 14 in both 1984 and 1994, and 15 in 1996 (Engstrom *et al*., 1999:316). . As outlined earlier it was the invention of PCR that really accelerated museums into building molecular laboratories. Dessauer & Hafner published the first list of molecular collections in 1984. The list comprises of 87 institutes (56 of which are in the USA). Eight of these institutes are museums (7 in the US and one in Australia) virtually all the rest are universities. Dessauer *et al.* (1996:42) provides the most recent list of institutes holding molecular collections. Here there are 60 institutes listed with 45 in the U.S.A and 14 of these institutes are museums. Universities are certainly carrying out a large portion of current molecular work. At the present time most large museums that carry out taxonomic and systematic research now have associated molecular laboratories and many will have frozen tissue and or molecular collections. The first museum to have a frozen tissue and molecular collections was the Louisiana State University Museum of Natural Science Collection of Genetic Resources which opened in 1978 (Brown, 1999a).

1.3.3 The conflict between curator and molecular biologist

Some curators hold the view that molecular biology will be the death of traditional morphological collections. It is easy to see why this view may be held. Any large museum has seen large amounts of funding being made available in the past 20 years available for the building of molecular laboratories and tissue collections with the perceived neglect of the traditional collections. They have also witnessed specimens being taken from morphological collections for molecular work and subsequently destroyed with no useful information being gained. There has definitely been a lack of understanding of the techniques involved in molecular work and the use they have for taxonomy and systematics. Molecular workers are also as guilty of not explaining their motives or work to curators and morphological workers. They also may have little understanding of a large collection, the history behind it and the issues concerning maintenance of a large collection. Many curators complain that molecular work does not make full use of the collection, that molecular work can be carried out anywhere and that the molecular worker is parasitising the museum. However molecular work relies on using large systematic collections for identifications of specimens to be used in molecular work. Even though there is a large body of evidence as to the best way to preserve new specimens for molecular work, some curators are choosing to still preserve new material in ways they know will not preserve molecular data. Molecular workers are also guilty of disposal of specimens once their work has been completed which could be incorporated in a traditional museum collection. Molecular workers also note that there is a great deal of prestige of having a laboratory associated with a long-standing, well-established natural history museum. Indeed the museum prestige itself can also benefit by having a molecular laboratory and collection. Better communication is needed between the curator, morphological worker

and molecular worker to overcome these problems. Certainly collaborative field trips where specimens for both morphological and molecular work are collected and results jointly published are a good way of encouraging team building. I can imagine that many of these problems will be overcome in the next 10 years or so as the 'old school' retire and the importance of molecular work is fully realised as of benefit to the museum as a whole.

CHAPTER 2- Museum specimens and DNA

2.1 Use of DNA from museum specimens

Museum specimens offer unique opportunities for studying DNA. Nowhere else can the researcher utilise diverse collections of correctly identified specimens going back over 200 years, and in the case of specimens preserved in amber several million years old. Museum collections also offer the chance to study extinct species, rare species or species difficult to collect because of current political situations in their countries of origin. Museum specimens are often extremely well documented and come with full ecological and phenological data.

The demand for access to natural history collections for the purpose of DNA extraction has soared in recent years. A search for the term "Ancient DNA" on the BIOSIS Biological Abstracts database (BIOSIS, 2003) returned no hits for 1980-1984, 2 hits for 1985-1989, 27 hits for 1990-1994, 48 hits for 1995-1999 and 100 hits for 2000-2003. Clearly an exponential increase in the number of papers dealing with ancient DNA, although admittedly not all of these will be relevant to natural history museum collections.

2.1.1 Is DNA still viable in museum specimens?

There are several problems with DNA from museum specimens. The DNA maybe too degraded for analysis due to the original preparation method or subsequent preservation method. The specimen may have also been contaminated with DNA from another organism thereby giving false results. Unfortunately it is impossible to tell this from a specimen until destructive sampling and subsequent analysis has taken place.

2.1.2 Destructive sampling

Molecular techniques result in the destruction of part or even the whole specimen (this is known as destructive sampling). This is nothing new as morphologists often need to employ destructive techniques to see the structures they are interested in (Thomas, 1994a). Large specimens such as mammals may only need a few hairs or an extract of bone to provide enough DNA for analysis. Smaller specimens such as insects will need by comparison a much larger fraction of the specimens although with some groups e.g. moths it may be possible just to use a leg. Some specimens are very small indeed and the whole specimen may need to be used to extract enough viable DNA for study. Certainly the destruction of a whole specimen should be discouraged. In the case of type material, extinct or endangered species careful consideration by the curator is needed before material can be used and if it is the case that the specimen will be completely destroyed then I believe that permission should be refused. Perhaps the worst example of destructive sampling that led to no recoverable DNA and the loss of the specimens concern specimens that are preserved inside amber. There have been various claims of extracting DNA from amber preserved insects many of millions of years old cited by Austin *et al*., (1997). But he failed to detect any authentic insect DNA. They attempted to extract DNA from 15 specimens and failed, they also report on the attempts of three other groups who also failed to produce any DNA. They also identified three cases were the samples where contaminated by DNA from living organisms and also point out that all the samples in question where destroyed during the extraction process. In conclusion Austin *et al*., (*ibid.*) state that due to the lack of significant biological questions addressed by molecular studies, the primary value of amber preserved fossils lies in their excellent morphological preservation and not in the fragmented remains of any DNA whose existence remains speculative at least. This paper reinforces the care need in allowing specimens to be destructively sampled, as in this case specimens were totally destroyed yet no DNA was extracted.

2.1.3 Loan of materials for molecular work

Natural history museums have had a long tradition of lending specimens for morphological work. Recently there has been a demand for specimens to be loaned for molecular work. With this increase in demand for

specimens for molecular work pressure has been put on the curators' time and their ability to judge potential users of the collections as to their ability to extract DNA, causing the minimum of damage to the specimen and maximum benefit to the collection. Pääbo *et al*. (1992) was the first to address the issue of loan material for DNA extraction and gives four criteria to be considered before loan material for DNA work that involves destructive sampling.

- The project must be of sufficient interest to justify destruction of specimens
- The technical competence of the researcher and their laboratory
- Evidence that the specimens involved cannot have DNA sampled from wild populations
- The amount of staff time required to evaluate and process the loan

The first point to be considered is there sufficient justification to damage the specimen in the pursuit of DNA. The technical feasibility of the project should be evaluated independently by molecular biologists. As many of the larger museums already have molecular laboratories it may be prudent to ensure that work is done in the museums own molecular and that an appropriate charge be levied for this.

The second point to be considered is the competence of the laboratory and staff of the institute requiring the material. Do they have a published record of DNA work with museum specimens using small amounts of DNA? If not then the museum should err on the side of caution and lend fewer examples of the material required or insist that the museums own facilities are used. Once competence has been demonstrated then further loans can then be issued the researcher needs to demonstrate that the samples required cannot be obtained from the wild.

For many researchers museums may be a convenient and inexpensive way of obtaining DNA samples. One can imagine a group of closely related species that have a wide geographical distribution. The cost of visiting all these countries that the species occur in and gaining permission to sample DNA from the specimens would seriously prohibit the research concerned. In many cases the museum will represent the only easily available source of DNA. However when the cost of curation and storage of DNA samples is taken into consideration, the museum cannot be seen as the cheap option and samples from living populations may well suit the researcher better.

2.1.4 What should happen to extracted molecules?

The question of what to do with the extracted DNA also arises. With any DNA extracted from museum specimens the results are published and for some researchers this is deemed enough. The extracted DNA or aliquot has in the past been disposed of or held onto by the researcher. Whitfield & Cameron (1994) argue that many museums do not have the facilities, budget or curatorial skills to store tissues or molecules over a long period of time and that museums should not require the borrower to return material, claiming that the borrower could look after the sample better than most museums. However actions like this could lead to samples of museum material being scattered amongst academic institutes and there is no guarantee that they could look after the material any better than a museum. In a reply to Whitfield & Cameron (1994), Hafner (1994) points out that many samples have been lost by poor curation on the part of researchers, and that the emphasis on preservation of data rather than samples will only perpetuate this wasteful practice. Hafner (*ibid*.) also points out that there are many institutes such as the Louisiana State University Museum that will accept tissues and molecules for long-term storage. With this in mind it is irresponsible of researchers to waste material. The problem of disposal of extracted material is highlighted by Pääbo *et al*. (1992), where species of high interest to researchers such as Galapagos Finches may receive many requests for samples for molecular work. This is only a finite resource so Pääbo *et al*. (1992) argue that returned samples of molecular extracts should be lent out rather than destroying parts of or whole specimens for identical pieces of research. Pääbo *et al*. (*ibid*.) also suggest that where practical DNA from wild populations should be used in preference to museum specimens. This may not be possible in a number of cases particularly where the species required is rare, endangered or even extinct. Certainly botanists probably have an easier time obtaining samples from wild caught populations as many botanical gardens often contain a wide variety of plants including endangered species. Although zoos do contain many species there is a bias towards vertebrates and although some zoos do keep invertebrates the species range in minute when compared to museum collections.

As well as returning the sample back to the museum or depositing it in a suitable repository, each sample needs to be given a GenBank® accession number. GenBank® was set up in 1988 by the National Centre for

Biotechnology Information (NCBI) in the U.S.A., and is a database of nucleotide sequences from more than 130,000 organisms (National Centre for Biotechnology Information, 2003). The majority of journals now require a GenBank® accession number before an article may be published and GenBank® will also include details of the repository where the sample is held (National Centre for Biotechnology Information, *ibid*.). It is also linked to two other large databases of molecular information, DDBJ (DNA Data Bank of Japan), and EMBL (European Molecular Biology Laboratory) (National Centre for Biotechnology Information, *ibid*.). As the GenBank® database is the central depository for molecular sequence information it is essential that any samples lent to researchers by museums must have a GenBank® accession number associated with them.

CHAPTER 3 - Preservation techniques and molecules

3.1 The effect of preservation techniques on molecules

Many museums still have an active collecting policy, particularly with invertebrates as there is still much to be learnt about systematics and many groups of invertebrates are poorly known and many species are still awaiting description. There is plenty of evidence that many museum specimens are totally unsuitable for DNA extraction. This is the due to treatments both physical and chemical before and after preservation.

3.1.1 Chemicals used in preservation for morphological studies and their affect on DNA

Chemical treatments that are good for morphological work can be extremely detrimental to molecules required for molecular work and vice versa. There is also often no documentation associated with specimens as to which chemical and physical treatments the specimen has been subjected to. Pre molecular times, understandably nobody gave a thought to the effect of processes on molecular structure and no documentation was kept with the specimen. There are many chemicals in use that may affect DNA. Lists of certain chemicals that affect DNA are given by Brown (1999a: 136) and Carter (2002). Their lists are not comprehensive and the list provided by Brown (*ibid*.) is divided into 'probably safe' and 'probably not safe'. I will consider the following three chemicals in more detail, ethyl acetate (used for killing insects), 80% IMS (used for killing and preserving invertebrates and preserving invertebrates) and formalin (used for fixation and preservation of both invertebrates and vertebrates). These are chemicals commonly used in the preservation of museum specimens. Zoological specimens have to be killed before they can be preserved. The method of killing varies from group to group, although whole vertebrates except fish are rarely collected today. A large amount of insect collecting still occurs as museums play a major role in the naming and classifying of insects. Although there are many methods for killing insects for museum collections, traditionally most insects were either killed by gassing with cyanide (cyanide is no longer used as it is banned in most countries) or ethyl acetate (which is still in use today) and the specimens subsequently air-dried. This method is fine for morphological work but Quicke *et al.* (1999) has shown that method of killing plays a crucial role in the ability to extract DNA. The use of ethyl acetate as a killing agent is extremely detrimental to DNA (Reiss *et al*., 1995; Dillon *et al*., 1996; Quicke *et al.*, 1999). These authors found either little or no DNA from specimens that had been killed with ethyl acetate. Although ethanol appears to preserve DNA well, most of the spirit collection in The Natural History Museum, London is preserved in 80% IMS which is 96% ethanol with 4% methyl alcohol added and then diluted with 20% distilled water. 80% IMS was used in preference to ethanol as ethanol attracts a much higher rate of duty and is therefore more expensive to buy. There is a question as to whether DNA is affected by 80% IMS. Carter (2002) states that 80% IMS gives fair to good results when extracting DNA from invertebrate specimens where as Wilkinson (2001) suggests that storage of specimens in 80% IMS causes further degradation of DNA and that The Natural History Museum should abandon the use of 80% IMS and any new collection should be stored in pure ethanol. Formalin (generic name for a solution containing Formaldehyde of varying concentrations) was commonly used for the preservation of whole animals particularly vertebrates and it is still used today for 'fixing' specimens before they are preserved in ethanol. There appears to be some debate as to whether this affects specimens or not. It is difficult to ascertain the exact chemical nature of formalin, Brown (1999b: 137), Reid (2000) and Carter (2002) state that formalin is very detrimental to DNA. Although it is not the formalin itself but the possibility that formalin oxidises to formic acid, which causes damage to DNA. Vachot & Monnerot (1996) conclude that buffered formalin solutions when the correct chemical composition is used cannot react with DNA.

Many smaller museum specimens are mounted onto microscope slides. I will take the example of Hemip-

tera (true bugs). The specimen is first boiled with potassium hydroxide to remove all fleshy parts leaving only the exoskeleton. The exoskeleton is fixed using alcohol or some other fixative. The specimen is then placed in a mountant (such as euparal or canada balsam), which is placed on the microscope slide. The specimen is placed within the mountant, a coverslip placed on top and the mountant is allowed to set hard. Although the specimen may be recovered from the slide by dissolving out the mountant. Large numbers of specimens, including type specimens, are stored in this way. I can find no reference as to whether slide mounted specimens have viable DNA for study although one would expect not after this kind of treatment.

Botanical specimens are also chemically treated for preservation and this has also hindered DNA extraction. Certainly the use of mercury salts (and arsenic) was commonplace on herbarium specimens to deter fugal growth and pest attack. Not only does this represent a considerable hazard to human health (Rader & Ison, 1999:354) but also can adversely affect DNA as it is listed as 'probably not safe' by Brown (1999b: 136). Although at least with botanical specimens they are ways of detecting whether the specimen has been treated with mercury salts (Rader & Ison, *ibid*.). Jansen *et al*. (1999) conclude that chemical treatment should be avoided if the plant material is to be used subsequently for molecular analysis.

3.1.2 Physical treatments that may affect DNA

Physical treatments affecting specimens include drying, heating and freezing. It has been pointed out by Quicke *et al*., (1999) that rapid drying is essential for preservation of DNA and that this may be the reason why insects specimens killed with ethyl acetate and then subject to slow drying yield no usable DNA. Slow drying of specimens may also lead to fungal growth and Quicke *et al*., (1999) have actually sequenced only fungal DNA from wasp specimens. Contamination of DNA is a major problem in museum specimens. Contamination can come from a variety of sources. Handling of specimens can lead to contamination by human DNA. Often specimens are stored very close to each other, particularly closely related specimens. Thomas (1994b: 316) suggests that replicate extractions should be carried out to test for and ensure contamination has not taken place.

3.1.3 Preservation methods that conserve DNA

Certainly the collecting methods of natural history specimens are now going to have to take into consideration the effects on molecules. Although some usable DNA has been obtained from collections, the vast majority of collections, with current molecular techniques are not suitable for molecular work. Future collecting will have to collect for molecular work as well as morphological work. Except for the smallest of organisms it is possible to save a small part for molecular work and keep the rest of the specimen for morphological work.

The best method for killing specimens to obtain DNA is to place the specimen directly into liquid nitrogen and then freeze immediately at –80ºC (Dillon *et al*., 1996; Quicke *et al.*, 1999). However this then renders the specimen useless for morphological work so the identity of the specimen needs to be known beforehand. Also liquid nitrogen is difficult to obtain under field conditions. A compromise is to use ethanol of a concentration of between 70 and 100% here both morphological and molecular work can still be carried out (Reiss *et al*., 1995; Dillon *et al*., 1996; Quicke *et al.*, 1999). However ethanol is useless for butterflies and moths as the scales tend to fall off the wings when placed in ethanol making identifications impossible (*pers. ob.*). This can be overcome by removing the wings and placing them in a glassine envelope and just placing the body in ethanol (Brower, 1999). It is essential that all new material to be collected whether for DNA work or not should have method of killing labels and labels indicating any subsequent chemical or physical treatment attached to the specimen. This was not done for specimens currently held in collections and a researcher has no idea of the chemical or physical treatment history of a specimen.

3.1.4 Pest control measures and DNA

Although the killing, fixation and preservation of museum specimens pose many problems for the molecular researcher, pest control also can be just as damaging to molecules and is an essential part of the preservation of museum specimens. Chemical and physical treatments were routinely carried out for many years on specimens although many chemicals have now been withdraw for health and safety reasons. There are many pest control treatments available. It is worth noting that specimens preserved in alcohol do not suffer from pest attack. Dried specimens whether botanical or zoological however do suffer from pest attack. With many dried materials freezing at -30ºC for 72 hours or at –18ºC for 2 weeks is the current preferred method amongst museums. Heating to 60ºC is also a common pest control method although this can cause damage

to collections furniture (Ackery *et al., in press*). The Thermo Lignum® is another method that also uses heat but controls relative humidity and has a heating cooling cycle including three hours at 52ºC and this causes no damage to collections furniture (Ackery *et al., ibid.*). Botanical specimens are often subject to fumigation as a pest control method. Various fumigants are used such as methyl bromide, ethylene oxide, sulphuryl fluoride and carbon dioxide. There is very recent research into the effects of pest control measures and the effect on DNA. Kigawa *et al.* (2003) tested various methods on a freeze-dried fungi and chicken. They showed that all chemical treatments bar sulphuryl fluoride and carbon dioxide were detrimental to DNA. The sulphuryl fluoride treatment has also been deemed non-detrimental to DNA by Whitten *et al.* (1999). Physical treatment such as freezing and heating also appeared to not be detrimental to DNA (Kigawa *et al.,* 2003). The Thermo Lignum® method was also found not to affect DNA (Ackery *et al., in press*). However Kigawa *et al.* (2003) point out that they did not test for repeated pest control treatment of specimens and further work was needed to elucidate whether DNA would be affected by repeated pest control methods. Again I think it is essential that with any future pest control measures steps should be taken to keep information on what specimens were treated and what methods were used particularly with the chemical treatments that appear to render DNA unsuitable for study.

CHAPTER 4 - Storage of molecular collections

4.1 Storage of molecular collections

The storage of molecular collections presents new challenges for museums. Much is known about the storage and long term preservation of traditional natural history collections exemplified by the fact that many of the earliest specimens collected over 200 years ago are still in existence today. The fact that molecular collections need a completely different array of (expensive) equipment has far reaching effects on museum space and budgets. Molecular collections are generally kept deep frozen in freezers at -20ºC, -80ºC or in vats of liquid nitrogen at -155ºC. Most museums use freezers for storage of their molecular collections and only a very few museums have the resources for storage in liquid nitrogen.

4.1.1 The use of freezers for tissue and molecule storage

Freezers, whether -20ºC or-80ºC, are available in two models, either upright or chest. The advantage of the upright model is that it takes less floor space and gives better access to specimens whereas a chest freezer maintains a more constant temperature and is less prone to mechanical breakdown (Dessauer *et al*., 1996:37). When the freezer door is opened, particularly with -80ºC freezers rapid temperature rises will occur. This consumes a lot of energy, puts a strain on the mechanics of a freezer and could eventually contribute to freezer failure (Dessauer *et al*., *ibid.*). It is preferable that the contents of the freezer is databased or at least a map of the contents of the freezer is placed on the door thereby minimising time wasted while searching for samples within the freezer, causing problem outlined above. Frost-free freezers are not desirable as the temperature inside the freezer is raised temporarily to get rid of ice, and this can be extremely detrimental to the samples stored inside (Dessauer *et al*., *ibid.*).

4.1.2 Problems associated with freezers

The mechanical failures of freezers or power interruptions are a big threat to tissue collection security. Samples are easily lost if allowed to defrost. All freezers should have audible alarms in case of failure and these should not only be in the laboratory but also linked to the general museum security team. A list of staff telephone numbers, particularly during holiday period should be posted on the freezer and made available to general security staff. Some other form of backup such as another freezer, liquid nitrogen or dry ice should be available in case of failure and emergency generators also available in case of a power cut (Dessauer *et al*., 1996:37). The recent power cut across North-eastern America in August 2003 reinforces the need for back up generators. Luckily the major research collections were saved in this area due to back-up generators (Pearson, 2003).

4.1.3 Freezers and long term preservation of DNA

There also are serious doubts to the longevity of specimens stored in at -20ºC and at -80ºC. According to the American Museum of Natural History (2002) specimens held at -20º are subject to protein and lipid changes and damage from the growth of micro-organisms while specimens held at -80º are also subject to

protein and lipid changes, with extensive desiccation of specimens being observed upon light microscopic examination of frozen sections after only six months of storage, this degree of structural change may also induce some types of molecular change. This problem of long-term viability of samples is also echoed by Wood *et al.* (1999:269). This should be of great concern to natural history museums, as most that have molecular collections do not have the resources to store tissues in liquid nitrogen. Further research into the long-term viability of materials stored in freezers should be urgently carried out. If this is indeed the case the materials need to be stored below -130ºC then surely many museums are wasting valuable resources by not investing in liquid nitrogen storage.

4.1.4 The use of liquid nitrogen for tissue and molecule storage

The American Museum of Natural History (2002) advocate a colder is better regime and the majority of their collections at held in liquid nitrogen at -155ºC. Simione (1995:158) also state that animal and plant cells must be maintained below -130ºC to ensure long term stability. Liquid nitrogen is by far the best medium for long-term storage of tissues. It is worth noting that liquid nitrogen has only really been used for tissue storage in the last 30 years and only time will tell if it can keep tissues in a suitable state for molecular work indefinitely.

There are many problems with collections in liquid nitrogen. The first is the cost of setting up such a storage area, which can cost a minimum of £500,000 (see chapter 1.4.1 for details). This is a colossal amount of money for a museum to find from scratch and corporate sponsorship or collaboration with other institutes is likely to be the only way many museums can afford to set up and run a liquid nitrogen facility. Collecting of new material into liquid nitrogen in the field also presents problems. Few airlines are willing to transport material in liquid nitrogen and the availability of liquid nitrogen in developing countries is also problematic. The American Museum of Natural History does loan a field kit if the collection is to be deposited at the museum, included in the kit is a dry-shipper. The dry-shipper is a large flask, which can carry up to 80 small tubes. It contains liquid nitrogen in the vapour phase and it therefore allowed onto commercial aircraft. The contents may be kept at –155ºC for up to three weeks liquid nitrogen (American Museum of Natural History, 2003b). There are many health and safety issues concerning liquid nitrogen, which are outlined in chapter 4.2.

4.1.5 Databases for frozen tissue and molecular collections

The Freezerworks™ database is a tailor made database already in use by several museums throughout the world thereby allowing easy exchange of information. Many in the museum community have reservations about the ephemeral nature of tailor made databases. However Freezerworks™ is used right across the medical industry, worldwide, so there is little chance of the company behind it, Dataworks Developments, going into liquidation. The Freezerworks™ database tracks each bar-coded entry, has over eighty different data fields, including the specimen's placement in the collection, taxonomic identity, morphological voucher specimen catalogue number (or zoo animal identification number), tissue type and quantity, GenBank® accession numbers and bibliographic references associated with a given specimen (American Museum of Natural History, 2002). Freezerworks™ also has an easy to use web interface allowing collection of tissues and molecules to be made much more accessible to the researcher. One such example of a frozen tissue collection website using Freezerworks™ can be found the AM-CC at the American Museum of Natural History (American Museum of Natural History, 2003c).

4.2 Health and safety and tissue and molecular collections

There are many health and safety issues associated with molecular laboratories and in particular liquid nitrogen. Liquid nitrogen can cause severe burns and protective equipment such as goggles cryo-gloves, cryo-aprons must be worn at all time to avoid contact with liquid nitrogen (Simione, 1995:159). There is also a danger that when specimens are retrieved from liquid nitrogen that nitrogen may enter the atmosphere thereby lowering the oxygen content of the atmosphere. Oxygen monitoring alarms are essential in any liquid nitrogen facility. There are further health and safety issues concerning the reagents used in molecular biology, which are beyond the scope of this paper. Equipment such as centrifuges may also represent further hazards.

CHAPTER 5 - Museums and molecular work

5.1 Should museums be carrying out molecular work and be repositories for tissue collections?

As outlined earlier large museums have always conducted research into taxonomy and systematics and there is no reason why this should not continue just because there is a whole new method of answering these questions. There certainly is a perceived conflict between curators of natural history collections and molecular workers within the same institute. In the early days of molecular research whole specimens were destroyed in an attempt to locate usable DNA, often with no DNA being extracted (Austin *et al.* 1997). Most institutes now have policies in place regarding loan of material for molecular work and destructive sampling. In many cases specimens used for molecular work do not come from museum collections but are wild caught. However, museum specimens are used extensively to confirm identifications of the specimens concerned, which is often essential, as little will remain of the specimen after molecular work has taken place.

It is the case that museums should be repositories for molecular samples. Having had such a long history of maintaining collections of morphological specimens, it would seem only a natural progression that molecular samples should also be stored at museums. Museums often rely wholly or partly on public money for funding. Criteria for funding are often measured in output of scientific papers. A museum with a molecular laboratory is always going to publish more than a museum relying solely on morphological work. Systematics can now utilise a whole new selection of tools using molecular data and this can often compliment and confirm molecular studies. One complaint of traditional natural history curators is that molecular work is very expensive and diverts already tight budgets way from traditional collections, However molecular work often attracts large grants (unavailable for traditional natural history collections), which will include infrastructure costs, and this does benefit traditional natural history collections. Often molecular biologists have been accused of riding on the back of natural history museums. Many specimens collected by molecular biologists find their way into natural history collections, as sometimes only a small part of the specimens is required for molecular work. Clearly collaboration is needed between museum curators and molecular biologists working within the same institute. Collecting of new material can serve both a morphological and a molecular need. One question often asked is whether natural history museums are mimicking universities to survive. There should not be a conflict between natural history museums and universities. Many universities have natural history museums and many universities run courses associated with natural history museums (e.g. MSc in Taxonomy & Systematics jointly run with The Natural History Museum and Imperial College, London). This collaboration between museums and universities could solve a lot of the funding problems. Theodorides (*pers. comm.*) suggests that the cost of setting up liquid nitrogen facilities at The Natural History Museum, London could be shared with Imperial College, London.

5.1.1 Redundancy of molecular techniques

Molecular techniques evolve rapidly with new techniques being regularly developed and current techniques often become quickly redundant. There are six major techniques listed in Hillis *et al.* (1996:vii). According to Theodorides (*pers. comm.*) four of these are now obsolete. Not only are the techniques obsolete but so is a lot of the (expensive) equipment associated with these techniques. Any molecular laboratory will have to budget for the continuous replacement of equipment.

5.1 2 Do natural history museums need molecular biology to survive?

This is a bone of contention between traditional natural history curators and molecular workers. I believe that the future of systematics and taxonomy lies with molecular work. Certainly morphological work has its place but systematics and taxonomy relies more and more on molecular work to solve problems. I can envisage in 20 years time that systematics and taxonomy will be dependent on molecular work. Large natural history museums will have to embrace the molecular revolution otherwise the work of systematics and taxonomy will move elsewhere into the academic sector and funding bodies will fail to see the point of a large museum that does not use current techniques in its work. There is no doubt that molecular work gets far more funding than traditional morphological work. In order for museums to survive as leaders in systematics and taxonomy, the setting up of long term storage facilities for tissues and molecules with their associated laboratories is essential.

Collaboration in collecting of new material can greatly enhance large collections and the molecular worker should not be seen as the enemy by the traditional natural history curator.

CHAPTER 6 – Conclusions

6.1 Conclusions

There are many implications associated with frozen tissue and molecular collections and their impact on natural history collections. The most urgent of these is the cost of setting up and maintaining a frozen tissue and molecular collections. The cost of building these facilities runs into six figures and the maintenance is also a six-figure sum. At the moment few museums have a liquid nitrogen storage facility and the long-term preservation of tissues and molecules will require that they are stored in liquid nitrogen. Museum marketing people should be able to secure funds for a liquid nitrogen facility as many biotechnology companies have the resources available to sponsor such as facility. Running cost must be taken into account when such a facility is built. It would appear that if the large museums do not invest in liquid nitrogen facilities then a large amount of research into molecular systematics would just move to where such facilities are provided. If the research carried out did go elsewhere, this could well affect the funding museums rely on for their existence. Large natural history museums are going to have to invest in liquid nitrogen facilities to maintain their positions as world leaders in taxonomy and systematics.

The use of museum specimens for molecular work was fraught with problems in the earlier days, particularly regarding loan of material, destructive sampling and deposition of samples. At the present time most museums have policies in place regarding this issue. The issues of chemical and physical treatment of specimens during preservation and pest control measures have to some extent been addressed. However much more research is required into the effects of chemical and physical processes and a definitive list of safe and unsafe processes needs to be urgently drawn up. The collecting of new material for museum collections is an essential part of any large museum and consideration will have to be given to the methods used and their effect on molecules. Already many collections are made specifically for molecular or with molecular work in mind. It is also essential that specimens collected for molecular work also attempt to retain a voucher specimen for the morphological collection.

One can understand the concerns of curators and morphological workers of the indent molecular work is making on museums particularly where space and financial issues arise. Mistakes have been made in the past by both groups. Both morphological and molecular workers are working towards the same goal, that of better understanding of taxonomy and systematics of the natural world. There really should not be a conflict between the two groups and better communication is needed between both parties as they both have a lot to offer each other. Already there are curators of frozen tissue and molecular collections and more curators will be required as frozen tissue collections grow in size.

Systematics and taxonomy is relying more and more on molecular work to answer the many questions posed by the natural world. Although morphological work will not become redundant, molecular work will continue to increase in importance. Natural history museums have always carried out studies on systematics and taxonomy and to continue this work molecular biology must be embraced. Natural history museums have also acted as repositories for morphological specimens and it is logical that they must act as depositories for molecular specimens as well.

I believe that molecular collections are an important part of the future of natural history collections.

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NEWS

Notices, Adverts & Meetings

Meetings:

GCG Seminar and 33rd AGM, 4 - 5 December 2006
Learning with Geology Collections
Plymouth City Museum & Art Gallery
Helen Fothergill, Plymouth Museum. 01752 304774
helen.fothergill@plymouth.gov.uk

Study Visit: Liverpool/Manchester
To be arranged
General Contact, Steve McLean, Hancock Museum, 0191 222 6753
s.g.mclean@ncl.ac.uk

SPNHC Annual Meeting, May 21-26, 2007

Building for the 21st Century with a special focus on capital projects

There will be sessions and a workshop examining these issues. This meeting will also feature plenary talks, a poster session, a trade show, and workshops.

This conference is shaping up to be a fantastic one. In recent years many institutions in the area have undergone major renovations and new construction. You will have the opportunity to visit a number of these premier museums.

Pre-conference field trips will take you to an amazing array of places within a 2 hour radius of the Twin Cities. Minnesota and nature go hand in hand. You will have the opportunity to experience some of the many parks and impressive natural settings.

Taxidermy Workshop, 13th February 2007

In association with the Guild of Taxidermists, Lancashire Conservation Studio
Lancashire Museums, Preston

This will be a practical workshop on taxidermy. The programme will include presentations by Pat Morris, 'Art, Science and Bad Taste', and 'Changing Attitudes to Taxidermy'. Museum taxidermists, James Dickinson and Peter Summers will conduct practical demonstrations on how to prepare study skins of a bird and a small mammal. Information will be available on modern methods, materials and techniques. Advice on obtaining specimens and information on legal aspects and the work of the Guild will be on hand throughout the day.

Places are limited to 30 people
Cost £25

Training:

Fluid-Preservation Seminar
April – May 2007

Is all or part of your fluid-preserved collection the shame of your museum so that it's shunted into some back room or exterior storage area? Do your gallery fluid-preserved specimens require attention? Do you need to know how to mount fragile specimens in fluids, seal those awkward glass jars, understand the basics about fixatives and preservatives?

Simon Moore is presenting a course to redress all of these problems sometime during April to May 2007.

Cost is still low: £250 for the course: including presentations, practical sessions and handouts.

If you have any specific problems either bring them along or ask if this problem could be incorporated into the course (notify Simon first).

Please also notify Simon of any personal allergies – asthma, dermatitis &c.
The venue will provide some problem specimens but feel free to bring along any portable problem specimens (we will need something extra to work on) but preferably not too valuable!

At the moment I am just trying to get an idea of interest and numbers attending. This is important and quite urgent so that I can decide on a suitable venue.

Please notify Simon Moore: couteaufin@aol.com

Or by telephone: 01962 826737.

IPM Workshop
Natural History Museum, London
16.1.2007

Pests are now widely recognised as one of the major risks to museum collections, yet many of the chemical methods which were successfully used in the past to control them are now known to be hazards in their own right and can no longer be used.

Integrated Pest Management (IPM) looks instead at the whole organisation of a museum, its staff, geography building fabric, and how appropriate training and planning can reduce the pest risk. This one-day workshop will look at how to identify and raise consciousness of the risk, who needs to be involved, policy change, communication, training, priority areas and overall strategy. We will be looking at the practical steps that need to be taken and how the latest techniques can be used to best advantage.

All the presenters are actively involved in implementing the first IPM strategy for a national museum using a **risk zones** concept and regularly lecture at and advise other national and regional museums, libraries and institutions.

email: C.Ung@nhm.ac.uk