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## *Jungles and peer review papers*

It has been a busy few months, trekking through jungles, eating breakfast with humming-birds and watching troops of monkeys jump from branch to branch. Argentina and Brazil are beautiful countries, and three weeks there on my honeymoon, was not enough time. Charles Darwin spend months travelling around inland South America on horseback, collecting specimens, studying the geology and staying with locals.

This year marks Darwin's 200th birthday, and 150th anniversary of the classic *On the Origin of Species*. Trekking through the Brazilian jungles and seeing so many amazing variety of animals and plants, you can immediately see Darwin's fascination with the natural world. It also made me want to know what other fantastic collectors and collections museums have. Papers about collectors and their collections from your museum would be great additions to *NatSCA News*!

Apologies for the lateness of Issue 16. Unfortunately, I did not have enough articles for this Issue of *NatSCA News* to be sent out in November.

However, this issue is a full packed one, with seminar write ups, papers on freezing, formalin and geoscience. This issue also contains the first paper to be peer reviewed. Kate Andrews paper on page 41, is about gap fills for geological specimens. We are aiming to peer review more papers for *NatSCA News*. At present, a peer reviewed paper will appear with the full reference beneath the article title.

Thank you to everyone who has contributed to Issue 16. Look out for details of seminars throughout the issue.

Please continue to send me papers, about natural history conservation, seminars, education, projects, and your collectors and collections!

- Jan Freedman  
Editor NatSCA

### ***Contributions for Issue 17, July 2006***

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 June 1st:

Jan Freedman [Editor, NatSCA]  
Plymouth City Museum and Art Gallery,  
Drakes Circus, Plymouth, PL4 8AJ

Email: [jan.freedman@plymouth.gov.uk](mailto:jan.freedman@plymouth.gov.uk)  
Tel: 01752 30 4765

## View From The Chair

I am sat at my new desk on the third floor of the new Iconic Darwin Centre (phase 2) at the Natural History Museum at South Kensington. This is only the sixth home I have had here in the last 30 years so moving should be becoming second nature to me (as stressful as divorce they say?) The job of unpacking into the new 'open plan' office working area will take a few days yet, and I am catching up on NatSCA and other jobs in between bouts of crate emptying. There are still very few of us moved in as yet and I have no close neighbours but I must ensure I do not start taking over the whole floor! My colleagues will arrive variably over the next six months. New collections furniture is being erected in the collections storage 'Cocoon' mostly on compactors by our contractor C & D metals of Belvedere, Kent and our collections will start to move next month with items from the Botany general herbarium moving via a suit of three large minus 35 degree container freezers situated in the back carpark and loaned by Maersk of Felixstowe. In Entomology, the Hymenoptera collections presently housed in our Spencer gallery will move at a similar time. We hope to resume 'normal operations' as soon as possible.

The latest issue that NatSCA is addressing is the situation at Bristol City Museum. NatSCA has been aware of a steady erosion in staffing levels due to natural wastage over the last couple of years. As reported by Gary Noakes in the Museums Journal (January 2009 issue) there is a current Service Review of Bristol's Museums, Galleries and Archives brought about by a funding crisis which is causing some concern in NatSCA and GCG and with former Bristol curators and conservators. A number of curatorial posts across the Bristol Museum service (9 out of 26) and conservation posts (8 out of 13) is projected with inappropriate merging of the two roles and redundancies and restructurings of security and 'front-of-house' posts. This may well reduce Museum opening hours and has already much reduced the effective Museums service to Bristol and the South West

Bristol has enjoyed '*Renaissance in the Regions*' funding for innovation and expansion of the Museums service and not for the subsidising of the existing infrastructure. If the reported principal funding crisis has been precipitated by the projected harbour-side Museum of Bristol which corresponds with Renaissance criteria, this should not be at the expense of existing staff and existing service and most importantly the Natural Sciences and other collections which are of national and international importance. The projected new emphasis on 20<sup>th</sup> century and contemporary visual arts also would further increase cuts in resources away from the care of the core collections and their future development.

NatSCA and GCG have both written letters of concern to Bristol City Council and Avon RIGS (Regionally Important Geological and Geomorphological Sites) Group are planning a coordinated petition to key decision makers in Bristol City Council and to the local papers to highlight their concerns about the geology curator post and the fate of the collections. NatSCA hopes for the resumption of effective curatorial and conservatorial staffing levels at the Museum and that the Natural Science collections will remain at the City Museum and be effectively cared for, displayed and be available to academic institutions for future education and research. We hope that Bristol Council will reconsider their priorities and that they take seriously their responsibilities to the Collections and for the whole Museum service and their audiences, both locally and nationally.

Paul A Brown, Chair NatSCA, 16.iii.2009

## Natural Sciences Collections Association Conference & AGM 2009

### 'Collections Use; Past, Present and Future'

7<sup>th</sup> and 8<sup>th</sup> May 2009 at Leeds City Museum

#### Programme

#### Provisional NatSCA Conference Timetable

#### Thursday 7<sup>th</sup> May

#### Thoresby Room at Leeds City Museum

- |               |  |
|---------------|--|
| 08:40 – 9:20  | Registration   |
| 09:20 – 9:30  | Introduction - Clare Stringer, Gerard McGowan, Paul Brown  |
| 09:30 – 09:55 | Welcome from John Roles, Head of Service, Leeds City Museums   |
| 10:00 – 10:25 | Leslie Noè – The Alfred Leeds collection of fossil vertebrates: past, present and future. Leslie F. Noè (Thinktank, the Birmingham Science Museum) and Jeff J. Liston (Hunterian Museum, University of Glasgow). |
| 10:30 – 10:55 | Susan Grayer - Is there a viable future for herbaria in British Museums? The Herbarium. RHS Garden, Wisely.  |

#### 11:00 – 11:30 Coffee Break

- |               |   |
|---------------|---|
| 11:30 – 12:20 | Paul Brown, Suzanne Ryder & Erica McAlister - Past, Present & Future of the Entomology Collections at the NHM |
| 12:30 – 12:55 | Jon Radley – Old Shells; new perspectives in a smaller museum. Warwickshire Museum                            |

#### 13:00 – 14:00 LUNCH

- |               |   |
|---------------|---|
| 14:00 – 14:40 | AGM   |
| 14:40 – 16:30 | A selection of guided and free roaming tours in Leeds Museums (details to follow) |
| 16:30 – 18:00 | Reception at Thoresby Room at Leeds City Museum                                   |
| 19:00 – 21:00 | Conference Meal at AAGAH Indian Restaurant  |

#### Friday 8<sup>th</sup> May

#### Venue: Thoresby Room at Leeds City Museum

- |               |   |
|---------------|---|
| 09:20- 09:30  | Introduction, Clare Stringer and/or Gerard McGowan  |
| 09:30 – 09:55 | Nigel T. Monaghan – Things to do with old bones. Natural History Museum of Ireland  |
| 10:00 – 10:25 | Jessica Shepherd – Reinvigorating a herbarium collection at Plymouth Museum   |
| 10:30 – 10:55 | Matt Williams – The Moore collection: world class palaeontology in a small museum. Bath Royal Literary & Scientific Institution |

**11:00 – 11:25 Coffee Break**

- 11:30 – 11:55 Mike Howe – Exploring Geoscience Collections – the contribution of serendipity – British Geological Society
- 12:00 – 12:25 David Craven – Uncovering a Relict Collection, Geology at Bolton Museum
- 12:30 – 12:55 Carolyn Holmes – Collections and Natural Heritage, Leicester County Council

**13:00 – 14:00 LUNCH**

- 14:00 – 16:00 Tours of Leeds Museum or a short train ride to Keighley to visit Cliffe Castle Museum (details to follow)

**General Information****Bookings:**

Please see separate forms for booking. Details are also on the NatSCA website at [http://www.nhm.ac.uk/hosted\\_sites/natSCA/](http://www.nhm.ac.uk/hosted_sites/natSCA/)

**Costs:**

Conference fees, including lunches, teas and coffees are:

	2 day rate	Day rate
Early-bird member (by March 31st):	<input type="checkbox"/> £70	<input type="checkbox"/> £45
Early-bird non-member (by March 31st):	<input type="checkbox"/> £90	<input type="checkbox"/> £55
Member:	<input type="checkbox"/> £75	<input type="checkbox"/> £45
Non-Member:	<input type="checkbox"/> £95	<input type="checkbox"/> £55

**Conference Meal:**

This will be at Aagrah's curry restaurant. It is costed separately at £18 per head – details on booking form. The menu can be found at [http://www.aagrah.com/setmeals\\_leeds.php](http://www.aagrah.com/setmeals_leeds.php) and some additional vegetarian main courses should be available. The restaurant needs final numbers by 22nd April so please return all booking forms by then. After the meal, the customary post-prandial refreshments including excellent real ales will be available at the 'The Palace' - the pub around the corner from the restaurant.

**Accommodation:**

Plenty is available in Leeds in all price ranges:

Etap - <http://www.etaphotel.com/gb/hotel-6002-etap-hotel-etap-hotel-leeds-centre/index.shtml>

Travelodge - [http://www.travelodge.co.uk/search\\_and\\_book/hotel\\_overview.php?hotel\\_id=144](http://www.travelodge.co.uk/search_and_book/hotel_overview.php?hotel_id=144)

Jury's Inn : <http://leedshotels.jurysinns.com/>

General hotels: <http://www.city-visitor.com/leeds/hotels.html>

A list of useful B&Bs can be found at:

<http://www.bedandbreakfast-directory.co.uk/results.asp?town=Leeds&county=West%20Yorkshire&country=England>

**Maps:** Useful maps can be found on Google Maps - search for **Leeds Museum Discovery Centre, Carlisle Road, Leeds, LS10 1LB.**

## **Bursaries for 2009 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 Committee has decided the simplest way to disburse fund is **to offer 10 bursaries of up to £100 each**. This sum may be set against your conference fee or against travel or accommodation costs where re-imburement will be made against receipts, and delivery of your article for the journal – see conditions below. We hope this allows for variable institutional practices in paying for conferences – some places will pay fees but not expenses, others the opposite.

### **Conditions:**

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.

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 for conference bursaries must be sent to the Bursary Committee by the 31st 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 the Bursary committee at the addresses below.

Nicola Newton  
Hancock Museum  
Barras Bridge  
NEWCASTLE UPON TYNE  
Tyne & Wear NE2 4PT

[Nicola.Newton@newcastle.ac.uk](mailto:Nicola.Newton@newcastle.ac.uk)

Jan Freedman  
Plymouth City Museum and Art Gallery  
Drake Circus  
Plymouth  
PL4 8AJ

[jan.freedman@Plymouth.gov.uk](mailto:jan.freedman@Plymouth.gov.uk)

**2009 CONFERENCE & AGM BOOKING FORM - Part 1**

Please complete this booking form and send to Tony Irwin at Norwich - address below.

Keep a copy of your form for reference. Deadline for bookings is 22<sup>nd</sup> April 2009.

Name.....

Organisation.....

Address.....

.....

E-mail:..... Tel:.....

**CONFERENCE COSTS**

(Please tick as appropriate. All lunches & refreshments included.)

	2 day rate	Day rate
Early-bird member (by March 31st):	<input type="checkbox"/> £70	<input type="checkbox"/> £45
Early-bird non-member (by March 31st):	<input type="checkbox"/> £90	<input type="checkbox"/> £55
Member:	<input type="checkbox"/> £75	<input type="checkbox"/> £45
Non-Member:	<input type="checkbox"/> £95	<input type="checkbox"/> £55

Institutional members please note that this category of membership entitles you to two member rate places at conference.

Please note any special dietary requirements: Vegetarian/Vegan:

Allergies or other food intolerances (Please specify):.....

Please note that the dinner is an additional charge

I will be attending the Conference dinner - cost £18 per person

Payment total = £.....

Any queries: Clare Stringer/Joe Botting, Leeds Museum Discovery Centre, Carlisle Road, Leeds, LS10 1LB. (0113) 2141548  
 clare.stringer@leeds.gov.uk joseph.botting@leeds.gov.uk

Please photocopy this page, or go to the NatSCA website to download a form;

**[www.nhm.ac.uk/hosted\\_sites/natSCA/](http://www.nhm.ac.uk/hosted_sites/natSCA/)**

**2009 CONFERENCE & AGM BOOKING FORM - Part 2**

**PAYMENT**

Name.....

Payment total £.....

I enclose a personal cheque for £.....

This is for the conference fee only / meal only

Please send me a receipt for this amount

Cheques should be made payable to the 'Natural Sciences Collections Association'

My institution will pay by cheque

Send me an invoice for £.....

My institution will pay my fee into the NatSCA bank account by BACS transfer.

Send me an invoice for £.....

**Send booking forms and payments to :**

Dr A.G.Irwin,  
Natural History Section  
Norfolk Museums and Archaeology Service  
The Shirehall,  
Market Avenue,  
Norwich,  
Norfolk NR1 3JQ  
Direct line: 01603 493642  
Fax: 01603 493623  
E-mail:tony.irwin@norfolk.gov.uk

Please photocopy this page, or go to the NatSCA website to download a form;

**[www.nhm.ac.uk/hosted\\_sites/natSCA/](http://www.nhm.ac.uk/hosted_sites/natSCA/)**

## **Personal Review of 'Natural History Collections Conservation' Seminar. Leeds Discovery Centre, 4<sup>th</sup> April 2008**

Laura McCoy  
Natural History Museum  
Email: [absolom@lycos.com](mailto:absolom@lycos.com)

### **Introduction**

I am a complete beginner to natural history conservation. The April NatSCA seminar was recommended to me by a visiting lecturer to Lincoln University, where I've just finished my conservation course, and with some basic information I found out who to contact so that I could arrange to attend. Everyone was really helpful and I was informed that there was a bursary, which was much appreciated and eased my poor student purse strings. This was the first NatSCA seminar I attended, and helped put my experience from my conservation course into practice. Meeting the different people at the seminar who have to practically deal with different conservation issues, often with minimum budgets, is a fantastic experience, and a really useful way of sharing ideas and solutions.

### **Storage**

First on the agenda that day was a tour by Emma Bowron of the new storage and processing facilities at the Leeds Museum Discovery Centre. Having just learnt about all the conditions needed to best preserve a mixed collection I was really impressed with what I saw, right through from the RH and temperature regulated main store, to the lab and walk in freezer/quarantine. It was obvious how much work had been put into organising and getting everything set up and it is a credit to everyone working there.

### **Assessment**

Next James Dickinson, from Lancashire Conservation Studios, talked to us about the levels of quality of natural history specimens and the process of assessment. Having little experience in conservation it was interesting to hear about what is and is not salvageable, balanced against time and budget. Some of the problems with natural history specimens, include splitting, fading, loosening hair/feathers and pest damage. It is surprising what can be saved if the skin is still relatively intact, and feathers can be replaced/reattached, but when the original taxidermy is quite poor there is a question as to whether it is suitable for display. If we are trying to educate people on the appearance of an animal and increase the popularity and awareness of the value of taxidermy it could be considered detrimental to have an overstuffed or badly positioned specimen on view to the public. But even if a mounted animal has deteriorated beyond repair it may still be useful as a bag of DNA and so the decision to throw the specimen away can still be put on hold. When objects are part of a diorama the issue can become much more complex, as the scenery can be extremely fragile, especially if there is dried plant material. Many would argue that you have to treat the whole scene as one object and not just consider the animals it contains.

### **Record everything**

Paul Ensom, a freelance geological consultant, gave a presentation highlighting the dangers of "clearing out" collections and the importance of cataloguing, warning of the hazard of making decisions without expert advice and the difficulties in having to assess a collection from scratch. Recently more and more geological collections have become at risk, as sometimes it is not immediately obvious what valuable information is contained within them; when faced with a room full of rocks, some would view them as clutter! It drove home to me more than ever, that without a decent record system and the benefit of working with a specific collection for years and years, so much information can be lost. How many geological specimens with completely faded labels have lost their provenance and with that the ability to interpret them in full?

### **Computer says 'oh no'!**

After a much appreciated lunch it was Rob Huxley's turn to tell us about the SYNTHESIS project that has been developed at the NHM. The scale of what has been put together sounds enormous, and its aim is to give natural history collections around Europe a way of evaluating their institutions on all levels so that standards can be established and developed, from management, collections care, infrastructure and facilities. The survey has within it different sections which each have national benchmark standards that an institution should try to reach so that they are achieving an acceptable level of service. The questionnaire can get to grips with the condition of a museum within a matter of days, and once surveyed it shows where im-

provements or adjustments should be made and possibly where support is needed with the view of applying for funding. Once the survey is completed, the results are invaluable for those managing a collection and if there are areas where an institution needs help or advice then they can use an international support network of similar professionals who can give guidance on possible solutions to the problems. We were given an example of one of the SYNTHESIS surveys to fill out in pairs, and although at the time I had never worked in a museum, with some basic instruction it seemed a fairly straight forward tool and a good way of condensing a complex job into something that could be completed in a short time-frame.

**Stuffed?**

There were discussions afterwards about the importance of good quality taxidermy specimens and the need for hands on teaching collections. Sometimes being able to touch an animal can get across ten times more effectively than words or pictures how amazing that species, and nature in general, really is.

The seminar was brilliant for networking and I met some really great people. I got the impression that there has not been too many people in recent years wanting to specialise in natural history and it has made me more determined than ever to join their ranks.

**Acknowledgements**

I would like to thank Tony Irwin, Jan Freedman and Clare Stringer for all of their help and advice and NatSCA for providing the funding which allowed me to attend the seminar, it was much appreciated.

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**Fluid Preservation Course**  
**7th – 10th April 2008**  
**Shirehall Study Centre, Norwich**

Dr David Waterhouse<sup>1</sup> and Beulah Graner<sup>2</sup>

<sup>1</sup>*Dr David Waterhouse, Assistant Curator of Natural History, Norfolk Museums and Archaeology Service.  
Email: david.waterhouse@norfolk.gov.uk*

<sup>2</sup>*Beulah Graner, Trainee Natural History Curator, Horniman Museum and Gardens  
Email: bgarner@horniman.ac.uk*

**Course Summary**

The Fluid Preservation course, or indeed Master class, given its scope and series of extensive workshop practicals, is an essential training experience for natural history curators, conservators and anyone with responsibility for fluid collections. Many a natural history collection can lay claim to a dark suppurating secret locked away at the back of an unsuitable cupboard! For this reason alone, this course is worthwhile hosting, given the success stories of our 'before and after' projects, which were practiced on and preened over for the duration of the four day course.

The level of expertise required for attendance can range from the novice to the experienced practitioner, as the course provides a 'top-up', if you will, to those who actively conserve, and a fully comprehensive introduction for those whose experience does not extend beyond topping-up or being alert to the warning signs of a collection in need of conservation.

The format of the course provides the opportunity to put the lecture series into practice by supervised workshop sessions. The material provided by the Norwich Castle Museum, Natural History Department gave plenty of scope for encountering the many problems of caring for fluid collections. This provided a far-reaching application to the theoretical.

Lectures followed by question and answer sessions were interspersed by lab workshops where each attendee could choose a number of projects to work on throughout the week. Given that many of the conservation measures needed for fluid preservation are time consuming, the four-day duration was time enough to see a relatively long-term project to fruition, and in most cases with excellent results.

Fluid preservation is not just simple 'topping-up'; neither is it simply reapplying sealant to leaky jars. It is the application of chemistry for the long-term preservation of biological material and the practical measures required to store such media effectively. Firstly you must understand the histological and historical context of fluid preservation (many preserved specimens are ancient!) to calculate their worth: do they come with documentation and scientific data, is the specimen of scientific and/or of historic value, to what extent has the specimen deteriorated. In effect: to conserve or not to conserve?

Knowledge of the practical reparative methods is essential as it can be the case that poorly sealed or unsuitable jars are the culprit for escaping vapours and fluids, and chemical reactions. Therefore, knowledge of the materials available is essential. Learning the brave skill of glass cutting, drilling and grinding is invaluable when replacing cracked lids or even old Bakelite lids, as is the sealant process.

Mounting specimens within jars can be a fiddly process, especially with such groups as the Coelenterates (sea anemones, jellyfish and hydroids). Methods of attachment along with the appropriate type of thread, adhesive, backing plate or suspension material were demonstrated and made available. The first experiment involved using Celloidin glue to attach snail shells to glass and then immersing in 70% industrial methylated spirit (IMS). This proved to be an ongoing obsession for the group (whose shell would be the first to bob to the surface with shameful failure!)

Assessing what fluid a specimen has been formerly preserved in is essential (in the absence of any preservation data) both to the safety of the conservator and to the future preservation and maintenance of the specimen. Various methods were employed and tested, including making our own floatation devise: an effective ‘Heath Robinson’ alternative to gravity detectors. From this action can be taken as to what preservative the specimen should then be stored in and the appropriate labelling employed – this is another subject in itself.

Each of our practical projects was supervised step-by-step. Most of the specimens required re-hydrating, which can be a lengthy process and involves the use of TEEPOL or Decon 90, either in cold preparation, a heat bath or local injection of fluid. The next step is to ‘fix’ the specimen with formalin, even if it has been fixed previously. If specimens were to be stored in IMS then a ‘ladder’ process of reintroduction of the specimen into various dilutes of IMS was followed to minimise osmotic shock. Any chemical must be assessed for its compatibility to the specimen and to the storage medium, for example, if a backing plate is made of plastic then IMS is not suitable. Various other tests can be carried out post immersion. There may be some discolouration to the preservative, which could be pigment or lipid leaching from the specimen. Lipid leaching can lead to deterioration of the specimen, and so pH must be taken to ascertain contamination levels (Fig 2).

Each specimen is unique and requires an individual assessment and resulting treatment. It is not guesswork, it is a lengthy process. It is however, incredibly worthwhile given the results we achieved as a group under Simon Moore’s excellent instruction over the week.

The outcomes of the course are the acquisition of a number of new skills and recommendations for best practice. It is important for natural historians/curators to have an understanding of the time involved in assessing and conserving fluid collections, enabling them to work effectively with in-house departments and to schedule an efficient programme of maintenance. A heightened awareness of the financial and time constraints of ensuring a dedicated programme of future conservation practice is beneficial to all hierarchies within the museum environment. The methods available to the natural science practitioner for trouble-shooting, problem solving, reparative and pre-emptive work, resulting from this course, should ensure a high standard of collection care for the future of your fluid collections.



Fig 1. Beulah Garner with jellyfish in hand.

Various other tests can be carried out post immersion. There may be some discolouration to the preservative, which could be pigment or lipid leaching from the specimen. Lipid leaching can lead to deterioration of the specimen, and so pH must be taken to ascertain contamination levels (Fig 2).

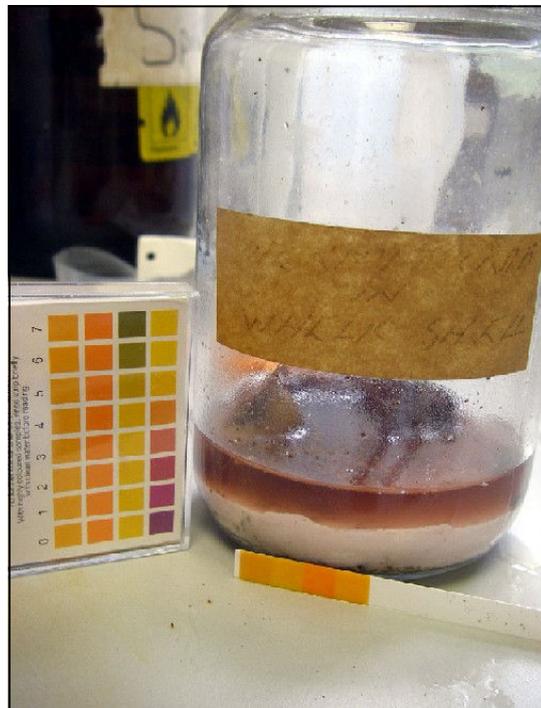


Fig 2. Testing the pH of preservation fluid.

**Monday 7th April 2008**

After an unscheduled fire alarm (we like to keep people on their toes!), the course started off with a general talk about fluid preservation and its history. Simon Moore (himself well-preserved, despite [or perhaps because] of the amount of noxious chemicals he's dealt with over the years!) described fluid preservation as 'an open field', where the technology is constantly being pushed forward. However, much of the basics of fluid preservation are still the same as they were 100 years ago.

Biological specimens were historically stored in glass 'battery' jars, with a polished side for viewing through. Today the problem is that a lot fewer people know how to look after such specimens. Another common problem is that many spirit collections are in a variety of jars and containers, fluids and lids. Specimens often get dried out because the seals are not terribly good. Fungal decay can even occur if the industrial methylated spirit (IMS) is under 30% or formalin (40% saturated formaldehyde gas in water) is under 2%. Normal fixing strength for formalin is 10%. Formalin is aqueous, so it would take a very warm store for it to evaporate away. Glycerol can sometimes be used in order to save a collection from drying out.

**Dried-out specimens-**

To re-hydrate or leave? That is the question! Arthropods in particular don't re-hydrate well. But it is advisable to re-hydrate soft specimens. It is recommended that DNA samples be taken before re-hydration, as the process can 'scramble' the DNA (Fig 3).

Re-hydration fluid can be used (TEEPOL or Decon 90), heated up to about 40°C with a top on it so that it doesn't evaporate. After re-hydration, re-fixing must occur with an internal fixative (e.g. injecting formalin). Air bubbles can be removed from a specimen by placing it in water and using a mild vacuum pump – this stops the specimen from floating (Fig 4).

You can tell much older jars from newer because the older have 'pontil' scars on the bottom (where they were hand-blown). Newer jars tend to have been ground flat.



**Fig 3.** Dried out frog specimen.

**Fig 4.** The rehydration process in action.

**Other problems-**

Temperature fluctuation problems arise when formalin is used as a preservative (rather than a fixative). Formalin can solidify when the temperature fluctuates between 5°C to 25°C. Ideally formalin preserved specimens should be kept at a constant temperature of between 10°C and 15°C.

These solids can be dissolved away by putting the specimen in IMS. Crystals in the solids may have already broken the specimen, so glass needles can be used to fix the specimen. Glue called celloidin (a solution of

pyroxylin in alcohol) is also used to cement the specimens in IMS to glass. Gelatin is celloidin's equivalent when specimens are preserved in formalin.

Formalin is still used as a fixative today, despite its carcinogenic properties! Other alternatives to formalin have been sought out over the years, but formalin is still generally considered the most effective. Formalin essentially works by coagulating proteins into a stable condition. Fresh specimens can produce cloudy suspensions of insoluble salts in formalin – especially when incorrectly buffered. De-ionized water, plus a phosphate buffer will prevent this from happening (the pH should be about 7).

Dilute IMS is best made up to 24 hours in advance as tiny bubbles form in it when added to water. Many specimens change colour when stored in IMS but not in formalin.

### Tuesday 8th April 2008

#### **Narcotization, historical sealants and pelagic mounting-**

Certain animals close up or retract, so they need to be anaesthetised before fixing. Sea anemones have a two-stage narcotizing barrier. Stage one: they respond to physical stimuli, and, Stage two: they respond to chemical stimuli. Fixation must occur before autolysis (self-digestion) occurs. They also open and close according to the tide (circadian rhythms). Powdered menthol is often used in narcotization.

#### **Historical sealants-**

When working on 18th and 19th Century jars you may be required to use the same sealant as was originally used. Recognition is essential in these cases. Greases are vital on ground glass jars, but some silicone-based greases may solidify in time. Simon prefers 'paraffin soft white', which doesn't seem to solidify. To make an effective seal, the jar top must be ground down flat (this also gives a key for the sealant to work on). If the seal is yellowish and flaking, it is probably gelatine. Gelatine seals that look white in colour are no good (they are unstable). Silicone seal has a rubbery feel to it, and can be very tricky to remove if it was properly put on in the first place. However, you can buy silicone-reversing agent these days.

#### **Pelagic mounting-**

Animals that swim or float should not be destined to sit in a heap at the bottom of a jar – especially if they are going on display. They need to be correctly mounted on discs of acetate sheet, suspended by monofilament. Older jars tend to have suspensory glass loops or knobs under the lid. Glass floats (a bit like Christmas tree baubles) can also be used. Larger, more solid specimens such as vertebrates can be mounted on a back-plate (Fig 5).

Sometimes copper wire was used to hang specimens. This will stain the fluid blue/green and the specimens green (the fluid can be replaced, but the staining to the specimen is irreversible). Glass rods or cradles are good for holding specimens in place as glass is inert and can be easily heated and bent to suit the needs of the specimen.



**Fig 5.** Neil Mahrer with frog transparency (neil is the one on the left).

### Wednesday 9th April 2008

#### **Preservatives-**

Preservative fluids may suit a variety of different taxa. Opresol has been found to be effective for many invertebrate groups as a PFP (post-fixation preservative). However, as with most newer preservatives, the

long-term preserving stability has yet to stand the test of time. Other preservatives can react in the long-term with plastic jars (crazing them). Alcoholic preservatives will soften plastics with time. If in doubt – use glass jars. Also, some preservatives are not capable of maintaining preservation for densely muscled specimens.

Absolute alcohol (99%) is 74 over proof. Dowicil (made in the 1960s) reacted with protein to produce formaldehyde. Its powdered form was easy to carry, but some people got confused about amounts and strengths, and it didn't work – as a result it is no longer made!

A tri-part colour preservation technique was developed in the 1920s. Despite keeping the specimen colour quite well, unfortunately it does quickly yellow the fluid.

Transparencies are stored in a variety of fluids including glycerol.

#### **Contaminants-**

This occurs due to specimen reaction, seepage and things like copper wire, etc. Yellow alcohol can be cleaned with charcoal and filtering, but heavily lipid contaminated fluid will remain in solution. It is much easier and less time consuming just to change the alcohol. Latex-based injection dyes eventually break down and stain the specimen plus the fluid pink.

Fungi start to appear in 30% IMS. The following can adversely affect/completely alter DNA: fungal contamination, re-hydration, formalin (when used as a preservative rather than a fixative), and ethyl acetate. Black fungal staining of specimens is irreversible. It is very important to record the fixative and preservative on the label.

### **Thursday 10th April 2008**

#### **Transparencies, Containers, labels and tubes in jars-**

Once prepared, transparencies should require only minimum attention since their preservatives are viscous and dense fluids. They are stained with calcium specific dyes to show skeletal elements. This method is useful for showing unusual bone deformities.

When diluting dense fluids such as glycerol with water, you will experience mixing lines called 'Schlieren Optics' (you also get this when ice melts into whisky – although I was scolded for using this analogy as apparently one should always drink Scotch neat!).

Benzoate transparencies can have problems with crystallization – the specimens should be soaked in absolute alcohol (no water) in order to clear this.

Older 'Copenhagen' jar lids tend to degenerate in time or become too rigid. However, they are easy to use and good in the short-term (up to 20 years or so).

Ground glass jars by Dixon, etc. (Fig 6) are very expensive – but they are the best. Le Parfait-type jars are good, but you need to replace the rubber gasket often (which is a lot of work, especially in a large collection).

Screw-on lids are preferred in North America. Newer plastic lids should outlive the old Bakelite lids. Bakelite tends to be slightly patterned, which helps in telling the difference between modern plastic and old lids.

Visijars (plastic jars) have a finite lifespan (as they become crazed after a while). Also they sometimes reflect the light more strongly than glass, which can obscure the specimens on display.

#### **Labels (and what to do with them!)-**

Ensure fastness of ink and robustness of paper. Exterior labels should be for display purposes only. Vital data should always be inside the jar. Old, historic or frail labels should be stored in an archive, and the data from them transferred to a new label. The problem with external labels is that they detach themselves over time, they can obscure the level of the fluid in the jar, and they can become stained and wrinkled. Glycol-based preservatives make labels transparent.

Internal labels are best – ‘goatskin’ parchment (which isn’t real goatskin) is best (Wiggins Teape Paper Ltd.). Handwrite these labels using India ink. A diamond scribe can also be used to write on the glass what preservatives were used, etc.

#### **Tubes in jars-**

Tubes in jars are used for small things (especially arthropods). Simon prefers them upside-down to minimise the risk of their drying out if the jar lid becomes compromised or the shelf is too deep to see the jar. Others prefer the tubes with the lid on top to stop specimens from coming out of the tubes and therefore detached from their labels.

Pith or cork are no good for stoppers as they stain the preservatives and eventually crumble away. Rubber quickly perishes and stains the fluid. Nylon stoppers are probably the best as cotton wool gets trapped in antennae and legs. Pierce the nylon stopper with a fine needle to stop pressure from inside the tube pushing them off.

#### **Storage areas-**

Wooden shelves are good as spills evaporate off them easily. Metal shelves tend to rust very easily. Good ventilation is essential. A list of the fluids used in the store to be kept near the entrance is also a good idea. Very tall, narrow jars need additional support of struts and bars.

#### **Posting fluid preserved specimens-**

Formalin specimens – use tissue or wadding soaked in de-ionised water (with no actual fluid to slosh around). Put the wrapped specimen in a poly-bag, then heat-seal it, then pack it for the post.

For alcohol specimens – use tissue/wadding soaked in IMS and then the same procedure as above.

Another method might be to use either agar or tert-Butanol, which solidifies around the specimen below 20°C.

Some foreign museums send specimens back in osmotically different fluids because of laws in their country. Find out if this is the case before sending specimens and either come to a compromise or don’t send them the specimen!

#### **Comments**

“I found the course very interesting and extremely instructive, given I didn’t know much about museum conservation in general. I only wish I had dealt with more entomological specimens. This could be something to consider for the next courses; perhaps participants could give a general list of the groups of specimens they will find useful to work on during the practice.”

*Alessandro Giusti*

*Assistant Curator (Lepidoptera), Natural History Museum*

“General thoughts on the course were very positive. There were inevitably periods of waiting around during the practical work but I don’t see how that could be avoided so no beef there. The facilities were tight but never actually led to annoying queuing, so again no problem.”

*Neil Mahrer*

*Conservator, Jersey Heritage*

“Overall I thought it went well, technical side - mounting specimens and preparing containers particularly useful has haven’t done much of that before.”

*Tony Parker*

*Assistant Curator (Vertebrates), National Museums Liverpool*



**Fig 6.** Melissa Gunter grinding a glass jar rim.

“Name badges! More demonstration from Simon, like case studies and examples of various practices, so we could then take our specimens and follow his lead. It was a really good week. Resources were excellent.”

*Beulah Garner*

*Trainee Natural History Curator, Horniman Museum and Gardens*

“From my point of view and coming from a totally different background/discipline I can honestly say that I found it most informative and extremely interesting. The main reason for my being there ... is the Damien Hirst work that has recently come into our collection, but as the course unfolded it was clear that there were other works in our collection that the principles and techniques would apply to which was a real bonus. I suppose you could say in hindsight that participants do not have to be from a museum ‘wet specimen’ background; which would open it up to other interested institutes/individuals.”

*Keith Morrison*

*National Galleries of Scotland*

“I much enjoyed the course and found it extremely useful. Regarding the organisation; I liked the proximity of the lab to the room where we had the talks and the mixture of talks and practical work and the way we could pop through easily to check up on specimen progress.”

*Cathy Caudwell*

*College of Life Sciences, University of Dundee*

“I thoroughly enjoyed the course and am really glad I got to attend. Having had no background knowledge of fluid preservation before I attended, I came away more knowledgeable and with the skills and confidence to apply these course techniques to some of our specimens. I particularly enjoyed the lab based practical where we could work through the problem specimens and a real highlight was realising that dried-out or neglected specimens could be re-hydrated and restored to good quality. The only suggestion I have is possibly to allow everyone to acquire a problem specimen that needs to be mounted. Only so everyone can have a go at mounting with the microfilament or using celloidin to repair it etc. but apart from that it was great.”

*Amy Romanes*

*Natural Sciences Curatorial Assistant, National Museums Scotland*

“I thought the course was very good and run very well. Simon's papers, while extremely helpful and full of useful information, in no way compared with the hands-on experience and in-person instruction you receive during the course. As we all found, each specimen is completely different with separate and unique issues to assess and deal with. It was a good course and I was glad I was able to attend.”

*Melissa Gunter*

*Conservation Intern, Museum Victoria, Melbourne, Australia*



**Norwich Fluid Preservation Course 2008.** Top row (from left to right): Melanie Rolfe, Cathy Caudwell, Amy Romanes, Keith Morrison, Melissa Gunter, Tony Parker, Beulah Garner. Bottom row (from left to right): Neil Mahrer, David Waterhouse, Alessandro Giusti. (Photography by Simon Moore)

## **The future of fluid preservation - fixation in the balance: the case for using formalin**

Simon Moore

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### **Abstract**

Despite much research into safer alternatives, ten percent aqueous formalin is still the most effective fixing agent for biological specimens. Many countries are trying to ban its use, based largely on its carcinogenic property. This article lists possible substitutes and alternatives that are safer to use, reviews other traditional fixing and preserving agents that have been mixed with other compounds and briefly discusses the problems in posting loans of fluid-preserved material.

### **Introduction**

No matter how we may view collections of fluid-preserved natural science specimens (largely biological), with the coming of DNA analysis and molecular-based research, scepticism about the need to keep hazardous and high-maintenance collections of whole specimens, mooted by Peake (1989), seems to be reaching a zenith. A good example of this is the case for banning formaldehyde as a fixative as it is deemed to be too hazardous. Firstly there are many reasons why fluid collections need to be maintained and it isn't all because we need the DNA to unravel the mysteries of biological sciences in the future.

Ever since first Butlerov and then von Hoffman identified and isolated formaldehyde in the 19<sup>th</sup> century and the discovery of its antiseptic properties in 1893 (34 years later) it has been used as one of the most effective bactericides in the medical and biological worlds. Even in diluted solution formaldehyde is rather user unfriendly, provoking lachrymation and irritation of mucous membranes plus it is toxic, dematitic and can initiate cancer, yet there are many who have used it carefully for decades (including myself) without obvious ill effects (the carcinogenic properties of a substance are not dose dependent).

At lower temperatures (below 10° C) formalin starts to polymerise, forming a mixture of meta- and para-formaldehyde molecules creating a white mist effect which rapidly becomes much denser and can eventually solidify!

Considerable research has been carried out, especially over the past 20 years, to finding an equally-effective or better, fixing agent that is safer and yet formaldehyde's track record is still unrivalled, despite frequent attempts to discredit its use on health grounds, implying careless usage. The main problem, I suspect in these litigious days, is that many are turning their backs on formaldehyde, to the detriment of specimens, due to the risk of being sued.

### **Fixatives**

A fixative is defined as a chemical compound which initiates tissue preservation by precipitating or chemically combining with cellular proteins to prevent decay, lysis or osmotic collapse (Moore, 1999). Stoddart (1989) takes it to a molecular level. True fixation involves the formation of permanent covalent or coordinate bonds which link together the molecules composing a tissue, so that they are unable to undergo rearrangement or extraction.

There are several primary fixing agents:

- **Formalin** (37.5% formaldehyde gas dissolved in water – a saturated solution diluted to 3.75 ≈ 4% for fixation).
- 
- **Osmic acid** (a solution of osmium tetroxide) used primarily for transmission electron microscopy tissue fixation but also useful and effective for small and delicate biological organisms even though it does stain the internal organs black and it's also very toxic and hazardous to use. It has also been compounded with another cytological fixative - glutaraldehyde and buffered with sodium cacodylate.

- **Picric acid** must be kept moist as when it crystallizes it becomes explosive it also stains (almost) everything yellow – it is used as a compounding fixative and often combined with formalin in Bouin's fluid with or alcohol in Dubosq-Brasil's fluid.
- **Acetic Acid** – also used as a compounding fixative and often combined with formalin (again) and alcohol in FAA, formol-acetic-alcohol: it's used as a tissue swelling agent and can chemically 'unzip' chromosomes, so its use is fairly restricted.
- **'Dowicil'** is a formaldehyde release agent when combined with protein and was used widely during the late 60s and early 70s. It came in powder form and was used at 10% strength (in water) as a fixative. I have not heard of its use as a gross tissue fixative outside the boundaries of histology and I suspect it was used without injection into body cavities and eventually disfavoured due to its poor penetrative qualities (Fig.1).

Secondary fixatives (or pseudo fixatives) include alcohol (ethanol or IMS), mercuric chloride (very toxic and will attach mercury atoms to tissues), potassium dichromate (powerful oxidising agent) and cobalt nitrate - there are many more.

Additives can either raise or lower the pH, or function as humectants: lower glycols and glycerol, are well-reputed to prevent total desiccation in the event of a container's seal collapsing. Note how many of the above are 'acidic' in nature, having a relatively low pH but in fact are in fact, just more liberal with H<sup>+</sup> ions.

Today we are obsessed with fluid neutrality and yet the author has tested many fluids in which specimens were preserved in perfect equilibrium and with a pH between 4 and 5. Organic acids (acetic, citric, picric) have been used in fixatives (FAA –formol-acetic-alcohol) or Bouin's fluid (formalin, picric acid and acetic acid). Many of these are used in skin pickles or taws. While it is true that specimens start to denature if the pH drops below 4, this would not necessarily be due to acidic corrosion but the high concentration of H<sup>+</sup> ions in solution would form a cocktail of highly preservative-unfriendly compounds. Conversely, an overdose of OH<sup>-</sup> ions can just as easily lead to protein hydrolysis if the pH rises to even a tad above 7.5.

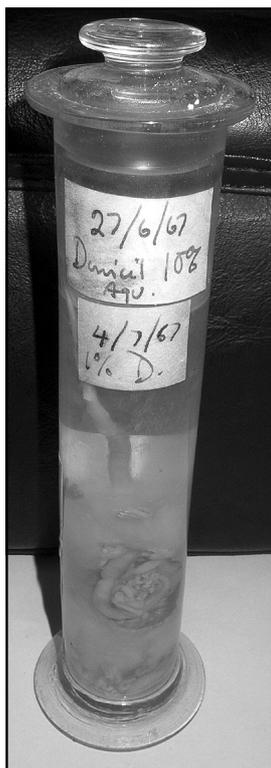
### Compound fixatives

These are used more by histologists to facilitate or enhance the preservation of tissue elements and many contain highly toxic compounds such as mercuric chloride (cf. Heidenhain's Susa and Zenker's fixative). These are rarely used in the preservation of scientific or museum collections of whole organisms. One store I worked in contained two jars of birds preserved in something called Serventy's fluid. The Serventy family were Australian ornithologists and Vincent Serventy produced a fluid for conserving bird feather pigmentation *circa* the 1950s; the formula is similar to Kew mixture for plants, containing formalin, alcohol and glycerine (70% alcohol - 90 parts, 40% formalin - 5 parts, glycerine - 5 parts). Then there have been effective dual and triple-stage methods for colour preservation (Kaiserling 1922 and Wentworth 1938) - all of these contain formalin, mainly for the fixation stage.

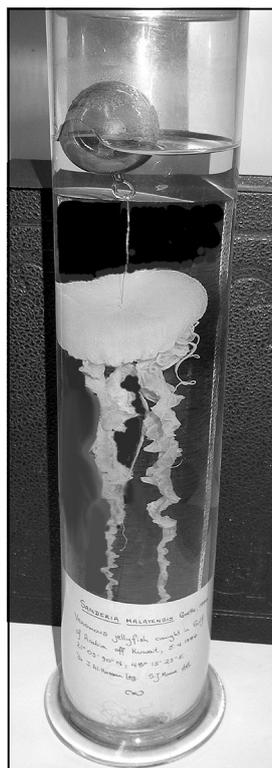
### Recent advances

Although we may not have advanced much technologically since the antiseptic qualities of formalin were revealed, several fixatives have been put forward for testing more recently.

Steedman (pronounced Stedman) produced fixing and preserving solutions for marine zooplankton for a UNESCO-funded book in 1976. The fixative contained formalin, propylene glycol as a humectant and propylene phenoxetol (or 2-phenoxyethanol, an embalming fluid). This gave excellent results both for the zooplankton and for larger tissues, providing a more osmotically friendly solution than previously and with results that showed a slight swelling of tissues rather than the usual shrinkage. Given this apparent panacea (since it is also slightly safer to use than buffered 10% formalin and more user friendly) it was greeted with enthusiasm and important collections were rather-too-rapidly transferred over without a proper test-of-time. Bearing in mind that this and the post-fixation-preserved (less the formalin), were intended for zooplankton, putting large specimens into the fixative seemed OK somehow. The problem with denser fluids is that they are poor penetrants for large and gross tissues and following some awkward moments over the ensuing years, Steedman's fluids were largely abandoned. Once again, a lack of fully understanding about fixation and preservation processes seems to have brought this about!



**Fig 1.** Eviscerated mouse fixed in 10% Dowicil and subsequently preserved in 1%, July 1967, preservative renewed just over 40 years later! (photographed in 2008).



**Fig 2.** Jellyfish fixed in Steedman's fixative (1986), then into PFP. Note the good state of preservation of each specimen. (photographed in 2008).

Since then people have been more cautious about proposing alternatives to formalin and Simmons (unpublished MS in prep.) will review these. In an in-depth attempt to remedy the situation, the formaldehyde-releasing bactericide DMDM-Hydantoin was put forward by van Dam (2001) but was found to crosslink with certain protein groups leading to their denaturation. Once again formaldehyde is at the root of fresh tissue fixation.

**Preservatives**

The text book definition of a preservative is a compound that maintains a sample in a fixed (stable) state both at macroscopic and microscopic levels. Many new preservatives have been tested but few have found to be effective in the long-term (over 20 years). There is often some regularly-occurring deterioration of a specimen (or part) somewhere during a specimen's preservation history.

Bactericides and even some plant fungicides (Chinosol – 8-hydroxyquinoline sulphate) have been tested as both fixatives and/or preservatives, many are highly beneficial to specimens but only in the short-term (up to five years). Crimmen (1989) records how large fish specimens can eventually rot internally. Moore (1997) puts this down to the poor penetrative properties of many preserving agents, especially those that are glycol-related or of slightly higher OP (osmotic pressure) than water.

Most workers now fix in formalin and then transfer to 70-80% IMS (methylated ethanol). This works well since the tissues are stabilised by the formalin and then preserved by the IMS. However, IMS has its own set of problems particularly solvency, osmotic pressure differential (related to that of water and formalin), evaporation, rapid dehydration, extraction of proteins and of course, flammability. The author has always maintained that keeping a collection in IMS is creating a rod for the back – some jar seals and especially greases are affected by its solvency and often end up as an unsightly layer of stickiness in the bottom of a jar with the specimen sitting right on it. Solvency also dissolves out lipids both discolouring and eventually acidifying the preservative, especially when the dissolved lipids oxidise into fatty acids. Osmotic pressure

can affect tissues if IMS is employed as an initial preservative or if specimens are transferred directly from aqueous solutions (formalin included) directly into IMS. The effect causes cells to shrivel (syneresis) and tissues to distort or even tear. Histological samples of rat liver have shown this effect (Moore 1999). Evaporation occurs slowly in a well-sealed jar and the IMS auto-dilutes since alcohol and water are not a true solution but a binary azeotrope; by 30% strength IMS can become infected with fungi which rapidly aid in specimen lysis! Dehydration means that specimens (especially delicacies) have to be brought up a ladder of increasing IMS concentrations until preserving strength is both achieved and equilibrated for the specimen. Flammability brings with it a whole raft of safety regulations.

We are still prepared to take on this tranche of problems as alcohol has been tried and tested as a preservative (and pseudo-fixative) for many centuries and it's good for preserving DNA. Many will leave formalin-fixed specimens in the fixative solution indefinitely and which will denature the DNA sequence. Half-strength formalin can be used as a more user-friendly preservative but this dilution will still not effect DNA deterioration.

A small group of museum-related conservators have been trying to rectify the fixative situation: John Simmons (USA), Andries van Dam (NL), Jules Carter and Simon Moore (UK) and although several fixatives and preservatives have been mooted and tested there is still no substitute for formalin.

There is also the slightly lesser question of finding something that will fix lipids – formalin will only preserve them which is why these can emerge from specimens that have already undergone fixation.

More recently the Smithsonian (Washington DC) has entered the 'preservation arena' by testing a new preservative called Novec. This comprises a mix of hydrofluoroethers forming a bactericidal envelope around the specimen. So far results are promising and it is being tested on a giant squid specimen; the colours have been well preserved and this author will be interested in observing the outcome. Novec is a dense fluid (1.5 Sp. Gr.) and I doubt that it will penetrate the interior of the specimen sufficiently to fulfil its preservative role on the tissues initially fixed by formalin (note!), longer than about 10 years. Small 'biopsy' samples are taken periodically to check for any deterioration. The fluid has the disadvantages of being quite expensive and dense causing freshly-fixed material to float so that it initially requires weighing down. It also has a lower boiling point than ethanol requiring a special jar/container seal to prevent evaporation (Drahl, 2008, via Simmons, pers. comm.).

### Postal loans

Specimens have been safely sent in the post around the world using either deionised water or IMS as moistening (note) agents but now many countries' postal systems are banning the use of IMS due to its evaporative and flammable properties even though IMS has not been shown to pose a danger in the concentrations used for museum specimens. In the USA museums, initiated by Andy Bentley (2007), are having a say and modifying these regulations to a sensible level. Some museums are substituting IMS with glycol-related preservatives, often without prior permission of the loaning institutions! For delicate specimens this can be deteriorative since the osmotic pressures of IMS and glycol-based preservatives are very different and such an OP reversal can cause microscopic tearing through cellular swelling and bursting.

### The future?

Firstly, IMS needs to be tested to determine whether or not it really poses a problem in the postage system. Secondly, and this is the difficult part, with easier access to litigation, increasing paranoia with formalin and an apparently-increasing sensitivity to its effects on humans, we do need to find an effective long-term and safer substitute for formaldehyde solutions. Perhaps regulating bodies might consider funding a research project into finding a fixation panacea that will effectively replace formalin in the long-term, before banning its use.

### Conclusions

Despite many years of research, trial and error, there is still nothing as effective as 10% formalin as a primary fixative. The author strongly suspects that John Simmon's unpublished MS will also similarly conclude. Despite efforts to shift formalin out of the fluid-preservation sector this will ultimately result in deterioration to many specimens in our care.

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### **Researching Ivory: Integrating Scientific Analyses, Historical Data, Artefact Studies and Conservation Needs**

AHRC/EPSRC Science and Heritage Programme

April 23<sup>rd</sup> 2009  
10am until 4.30pm

**Session 1 - The what, where, when and why of ivory studies**

**Session 2 - Sampling and analysis - problems and potentials**

**Session 3 Conservation & curation of ivories and approaches to questions problems**

This workshop is intended for anyone with active research interests and/or curatorial or conservation responsibilities for objects made from ivory – whether from elephants or other species – who would like to know more about current research in British universities and museums on their identification, origins, working, uses, history, exhibition, curation and conservation, and the potential for future multi-disciplinary studies. The workshop will also appeal to individuals responsible for monitoring and controlling the illegal contemporary trade in ivory and ivory products.

Attendance is limited to a maximum of 50 participants. Modest travel grants are available for UK-based curatorial staff, conservators and researchers who have relevant responsibilities or interests.

For more information about the workshop, including speakers, venue, and travel grants please contact Dr Sonia O'Connor via e-mail [S.Oconnor@Bradford.ac.uk](mailto:S.Oconnor@Bradford.ac.uk) or by post at Division of Archaeological, Geographical and Environmental Sciences, University of Bradford, Bradford, West Yorkshire, BD7 1DP, UK, Phone: +44 (0)1274 236498, Fax 01274 235190.

**Don't say 'glue', it's 'adhesive'!**  
**Personal View of Adhesives seminar held at the Natural History Museum, London,**  
**Tuesday 19<sup>th</sup> November 2008**

Laura McCoy  
Natural History Museum  
Email: [absolom@lycos.com](mailto:absolom@lycos.com)

### **Introduction**

Although I am now no longer officially a student, I am still volunteering at the NHM and gaining valuable experience, so I was very glad to have the opportunity to go to the seminar on adhesives led by Simon Moore and I am very grateful to NATSCA for again providing the bursary.

Adhesives are one of the most widely used and important substances in practical conservation. Whether it is analysing previous ones used or judging which one will be the most appropriate for a repair, it is important that people are aware of the choices of products there are and the properties that they have.

### **So many choices**

The first two presentations were by Velson Horie from the British Library, the first being, '*How to choose? The properties of suitable adhesives*' and the second, '*What to choose? Which are the most suitable for my specimens?*'

There are many things to be considered and Velson took us through a whirlwind tour of criteria, processes, definitions, considerations, and tips on how to evaluate the best adhesive for the job. Some of the criteria included points such as: the application of the adhesive must not harm the object; the setting process must not harm the object physically or chemically; the material must be removable without harming the object; the application must not harm the worker; the adhesive must be water white, should remain water white; should be strong enough and must not alter to become irremovable.

If the properties of the object material are known then the most appropriate adhesive can be chosen, taking into consideration the solvent and how the adhesive will interact with the object; does it have a different pH, how reactive is the adhesive, etc .

There was also practical advice on the application of adhesives, explaining that bond thickness must be thin and that setting can be through liquid solidification, evaporation or chemical cure. Does the adhesive shrink on setting? Most, except those which are pressure sensitive do (i.e. cello tape), and it is important to know how much, as this could affect the strength of bond or the object. He listed many types of adhesive, for example natural protein, cellulose derivatives and synthetic PVA, and listed their properties and explained a little about each, which was very useful. As there was so much information in such a short space of time, I was very grateful that he provided hand-outs containing all his slides!

### **Herbaria adhesives**

Next was Jovita Yesilyurt from the Botany department at the Natural History Museum, London (NHM) talking about botanical related adhesives and consolidants. There are a number of methods which can be employed to mount botanical specimens, they can be loose, pinned, stitched, strapped or glued. There were many adhesives that were tried but were found not to be suitable. Methyl cellulose dissolves in water and was found to be stable but was too weak; wheat starch paste was unstable and attracted pests; Evacon-R was difficult to apply, dried too quickly and was affected by temperature. Latex was used in the past as alcohol cannot be used on organic material and the reason it was used was because it is water soluble, does not set too fast and has a strong bond.

Since 1993 the Botany department started using PVA, which is a thermoplastic! polymer resin that is flexible and used on objects containing organic material. Jovita explained that it was a good consolidant and as well as plant material can also be used on bone, shell and antlers. It has good adhesion, is water soluble, stable and durable but no adhesive is perfect and so it was highlighted that even though they have been using PVA for years they always consider new products that come on the market.

**In a bit of a pickle?**

After coffee it was Simon Moore, from Hampshire County Council Museums Service, who told us about adhesives for fluid preserved specimens. The two main adhesives that are used are Celloidin (or Collodion) used for objects stored in alcohol based preservatives and gelatine, which is used in formaldehyde-based preservative solutions.

Celloidin comes in different forms including pyroxylin and necoloidine, and can be used as a cement to glue specimens in IMS to glass, for reattaching fallen labels in educational jars, rejoining broken or degraded bone, reattaching arthropod limbs with the reinforcement of glass needles (made by stretching glass rods over a flame) and even repairing a sponge or the split bell of a jellyfish! The gelatine for formaldehyde preserved specimens can be made only from leaf gelatine, not the powder form and objects must be rinsed in water and be fairly dry so that the gelatine does not gel too quickly. After 30 years or so hydrolysis will eventually weaken the bond and it will need replacing. It is astounding the results that can be achieved, even from specimens that have been corroded by fungal enzymes and gives encouragement to anyone that is faced with a collection that is desperately in need of a little TLC. You would be surprised at what is still salvageable.

**A bit of an animal**

Nanke Schellmann from the V&A gave a very comprehensive talk on animal glues, their adhesive properties, longevity and suggested uses for repairing taxidermy specimens. There are different types of animal glue with different chemical, physical and mechanical properties and they come in varying forms: raw, refined, dry and ready-to-use. Nanke went into detail on the structure of animal glue and how it is processed and formed from the raw ingredient. The raw ingredient, collagen, is formed of long strands of naturally occurring amino acids linked together by covalent bonds. By denaturing the collagen gelatine is formed, which is the active ingredient in animal glue. Depending on where the collagen comes from, i.e. mammal, marine, bone, skin or bladder, how it is extracted and how it is prepared produces different results and can improve or reduce the quality of the glue. If the gelatine is overheated then that reduces the gel strength, which is important for high cohesive strength, greater stiffness, higher resistance to impact and reduced swelling and increased stress development in rising RH.

Animal glues do not react well in dry conditions, as they shrink and become brittle, and in high RH their elasticity reduces and there is increased stress development. The more impurities in the glue then the lower the gel strength and the more discoloured the glue will become over time, so the purer the product the better.

Many ready-made glues may contain unknown additives which promote cross-linking, that will reduce solubility and allow the glue to become more brittle over time. Nanke highlighted that the properties required from a glue used in taxidermy are: appropriate adhesion qualities, 'reversibility' or re-treatability, stability with aging and minimal disturbance! of the original skin. The chemical nature of the glue means that there is good adhesion with animal skin and they both require the same environments to stay stable. If the skin was treated with metal salts then this may cause the glue to become insoluble and if the specimen is light or transparent in colour then only the best/purest gelatine or isinglass can be used.

**Fossil fillers**

Geological specimens were dealt with by Kate Andrew from Hertfordshire County Council Museums Service. Kate described numerous terrible things that were used in the past to gap-fill and piece together objects and also discussed more recent methods which are considerably more effective. Of the materials that Kate has found holding fossils together the list includes: compo, bees wax, AJK dough, plaster, glaziers putty and many more. Plaster of Paris produces many problems, as it expands when it sets and contains water which encourages pyrite decay.

Of the substances that are recommended, Milliput and Paraloid with glass beads are the most popular, all depending on what you are trying to achieve, and there was also another product called Apoxysculpt that was mentioned. Gap-fills can be used as adhesives, for structural support and for appearance and can be adapted accordingly. The size of the glass beads can be varied when mixed with Paraloid, as larger beads can be used for structural fills and then micro-glass beads can be mixed with Paraloid for the surface layer that needs to be smoother. Fills can then be painted with acrylic paint so that they blend in and are not quite so obvious.

### **Hands on conservation**

After lunch it was time for the demonstrations. For the first two we were taken into the Palaeontological Conservation Unit (PCU) and Adrian Doyle and Lu Allington-Jones showed us examples of solvent gels for the removal of adhesives, yellowed resins, gap-fills with resins and other materials. Lu had some examples of historical paper labels that were removed from mounted boards. It is important to salvage these, firstly for their historical value but also so that once the specimens were re-packed they would still have all their original information. It was quite remarkable that something which seems to be irretrievable can be retrieved and add to the provenance of the specimen.

Adrian Doyle, after being in the PCU for over 30 years had collected samples of adhesives which at the time were considered conservation grade, but that now were in some cases bright orange! It goes to show that just because we are told to use something we should always remain sceptical and keep a close eye out for any changes and constantly try to improve on the materials we use.

Liesa Stertz had brought out examples of some of the NHM's Blaschka glass models that she had cleaned and repaired. Compared to what they had looked like before she had done a remarkable job, and part of her work involved the reattachment of very fine glass spines and pieces using micro-tubing. It is a testament to her skill that the repairs are virtually invisible until you really get up close and shows what can be done with some time, patience and a very steady hand.

Lastly, everyone went back upstairs for the demonstration by the Botany department on the mounting of plant material with PVA. The lady that gave the demonstration was very deft and made it look easy, but there is a skill in presenting all the relevant parts of a plant, making sure that it stays intact and judging each plants' texture, as they are so varied, from woody to succulent, spines, flowers, roots, etc. Once dried plant material can be so brittle, so it is quite incredible the results that they can produce.

The seminar was very informative and to someone that is just starting out in a career in conservation it was invaluable. I spoke to people that have been working in conservation for years and they too thoroughly enjoyed the day, as it was a good chance to observe other people's craft, discuss methods, materials and learn new tricks of the trade. I would like to thank everyone that was involved in organising such a great day, all your efforts were much appreciated.

### **Geological Curator's Group Seminar**

#### **Casting Geological Specimens**

At the British Geological Survey, Keyworth, Nottingham

A two day practical workshop to include moulding and casting of geological material, presentations and a field trip to Charnwood Forest to consider the practical problems of moulding in the field.

An evening 'pub meal' is planned for delegates.

The workshop will be beneficial to curators, display technicians and conservators. The course will be lead by Sue Martin (BGS), Caroline Butler (NMGW), Annette Townsend (NMGW) and Mike Howe (BGS).

Costs: £10 per day per person (£20 for the workshop). Includes: tea/coffee, lunches, all materials, information pack and field trip.

Contact Mike Howe  
British Geological Survey, Kingsley Durham Centre, Keyworth, Nottingham, NG12 5GG  
Tel: 0115 936 3105  
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## Adhesives for Natural Science Specimens

Velson Horie  
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### **Introduction**

Conservation is object centred; so all the approaches should start with the requirements of the object. When considering an adhesive treatment, ask whether it needs an adhesive treatment, or is that a cop-out in dealing with a more difficult underlying problem? What are the alternatives: are we proposing the right thing for the long term? There is a growing literature to aid the process of thought (Hornie, 1987).

Numerous, often undocumented, materials are added to specimens during a specimen's life which can be discovered e.g. a mount by a conservator or adventitiously e.g. oxygen from the atmosphere. All of these materials interact with the object, with each other and with the object. This complexity makes the process of planning important and to focus on long term effectiveness; but this is not a reason not to take any action to solve the real problem. Using an adhesive on an object is part of a long term process, from application through ageing to removal and any adhesives used on specimens need to be documented. Criteria have been proposed for choosing material added to an object.

There are three main components, the object, the added materials and their interaction. Reversibility is an important interaction and should be considered when planning. The reversibility can be classified in a number of ways.

- No known method of reversal, e.g. silane in stone.
- Return to a state approximating to original state, e.g. revarnishing painting.
- Return to a state that does not affect subsequent treatment, e.g. dismantling stuck pot.
- No evidence of initial treatment remains after reversal, e.g. no contamination or change.

### **What is an adhesive?**

Liquid water is used as a (temporary) adhesive when transferring a piece of paper on a wet support fabric. But it does not last very long and it is not very strong; it is only temporary. English is poor at definitions and using them, so I have proposed a couple to help clarify;

- **Adhesive:** a substance capable of joining materials by surface bonding (adhesion).
- **Liquid adhesive:** a liquid which sets to a solid forming an adhesive bond.

A join between two components does not necessarily use an adhesive, even if you think you have added one. Joining can be achieved by mechanical interlocking, or by bonding (adhesion). Bonding requires wetting of adherend's surface by a liquid, setting of the liquid to form an adhesive which prevents movement at the joint, ability to adjust to stresses at bond interface.

Having made the bond, how does it fail? How would *you* want it to fail? Ideally, the adhesive should peel off the object, the adherend, leaving no trace behind, on demand. This is called adhesive failure and is what pressure sensitive tapes claim but never achieve. They leave a bit of the adhesive behind on the surface, because the adhesion is stronger than the adhesive, leading to cohesive failure of the adhesive. Worst of all is cohesive failure of the adherend, which breaks.

### **Liquid adhesives**

All adhesives must be applied in liquid form in order to flow over the surface of the substrate. This creates severe restrictions on the composition and thence on the final adhesive composition and properties. A commonly used formulation in conservation (but rarely in industry now) is a polymer in solution. The polymer must first be dissolved in the solvent. The solution then flows over the adherend surfaces, then evaporates (in whole or part) to deposit a solid film of polymer which acts as the adhesive for the long term before being removed. Choosing the correct polymer to optimise each stage of this process has created many inappropriate solutions, which still remain on objects for conservators to reverse.

There are many different types and subtypes of polymer. Polymers can now be designed, and manufactured to suit the application. In choosing the adhesive components the complete life cycle of the process must be worked through.

The conversion from liquid adhesive to solid adhesive, setting, can result from a number of mechanisms:

- Cooling from a melt, e.g. paraffin wax.
- Cooling from a solution, e.g. gelling of a gelatine glue, with the subsequent evaporation of the solvent.
- Evaporation of a solvent, e.g. water from starch paste.
- Evaporation of a dispersant (usually water) from polymer dispersion, e.g. white PVAC wood adhesives.
- Chemical reactions between two or more components, e.g. polymerisation of cyanoacrylate monomers by initiation with water on a surface.
- Pressure sensitive adhesives are special liquids that are (or should be) designed to not flow away but remain as adhesives.

The setting process can be fast (seconds) or slow (weeks). It needs to be adjusted in the formulation to be suitable for the methods used to make the join. For instance, a very viscous liquid adhesive (e.g. epoxy) needs plenty of time to flow and wet the interstices of a surface, whereas a highly mobile cyanoacrylate needs much less.

### Adhesives

There are many types of adhesives which can be classified in many ways, e.g. organic or inorganic, natural or synthetic, traditional or modern, well characterised or commercial secret, setting method, stability, mechanical properties. All choices are compromises, so both the benefits and disadvantages need to be explicitly considered in relation to the object. The normal starting point is the literature and customary practice in the field. However, each object needs to be considered individually. There is a tendency to keep reusing (inappropriate) materials without proper consideration for the application in hand.

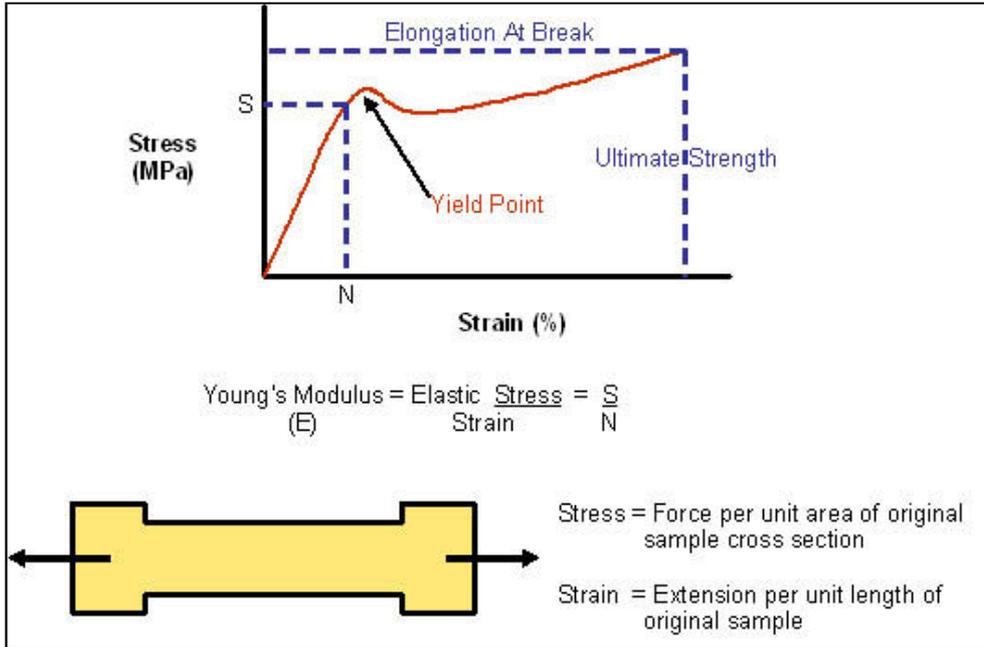
All adhesives are mixtures of components, e.g. polymer and solvent and stabiliser. The composition must be tailored to the setting mechanism and the adherend, e.g. different epoxies for glass or leather, different glues for parts of a violin. Each component matters, to the adhesive and the object. The main component of an organic adhesive is the film forming polymer. In most commercial adhesives, many additives are included in a formulation to improve properties such as stability in storage, flow and wetting characteristics, and stability in ageing.

Polymers have two properties that set them apart from other commonly experienced materials; molecular weight and glass transition temperature. Polymers are made up of mixtures of large molecules. This is different from many other types of substances. The molecular weight, MW, of a polymer can be 100s to many millions, which affects the mechanical properties of the adhesive. The largeness of the molecules leads to strength, flexibility and viscosity in melt and solution. If the size of the molecules is increased, these properties are also increased. So when choosing, say, a poly(vinyl acetate) for an adhesive, there are many varieties available, from weak and low viscosity to strong and high viscosity, in solution or dispersion etc. One needs to be explicit about which material is chosen and why it was used – “PVAC” is an incomplete and inadequate description.

The high molecular weight of polymers leads to another property, the glass transition temperature, T<sub>g</sub>. As one heats a polymer through this temperature (actually a range of temperatures), the polymer changes from a glassy rigid material to a plastic, mouldable, one. Further heating can lead to melting and flowing. Each polymer has its characteristic T<sub>g</sub>. Some polymers are extremely flexible, such as silicone rubber, T<sub>g</sub> = -125°C. Some are rigid and glassy, such as poly(methyl methacrylate), T<sub>g</sub> = 105°C. The best adhesives have their T<sub>g</sub> around the temperature of use, normally room temperature, which is why PVAC (T<sub>g</sub> 17-26°C) is frequently used.

Adhesives are chosen primarily because they do a physical task, holding components together. So their mechanical properties are important as is how the mechanical properties interact with those of the object.

When pulling a sample of polymer to destruction, the mechanical properties of stress (strength) and distortion (strain) can be measured (Figs 1 & 2). It is not usually possible to do the same test on objects to make sure that an appropriate adhesive is chosen. The aim is to ensure that any mechanical forces are dissipated in the adhesive and not concentrated in the object, leading to damage.



**Fig 1.** Measuring the mechanical (tensile) properties of a material.

<i>Polymer</i>	<i>E, Young's modulus MPa</i>	<i>Ultimate strength MPa</i>	<i>Ultimate extension %</i>	<i>Tg °C</i>
Silicone rubber	3	5	500	-125
PE (LDPE)	166	10	620	-20
PVAC	1200		15	17-25
PMMA	2600	65	4	105

**Fig 2.** The properties of typical polymers.

The next stage in an adhesive treatment's life cycle is ageing, when all the components and the object and the environment interact. The base polymer of the adhesive can deteriorate: cross-link, chain scission, yellow, shrink etc. The object can corrode, distort, give off degradation products etc. As a result, adhesion can be much weakened, without any outward signs, or be lost so the bond fails. Thus chemical and physical properties of properties of the adhesive change over time. Feller ((1978), proposed a classification of useful life, ranging from A1, >500 years, to T, <6 months. As it is impossible to remove all traces of an adhesive treatment, it is prudent to use treatments that have a useful life of at least 20 years, classification B. It should be noted that this "useful life" relates not to material but the total application. A join that may last many decades in a museum store, may fail in months if exposed outside.

Finally, the last stage in the cycle arrives, reversing the adhesive treatment. The removal process should be designed, and documented, as part of the original treatment. So the chemical effects of solvents and the potential of damaging swelling or mechanical scraping should be highlighted and minimised in the choice and application of the adhesive.

### Conclusion

Many conservators spend inordinate time and effort reversing the damaging effects of previous treatments. Adding materials to an original object complicates its future use and conservation. This should be carried out only after eliminating the other possibilities and then optimising the technique chosen. This means understanding the physical and chemical properties of the object, the adhesive and their long term interactions.

### References

Horie, C. V. 1987. *Materials for conservation, organic consolidants, adhesives and coatings*. Butterworth & Co. London.

Feller, R. L. 1978. ICOM Committee for Conservation 5<sup>th</sup> Triennial meeting: Zagreb, 1-8 October, 1978: preprints, Zagreb.

### **Picking over the Bones and Tinkling the Ivories - Identification of Osseous and Keratinous Materials**

A two day course organised by the ICON Ethnography Group with Glasgow Museums

Wednesday 25th March & Thursday 26th March 2009

The course will be led by Dr Sonia O'Connor, Research Fellow in Archaeological Sciences at the University of Bradford, with contributions from Colin Williamson, plastics consultant and a founding member of the Plastics Historical Society, and Pat Allen, Curator of World Art at Glasgow Museums. The workshop will be held at Glasgow Museums Resource Centre on the south side of Glasgow.

The structure, properties and decay of both osseous and keratinous materials in a variety of environments will be introduced. Characteristic features of each material will be described and a methodology given for their identification using non-destructive techniques. A practical session will provide the opportunity to identify selected groups of objects, with photomicrographs and a reference collection being available to aid this study. Sonia will also give a presentation on the conservation and storage of archaeological objects made of osseous and keratinous materials.

Participants have the opportunity to bring objects (or photographs of objects) to the workshop for discussion.

The cost of the 2 day workshop is £210, includes materials, handouts, coffee, tea and lunches. Handouts relating to the presentations will be provided along with a bibliography for further reading. Payment must be made prior to the course. 14 places are available. A limited number of student places are available at the reduced cost of £160. Please send proof of status with your registration form. Registration forms can be downloaded from the ICON website: [www.icon.uk](http://www.icon.uk)

Completed registration forms should be sent to Arianna Bernucci at [abernucci@thebritishmuseum.ac.uk](mailto:abernucci@thebritishmuseum.ac.uk) or mailed to: Attn: Arianna Bernucci, The British Museum, Organics Conservation, 38-56 Orsman Road, London, N1 5QJ

## **Botanical related adhesives**

Jovita Yesilyurt

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### **Introduction**

The bulk of the botanical collections in the Natural History Museum (NHM) are herbarium specimens comprising a dried plant specimens mounted on a sheet of paper. The material and methods used in preparing herbarium specimens varies from Institution to Institution. The principal methods used are:

- **loose** (perhaps the best practise from a purely conservation point of view and specimens easy to use, however, if the material is used, consulted, despatched for loans, etc. the likelihood of mechanical damage or separation from labels is high)
- **pinned** (there are health & safety risks and the likelihood of mechanical damage is high)
- **stitched** (not very practical, very time consuming; high risk of damage of material during preparation)
- **strapped** (it secures the specimens on the sheet but some material would require many straps, which could cover important features, there are also issues of the glue on the straps)
- **gluing** – two main methods:
  - **spot gluing**: glued applied in certain points (it secures the specimens in the sheet but the likelihood of mechanical damage is high)
  - **whole specimen glued**: glued applied to the whole of the specimen (very secure method, the likelihood of mechanical damage very low; important features can be hidden)

### **Adhesives**

Many adhesives have been used to mount herbarium material. Before 1950, they were often derived from animal skin and bone products, such as gelatin. Later, wheat starch paste, Methyl Cellulose and latex were also used.

As the result of a long history and being used widely for an extensive variety of conservation purposes, the adhesives most commonly used in conservation include Polyvinyl acetate (PVA), Polyvinyl alcohol (PVAI), Elmer's Glue All (still PVA emulsion) and Cellulose nitrate.

### **Selecting the right adhesive**

A variety of factors have to be considered when selecting adhesives. They must have certain properties including pH neutrality, flexibility, reversibility and longevity, as well as being easy to work with and not posing any health risks. Therefore, an adhesive should be:

- Soluble in water (giving a degree of reversibility)
- Flexibility (to support the specimen if the sheet is accidentally flexed)
- Drying condition: reasonable drying time (not too fast/slow, to allow a proper 'finish' and not shrink and become brittle)
- Easy to apply: spread easily with even coverage (thin enough not to go into globules or to stick/load into brushes)
- Easy to remove: 'balling up' (when cleaning off excess adhesive, and does not leave trace and the surface where the adhesive was applied is clean and smooth)
- Strong attachment: bonding with good stability (of both the specimen and the labels on the paper)

- Neutral pH (and archival quality)
- Not affected by temperature (high or low)
- Non-toxic (will not harm the object or the worker)
- Good adhesion to many porous surfaces, therefore suitable for paper (labels/capsules) and specimens (one-cell thick to woody).
- Good stability in light (doesn't yellow)
- Expected long term durability (stability with ageing, so that the specimens won't need to go through the process again)
- Non invasive (should not react with any chemicals/substances in the specimens, especially over long periods)

### **Botanical adhesives at the NHM**

It is unfortunately not known what was used to mount the specimens at the Botany Department of the NHM before 1970. Latex was used for over twenty years (from ca. 1970). This was substituted by PVA (Polyvinyl acetate) in 1993 when Latex became unavailable.

In 1999, the department trialled 'Evacon-R' adhesive, which was recommended by Stuart Welch, Conservation by Design. However, although it was satisfactory for labels and capsules, this adhesive proved unsuitable for our needs:

- It was very difficult to apply; it didn't spread evenly and was difficult to 'load' into brushes.
- It dried too quickly (diluting with water did not help); brushes became stiff and clogged after 30-45 min of work.
- It was affected by the temperature but neither warmer or lower temperatures improved its application
- This adhesive did not rub off from hands or brushes easily.

### **Recommendations**

Taking into consideration most of the properties and requirements, PVA seems for the moment, the most suitable adhesive for our purposes at the NHM. It is so far performing its herbarium related requirements, with some conservation aspects being covered.

It has been known that PVA is non-acidic (unlike many other polymers), but recently some controversies have been aroused, which certainly needs further investigation. Moreover, conservators from Natural History Museum have suggested a search for a more conservationally sound option.

If looked at only from the conservation point of view, perhaps the best practice would be to simply leave the specimens loose (as mentioned above). However, as the herbarium collections are an important source of information, they are always consulted and requested on loan, which means that there is a great risk of damage. We are not 'sticking' to PVA as the magic potion for mounting plant specimens. We are aware that we should continue to search and investigate other options. Please do not hesitate to contact us if you have any ideas! We will be happy to try it!

### **Acknowledgments**

I would like to acknowledge my colleague Alison Paul, the Pteridophyte Curator, who provided information for the talk and commented on the paper.

## Adhesives for fluid-preserved specimens

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### Abstract

Fluid preserved specimens, whether stored in formalin or alcohol-based preservatives, often require adhesion to backing plates, especially if used for display or education. Techniques for adhering delicate specimens (or parts of), labels and flags, also applications as gap-fills are mentioned together with reversibility and health and safety issues.

### Introduction

Most of us have to store, maintain and sometimes display dissections or mounts of whole biological specimens. When internal labels or bits of specimen become detached through physical abuse, many tend to hide these specimens away where they become forgotten and/or neglected.

As Art Museums and Galleries also start to acquire fluid-preserved biological specimens their untrained staff start to panic, unsurprisingly, when such works of art start to deteriorate over time.

### Adhesives

Most of us tend to store biological specimens in 70-80% Industrial Methylated Spirit (IMS), having hopefully fixed the fresh specimens in 10% formalin to stabilise proteins, amino acids and other related tissues.

For alcohol preservatives, celloidin must be used as an adhesive, for formalin-preserved material, prepared gelatine is used. Celloidin goes under many different names:

- **Necoloidine** – an 8% solution of pyroxylin (dry nitrocellulose flakes which are moistened with IMS to prevent instability (explosive/combustion) problems). This gels in 70-80% alcohol to produce a hard, semi-opaque solid which has an adhesion strength of about 100g for a 0.5mm layer increasing to c. 5Kg for a 2cm thickness preserved in IMS. It is/was used as a larger specimen embedding medium for microtomy.
- **Pyroxylin** – alcohol-moistened flakes of nitrocellulose. These are dissolved in a compound solvent - a 50:50 mixture of absolute ethanol and di-ethyl ether to produce Necoloidine.
- **Pro-celloidin/Collodion** – is a more European term for pyroxylin powder. Again it is alcohol-moistened and tends to flock together forming easier to handle soft lumps.

For formalin-preserved specimens you must use prepared gelatine and which also acts as a reversible (warm water soluble) jar sealant. This adhesive is prepared from leaf gelatine only so that the molecular strands are long enough to form good adhesion. Powdered gelatine may be fine for foodstuffs but not for adhesion:

- The gelatine leaves (11g for a small sample of adhesive) are hydrated in cold water (hot will melt them!) until very limp but not starting to dissolve. This varies from about 2 minutes to overnight depending on leaf thickness.
- Once soft, the leaves are heated, using a hot-water bath or *bain-marie* to prevent charring, until molten – do not overheat or this will break down the molecular strands of the gelatine.
- 2.5ml of glycerol are mixed into the warm mixture followed by 1.5ml of glacial acetic acid (using a fume extractor!).
- The mix is poured out onto a glass sheet or tray and once cool, it solidifies into a soft, rubbery and slightly sticky consistency.
- It should be stored in an air-tight container.

- The glycerol prevents drying out and the glacial acetic acid acts both as a fungicide and a glass-binding agent (essential when used as a battery jar sealant).
  - Leaf gelatine – 11g
  - Glycerol – 2.5ml
  - Glacial acetic acid – 1.5ml

### Techniques

#### **IMS-preservation:**

This will only work for specimens store in IMS in 80% strength or below to 60% (lower percentages will cause gradual specimen deterioration). Absolute IMS will dissolve celloidin, the water content of the preservative grade brings about the gelling and subsequent tack strength (Figs 1 and 2):

- Remove parts of specimen to be joined from the IMS preservative.
- Once touch dry or even slightly moist, pipette some solvent (ether-alcohol mix, see above) onto the surfaces to be joined.
- Apply celloidin or pipette around the base of a specimen (or label) to be mounted and join surfaces together. Support the joined surfaces so that they don't break apart.
- After 5 minutes, the celloidin will stop flowing if tilted, and will ripple. After a further 5 minutes, immerse into preservative strength IMS to gel (about 10 minutes to half and hour. For larger amounts it can take overnight).
- Reversibility can be brought about by applying solvent or peeling off the gelatinous layer but if this might compromise the specimen, always use the solvent.
- Bear in mind that these substances are highly flammable and that the ether (solvent grade) can still cause drowsiness.



**Fig 1.** Celloidin mounting of salmon ova and alevins – the right-hand set of ova was breathed upon during gelling, hence the opacity and the dropped ovum.



Celloidin repair of  
rhizostome jellyfish

**Fig 2.** Re-attaching a fallen tentacle from a jellyfish is straightforward enough; gap-filling a tear to the bell using a watch-glass to emulate natural curvature, is slightly more challenging.

### Formalin preservation:

This is also used for attaching specimens in plastic (perspex) jars or 'visijars', bearing in mind that alcohol will severely soften plastics!

- Melt the gelatine in a hot-water jacketed beaker – 2 beakers of slightly different volume are fine.
- Apply to both (touch dry) specimen surfaces and join before it cools.
- Once cool, submerge in formalin – it will gel.
- Try not to use too much gelatine at a time, if the beaker contents cool and require re-heating, the molecular strands of the gelatine start to break up and will result in adhesion loss.
- Bear in mind that this join will only last for 30-40 years. Hydrolysis from the water in the preservative will slowly undo the gelatine molecular fibres.



**Fig 3.** For fallen limbs of arthropods, needles of glass form a useful and inert armature to support enough weight for either adhesive to remain effective.

### Conclusions

These adhesives have been tested over a 40 year period and although the gradual failure of gelatine has been noted over that period, the celloidin technique seems to last even longer.

### Further Reading

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Moore S J. 1999 Fluid Preservation. In *Care & Conservation of Natural History Collections* (eds Carter & Walker). Butterworth-Heinemann, London.

## **Animal Glues – their adhesive properties, longevity and suggested use for repairing taxidermy specimens**

Nanke Schellmann

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### **Introduction**

Animal glues have a long tradition of being used as structural adhesives, sizes and consolidants not only in furniture making but also in the preparation and conservation of the most varied materials such as those found in natural history collections. With a variety of different animal glues on the market, such as hide and bone glues, fish glues, isinglass and gelatin, their individual properties need to be well understood in order to determine whether and which of these glues are appropriate for a specific purpose. This paper will look at some of the most important physical, chemical and mechanical properties of collagen-derived glues, their stability and ageing properties (a list of which can be seen in Appendix 1), and will consider their appropriate use in taxidermy conservation.<sup>1</sup>

### **Chemical structure and properties of animal glues**

#### ***Chemical structure and denaturation***

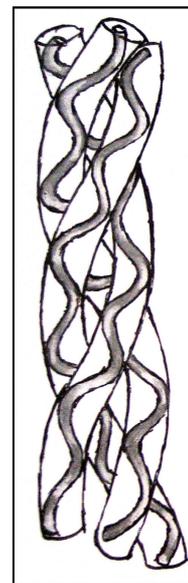
Animal glues are natural polymers derived from mammalian or fish collagen – the major structural protein constituent of skins, connective tissue, cartilage and bones. Collagen consists of long protein molecules composed of naturally occurring amino acids that are linked in specific sequence by strong covalent bonds. Due to the spatial structure of some amino acid units and the presence of many ionisable and polar functional groups in the protein molecule, the individual chains form triple-stranded helical coils (Fig 1) that are internally stabilised by hydrogen-bonding (Woodhead-Galloway, 1980).

Collagen itself is insoluble in cold water, and its transformation into soluble gelatin is of critical importance for the performance of the resulting glue. The transition (a process known as *denaturation*) is achieved by pre-treating the raw collagen with acids or bases followed by hot water extraction. During this process, the stabilising bonds (predominantly hydrogen-bonds) are broken which causes the triple-helix formation of the collagen molecules to separate into disordered coils of single protein chains, of which gelatin is composed (Rivers and Umney, 2003). The temperature ( $T_d$ ) at which collagen denatures is typical for its source and is dependent on the chemical structure of the proteins. Generally, mammalian collagen has higher  $T_d$  at around 40-41°C compared with that of marine species, which converts to gelatin at much lower temperatures (Holmgren, 1998). Collagen of deep, cold water fish (such as cod used for fish glue) denatures at approximately 15°C while warm water species, which are the preferred source of isinglass produced for commercial clarification of alcoholic beverages, have a  $T_d$  of up to 29°C (Haug et al, 2004, Norlands product).

Denatured collagen in its pure form is pure gelatin. However, unless the denatured collagen is purified, the gelatin-based glue matrix gained after extraction contains many impurities, e.g. other protein degradation products, minerals and fats. Glues such as hide and bone glue, rabbit skin glue or cold-liquid fish glue contain many impurities and thus have a yellow or brown colour. Bovine or porcine gelatin, available in food stores or from chemical suppliers, is the purified product. Isinglass, usually extracted directly by the end user from commercially available dried fish bladders, is naturally a very pure product. This is because fish bladders are the source containing the highest amount of collagen, which is also the least chemically linked, and thus only requires the mildest extraction procedure.

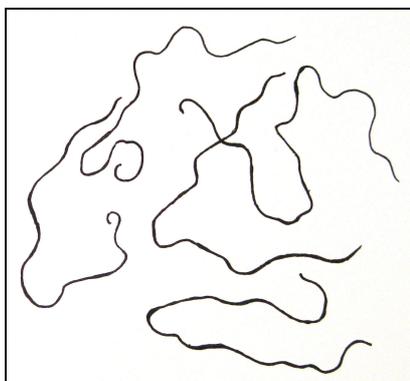
#### ***Gelation and gel strength***

Gelatin in solution has the ability to form a rigid gel upon cooling, which can be repeatedly reactivated with heat. Gelation is based on the partial rearrangement of the protein solution's single random coils back into collagen-like triple helices, occurring at around 32°C in mammalian gelatin and at temperatures as low as

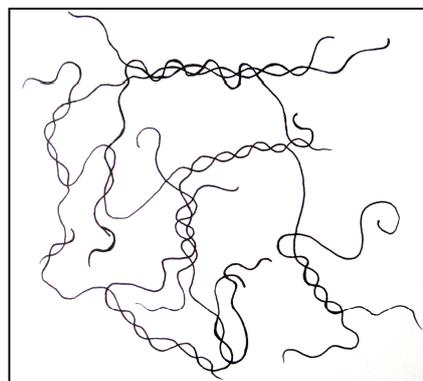


**Fig 1.** Collagen triple-helix

around 8 °C in cold water fish gelatine (Horman and Schlebusch 1971, Haug et al, 2004, Badii and Howell, 2006). This renaturation only develops in sections due to natural misalignment of the single strands, and a continuous three-dimensional network structure is formed (Fig.2a-b). The number of nodes that are established by hydrogen-bonds within and between the molecules determines the rigidity and elasticity of the gelatin or glue matrix, and is measured as gel strength (also known as Bloom strength) (Kozlov and Burdygina, 1983).



**Fig 2a.** Denatured collagen, consisting of individual protein strands



**Fig 2b.** Renaturation of protein strands (gelation)

Gel strength is strongly influenced by the molecular weight of the protein molecules, but is also determined by the polymer's chemical composition (which varies with the collagen source and is also influenced during manufacture), and its concentration in solution and temperature, which affects the renaturation level (Kozlov and Burdygina, 1983, Horman and Schlebusch 1971). Long protein chains, high solution concentrations and slow gelation at low temperatures promote the development of collagen-like helical formations and highly ordered network structures that produce high gel strength (Hickman *et al*, 2000, Hull and Bangert, 1952). Mammalian gelatine produces higher gel strengths than that of marine species.

### ***Molecular weight***

The molecular weight of the protein chains is one of the most important properties of gelatin-based glue as it influences many of its adhesive properties. Generally, the more vigorous the extraction process of the glue during manufacture (i.e. the more extreme the pH during pre-treatment, the longer the treatment and the higher the temperature at extraction), the more the long protein chains are broken down, which leads to increasingly lower molecular weights (Hickman *et al*, 2000). Mild extraction at moderate pH and low temperatures yields gelatin-based glues with long chain lengths and high molecular weight (MW) (Hull and Bangert, 1952, Haupt, 2004). As a general rule, gentle processing is appropriate for the hides of young mammals, fish skin and swim bladders because they are rich in collagen content and less stabilised by additional chemical bonds that develop in collagen with ageing. Preparation of animal glues prior to their use by conservators should also follow mild procedures (Luybavskaya, 1990, Haupt, 2004). Ideally, gelatin-based glue solutions should always be prepared fresh and not be kept heated for longer periods, as the glues will gradually degrade and lose their adhesive properties. It is generally recommended to prepare glue solutions at around 60°C, but it should be noted that heating at elevated temperatures (e.g. 80-90°C) can take place without much loss of gelling power if such temperatures are limited to a few minutes only (Haupt, 2004).

Animal glues can be characterised by their average molecular weight to roughly indicate the physical and mechanical properties of the adhesive such as gel strength, viscosity, penetration ability, speed of set and final bond strength. For example, high average MW adhesives are usually expected to have higher gel strength, be more viscous, penetrate less, gel more rapidly and produce stronger bonds. A more common way of characterising gelatinous glues, however, is by giving their gel strength, which reflects their properties in use.

### ***Influence of gel strength on physical and mechanical properties***

The cohesive strength of a gelatine-based glue is determined by its molecular structure and intermolecular bonding, as expressed in Bloom values. To produce strong animal glue films with great stiffness and a high

resistance to impact in the dried state, the same rules apply as obtaining high gel strength, i.e. long protein molecules / minimum degradation, high content of renatured collagen-like triple-helices, and high intra-/ intermolecular bonding. Hide glues generally have greater cohesive strength than strongly denatured and degraded bone glues, which display lower tensile strength and are much more brittle. Mammalian collagen tends to yield stronger glues than most aquatic sources, owing to reduced contents of stabilising inter- and intramolecular bonds in fish collagen (Hormann and Schlebusch, 1971). Cold water fish gelatin in particular shows comparatively low tensile strength which is comparable with that of bovine bone gelatine, while a high tensile strength, similar to that of hide glue, has been reported for mildly prepared sturgeon isinglass (Luybavskaya, 1990, Simon et al, 2003, Zumbuhl, 2003).

#### ***Stability with ageing and resolubility***

Dry conditions cause gelatine-based glues to dry out, shrink and embrittle, due to the development of high inner stress and tensile forces within the glue matrix. In conditions of changing relative humidity (RH,) low gel strength glue will deteriorate rapidly in their mechanical properties, while high gel strength glues retain their mechanical properties much better. The reason for this is because at high RH levels a continuous re-naturation of the protein molecules is taking place which increases the stress in the glue matrix upon drying. Due to their more elastic molecular structure, highly renatured glues can compensate inner stresses much more successfully than low gel strength glues.

Of all animal glues, sturgeon isinglass best retains its mechanical properties with ageing, closely followed by mammalian gelatine, as it remains much tougher and more elastic as well as showing less dimensional changes than any other gelatine-based glues (Michel *et al*, 2002).

Generally, animal glue readily swells in water and shows good resolubility even after centuries, unless it has developed strong internal cross-linking of the protein molecules. This happens when the glue is either deliberately treated or accidentally exposed to metal salts, formaldehyde or other tanning agents. Particularly, ready-made liquid hide and fish glues may contain unknown additives that promote cross-linking which will render the glues increasingly insoluble.

#### **Considerations for the use of animal glues in taxidermy conservation**

When it comes to choosing an appropriate adhesive for the conservation of taxidermy specimen, certain requirements are of particular interest. The adhesive should :

- have appropriate adhesion and cohesion properties
- minimally interfere with the original skin material
- be reversible or at least render the specimen retreatable
- be stable with ageing

#### ***Adhesion and cohesion properties***

Considering that gelatinous glues are a chemical derivative of collagen, they can generally be considered a suitable type of adhesive for skins and other collagen-based products, as they are able to develop good chemical adhesion to the substrate. Gelatin-based glues containing long protein chains (i.e. having high gel strength such as hide glue or isinglass) also show very strong cohesion and would thus be an appropriate choice.

#### ***Interference with original skin material***

Sensitivity to moisture:

Animal glues are very sensitive to changes in relative humidity, as are taxidermy specimen, and they will subsequently react with dimensional changes. This, however, may not be desirable for the conservation of taxidermy specimen, and it may be considered more appropriate to opt for an adhesive that is less sensitive to moisture. As gelatin-based glues are applied in an aqueous solution, the water sensitivity of the specimen has to be considered, too. Low viscosity glue solutions and those which gel slowly (such as isinglass) are problematic in cases where the substrate is very water sensitive. Fast-gelling glue solutions (those with a high gelling temperature) would be a more suitable choice in such cases, or even the use of a non-aqueous adhesive.

Denaturation temperature ( $T_d$ ) of specimen:

The collagen material in some taxidermy specimen may have a very low denaturation temperature, e.g. fish and reptile skins or strongly degraded skins of other animals. Using hot hide or bone glue on such a speci-

men would risk the denaturation of its collagen, while cold-liquid fish glue or isinglass could be applied with much less risk of damaging the specimen.

#### Colour:

For light coloured or semi-transparent specimen only high gel strength gelatin or isinglass should be considered, as all other animal glues have a yellow to brown colour and low gel strength gelatin has the tendency to yellow with age.

#### ***Reversibility and stability with age***

The original preparation treatment of the taxidermy specimen may have an influence and long-term effect on a gelatin-based glue that is applied to it. If the specimen had been prepared using metal salts or other tanning agents, which still remain in the substrate, these can react with the gelatin and cause it to develop strong chemical crosslinking that will render the glue increasingly insoluble in water.

#### **Conclusion**

Gelatin-based glues may under certain circumstances be a suitable type of adhesive for the conservation of taxidermy specimen. In many cases, however, their application in an aqueous solution as well as their great sensitivity to moisture with stress development in fluctuating environmental conditions may cause an array of unwanted interactions with the specimen. Last but not least, their chemical affinity to skin material and their potential to contaminate the original DNA of the taxidermy specimen has to be acknowledged so that the use of gelatin-based glue should thus always be weighed up against the advantages of alternative synthetic adhesives.

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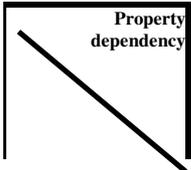
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#### Notes

<sup>1</sup> This article is based on a presentation given at the NatSCA Seminar on Adhesives for Natural Science Specimen held at the NHM on 18. 11.2008. The paragraphs about the chemical, physical and mechanical properties of animal glues are an abbreviated summary of the article 'Animal glues: a review of their key properties relevant to conservation' originally published by N. Schellmann in *Reviews in Conservation* **8** (2007), pp.55-66.

**Appendix 1.**

Table of animal glues and their properties.

PROPERTY	molecular weight (MW)	gel / Bloom strength [gB]	viscosity	mechanical strength	elasticity	stress development in fluctuating RH	stability in fluctuating environment
Property dependency 	decreases with rigorous pretreatment and with excessive / prolonged heating	increases with higher MW and increasing content of helical structures	increases with increasing Bloom strength	increases with increasing content of helical structures	increases with increasing molecular weight, helicity and solution concentration	increases with increasing content of helical structures	increases with increasing content of helical structures
<b>GLUE TYPES</b>							
<b>bone glue</b>	low to medium	low to medium	low to medium	low to medium	more elastic than hide glue (but more brittle, too)	medium	less stable than hide / rabbit skin glue
<b>hide glue</b>	high	high	medium to very high	medium to high	less elastic (stiffer) than bone glue, and gelatin from aquatic sources	high	more stable than bone glue
<b>rabbit skin glue</b>	high	high	high to very high	high	more elastic than hide glue	high	less sensitive to moisture than hide glue
<b>mammalian gelatin</b>	medium to high (pure gelatin is produced with different average molecular weight)	high	medium to high	medium to high	less elastic (stiffer) than gelatin from aquatic sources	medium to high	less stable than isinglass
<b>isinglass</b> (from fish swim bladders)	high to highest	medium to high	very high to highest	high	more elastic than hide glue	very high	higher than mammalian gelatin
<b>liquid fish glue</b>	low	-	high (at manufactured concentration)	medium	more elastic than hide glue (but more brittle, too)	medium	less stable than cold liquid hide glue

## **Gap fills for geological specimens – or making gap fills with Paraloid**

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Andrews, K. 2009. Gap fills for Geological specimens—or making gap fills with Paraloid. *NatSCA News*. Issue 16. pp. 43 - 47.

### **What is a gap fill?**

A gap fill is a material used to fill a gap where a piece is missing either to provide structural support or to make the specimen look better. Some gap filling materials can also be used as an adhesive to effect the actual repair too.

Gap filling materials can also be used to mount specimens and fix them onto backing boards for display.

### **Review of materials used for gap fills**

Many different materials have been used in the past as gap fills with similar materials being used across disciplines. A gap fill needs to be malleable in order to shape it to fill the gap but once shaped, to set sufficiently to complete the integrity of the object. Gap fills are used on all types of materials from paper documents to palaeontological specimens. An appropriate gap filling material should be weaker than the material being filled, so the fill, rather than the specimen breaks if there is any strain.

In the 1980s there was a view that the restoration achieved through gap fills should be obvious and so such repairs were not re-touched and were often painted in a contrasting bright colour, such as yellow on dinosaur bones or filled in with closely spaced vertical lines or *tratteggio*. *Tratteggio* was developed as a technique for gap fills on paintings and wall paintings, such as those in Egyptian tombs.

Other authors have covered areas of this topic, for example, Howie(1984) reviewed materials used for geological conservation since the 1930s. Larkin and Macridou (1999) compared the effectiveness of gap fills for sub-fossil bone. This paper is intended to provide an overview of both historic and current practice for gap fills in all types of geological material.

### **19<sup>th</sup> and early 20<sup>th</sup> century products**

**Plaster of Paris** – white or cream colour plaster made of ground gypsum (calcium sulphate) – it is made up by mixing the powder with water. Generally, the thinner the mix, the quicker the set. The setting reaction is exothermic and shrinkage can occur.

Plaster of Paris is often used to mount marine reptiles (encased in wooden frames and boxes) and to provide a join between blocks – however is was usually only to provide a flat surface layer with the areas beneath packed out with all manner of materials.

Rixon (1976) described the method to cast specimens into plaster of paris blocks but points out that weight will be a serious problem for larger specimens. Conservators at the Natural History Museum (NHM) reported the use of wood, string, hemp, cotton, horsehair, scrunpled newspaper, iron nails, sand, pebbles, wax and even sulphur as packing out in the large number of mounted marine reptile specimens conserved in the Gallery 30 project (Cornish, Doyle and Swannel, 1995). Straw, tiles, brick fragments and fragments of stone have also been reported by NHM conservators and other conservators (Doyle, 2008).

The water in the plaster mix however raised the relative humidity and can induce pyrite decay in specimens. The resultant expansion from both the exothermic reaction of the plaster setting and the subsequent pyrite decay can cause the gap fills to fail.

Plaster of Paris was also commonly used to “stick” specimens to back boards in displays – an early 20<sup>th</sup> century technique. With large flat backed blobs often obscuring data labels.

**Other types of plaster** – all manner of plasters tend to be encountered, some blueish grey and very coarse,

others more akin to lime plaster. Modern Portland cement based plaster however is not common on specimens.

Cornish, Doyle and Swannel (1995) reported finding asbestos fibres mixed in plaster gap fills on some of the marine reptiles during the work on the gallery 30 wall mounted specimens at the Natural History Museum. This technique appears to have been developed in the 1970s but was not documented.

**Wax** – often used on nineteenth century marine reptile mounts to fill small gaps, such as joins between pieces of matrix and gaps in ribs where a small chip might be missing. Some types of wax are surprisingly hard but very brittle, sometimes the characteristic smell can be used to identify it as beeswax. Using a warmed metal tool or a hair dryer is the most effective way to softening wax. Presumably originally it was applied in a malleable warm state and coloured before application, since the wax is normally the same colour all the way through.

Petroleum wax and coloured furniture conservation wax was used successfully as a gap fill on decorative Blue John artefacts, including an obelisk and a goblet conserved for Birmingham Museum and Art Gallery. No other material had the same translucent quality and the coloured wax, mixed in with the colourless wax proved to be a good match for the deep purple blue fluorite.

**Red letter sealing wax** – this wax, applied in a hot molten state is not the most effective gap fill since it is so obvious and detracts from the aesthetic appearance. It has been encountered on a few rather amateurish repairs on 19<sup>th</sup> century geological specimens, without any attempt to disguise it with paint. Sealing wax is occasionally found as a repair medium on ceramics, it tends to be rather brittle but was probably water-proof unlike most nineteenth century adhesives, so allowing a cracked container to continue to be used rather than thrown away.

**Lead** – seen on a specimen at Haslemere Museum to hold a metal staple in place on a Giant Irish Elk skull – the same technique was used to hold cast iron railings in place in stone.

**Glaziers putty** – a mix of linseed oil and dry plaster of paris. Quite commonly found used as a gap fill and adhesive on sub-fossil elephant teeth in particular. Becomes dry and brittle and loses adhesion leading to failure.

**Taxidermists “compo”** – a pale coloured plastic material that sets hard and is a mix of plaster of paris, paper mache and animal glue used to model soft parts on taxidermy mounts. Not something knowingly encountered on geological specimens but since it is similar in consistency to glaziers putty, it may well have been used and not yet identified.

### Mid 20<sup>th</sup> century products

**Fibronyl or AJK dough** – a dough used by mixing Alvar (a polyvinyl alcohol), kaolin and jute flock and sepiolite clay together produces a brown fibrous, fairly light weight, strong but drying to quite a shiny material. It is malleable when first made and remains so if stored in a sealed container. It can be used as a gap fill and painted. Rixon (1976) advocates the use of this material for gap filling both freshly collected damp material such as sub-fossil tusks and on dry material. Even as late as 1995, staff at the NHM were using the last of their stocks of Alvar to make AJK dough as a gap fill on Gallery 30 specimens (Cornish, Doyle and Swannel, 1995). AJK dough does shrink when dry.

This dough was also used extensively in the late 60s and 1970s as a mount method for geological specimens – a large blob placed on the reverse and shaped to allow the specimen to hang as required, often a brass key-hole surround pushed into the dough to allow the specimen to hang from a nail on the display back board.

**Polyfilla** – Polyfilla, a plaster of paris and cellulose based product has been used as a gap fill for wall paintings conservation and ceramics. It can be mixed with water from a powder or bought in a ready-mixed form. It is apparently stable and effective, it can be smoothed with damp tools before it is fully set and can be sanded and painted. It is not an effective adhesive and when filling large areas such as a missing piece in a ceramic vessel, needs to be supported, for example with netting.

**Polyurethane foam** – Rixon (1976), suggested that polyurethane foam might be a suitable “modern” replacement material. Given the toxicity of the components of this material when being mixed and its extreme instability in light, polyurethane foam is in fact a far from suitable material. It was used to support the cradle for the plesiosaur specimen re-mounted in the 1980s at the Sedgwick Museum in Cambridge by Simon Timberlake.

**Milliput** – Milliput is a two part epoxy putty available in standard and superfine grades. Equal lengths of the two parts are cut and kneaded together, it has the consistency of rather sticky plasticine which can be shaped with damp tools before setting to a very hard material which can be sanded and painted. The superfine grade was often used in porcelain restoration.

The two parts do tend to go off if unused and a far more easy to work material epoxy based material is now available.

Buttler (1994) used milliput successfully to model the missing section of a tusk of the Barrington hippopotamus. Since epoxy resin based products are hard to break down, a barrier layer of a reversible adhesive should be used to separate sections modelled from Milliput from the original matrix.

**Resin and rock-dust fills**

An effective gap fill can be made by mixing ground rock with any resin or adhesive. Epoxy resin and rock dust fills are widely used on “enhanced” specimens to disguise joins between the matrix and an added specimen or section. Due to the nature of epoxy resins, these are not reversible and so are not usually used by conservators.

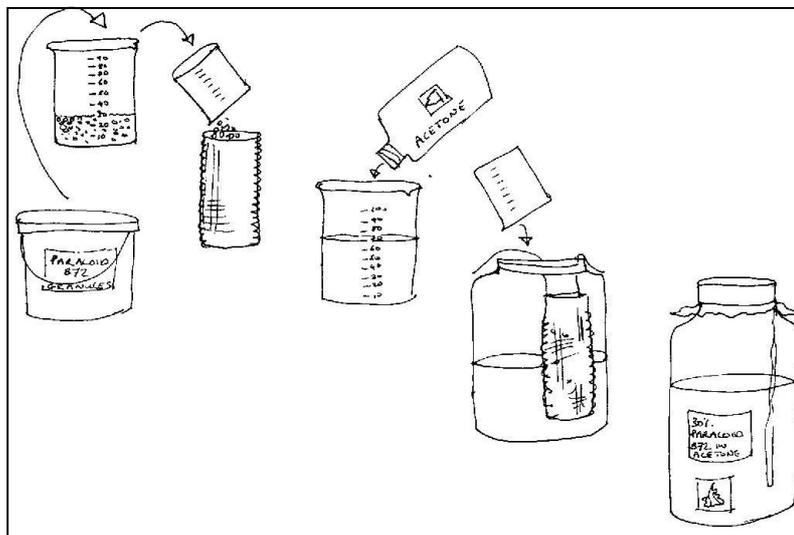
**Paraloid based gap-fills**

Paraloid B72 has been a favoured conservation adhesive and consolidant since the 1980s due to its good ageing properties – it does not cross-link, it is supposed not to yellow and it remains easily reversible, however, it does have a high glass transition temperature.

Glass transition temperature is the temperature at which a polymer changes from a glassy state to a rubbery state. Polymers with low glass transition temperatures can become sticky and attract dust or cold flow even at moderately low temperatures, polymers with high glass transition temperatures will be brittle. (Horie, 1987)

A gap fill can be made by mixing a solution of Paraloid B72 in a suitable solvent with any kind of filler, from Plaster of Paris, marble dust to specially manufactured fillers.

To make up a solution of Paraloid, the beads of adhesive museum be dissolved in a solvent (Fig 1). This is most easily achieved since simply adding solvent to the beads lead to the beads softening and forming a solid layer in the bottom of the container with a layer of acetone lying above.



**Fig 1.** Diagram illustrating how to mix up paraloid B72 beads with acetone.

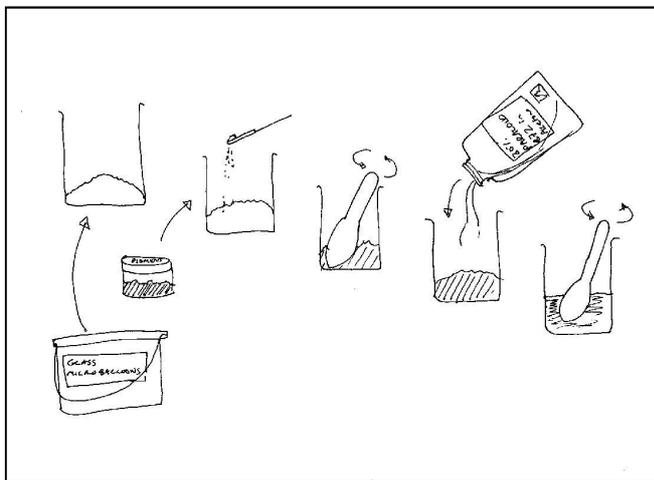
**Glass bubble and Paraloid gap fills**

SP systems glass bubbles (also known as microspheres or microballoons) make an effective filler mixed normally with a 30% Paraloid in acetone to the consistency of butter cream icing in a flexible polythene container. It is most effective to measure out the quantity of fill required, add the consolidant then mix up to the required consistency. Approximately 30% consolidant to 70% filler is suggested by the manufacturer. It can be applied as a thick slurry, or allowed to dry out a little and applied as more of a paste.

Fig 2. shows the process for mixing and colouring.

The filler will set hard in the container but can be cracked off the sides of flexible containers and then re-mobilised with additional acetone or Paraloid in acetone. In situ, the fill dries to a hard and rather brittle finish, which is not that strong but is easily reversible by dropping acetone onto the fill from a pipette.

The filler can be packed and smoothed with either metal or nylon tools. As the acetone evaporates, the mix becomes slightly elastic before it sets and it is at this stage that it is best to compress and smooth it to the desired finish with tools dipped in acetone. Since it doesn't sand down that well, it is best to get a smooth finish with a tool before it sets hard, alternatively, it can be smoothed once set with acetone swabs. Buttler (1994) suggests building up areas requiring deep fills in thin layers and used this technique extensively on a sub-fossil hippopotamus skeleton.



**Fig 2.** Diagram illustrating the process for mixing and colouring.

The filler can be effectively coloured with artists pigments in its dry state before adding the consolidant - earth pigments and ivory black will make most colours needed for palaeontological specimens. Colouring the filler before application requires only tiny amounts of pigment and is far quicker than painting afterwards. The fills can also be painted once dry with acrylic medium mixed with dry pigment or acrylic paints.

It is best to consolidate the join surfaces before applying a gap fill with dilute Paraloid B72 (5 to 10% in acetone). This is particularly important on sub-fossil bone, otherwise the adhesive property of the fill will pull material away from the matrix.

Using a thick paste of filler mix on breaks works very well for dry sub-fossil elephant teeth that have broken into several slabs as once consolidated, this consistency will act as both adhesive and gap fill. Such specimens should be left to set in a sand tray or on sand bags with each joint horizontal, and with careful setting, more than one break can be fixed at once. Some compression from masking tape can be effective but not at the risk of pulling further crumbs off the tooth surface. A sprinkling of yellow ochre into the filler mix is a good colour match for the dentine element which tends to be what fails on such specimens.

Paraloid and glass bubble fill was used extensively on the wall mounted marine reptiles at Whitby Museum conserved from 1994 to 1997 and was still stable and undamaged when inspected whilst treating a later outbreak of pyrite decay in 2007 (Andrew, 1999). This filler has also been used on subfossil elephant teeth (including one in the re-displayed Kelvingrove geology gallery), sub-fossil bone and other smaller teeth (eg woolly rhino) as a packing material around dowells for the tines of Giant Irish Elk antlers for the specimen at Kendal Museum, as gap fills in joins of fully fossilised material and as gap fills and to fill cracks between plaster and original mounts on marine reptile material.

Since creating localised high relative humidity is not advisable for many types of geological specimens, water based consolidation is not normally appropriate to museum specimens and therefore, I've not tried mixing glass micro bubbles with water based consolidants or dispersions.

**Other types of glass bead fills**

Larger sizes of glass spheres and beads are also available and can be used to create gap fills where greater

structural strength is required, but these products are considerably more dense than the glass bubbles. It is also possible to use glass airbrasive powder and Paraloid B72 in slurry form to fill in large areas around specimens, in the same way that plaster of paris was used historically to set specimens into wooden frames or boxes. Glass airbrasive powder is quite dense, so the resultant block will be heavy. .

### Health and safety

Consult the material data sheets prior to use and put together an appropriate risk assessment for the procedure and use (COSHH regulations in the UK).

Although not classed as hazardous to health, eye and face protection are recommended for handling glass bubbles at close quarters because of the small particle size. The concentration of acetone in the Paraloid mix will require the user to adopt appropriate protection from inhalation or use with extraction.

### A note on replacement sections

Geological specimens are rarely complete, so replacement parts are common on specimens, either composed of pieces from other specimens or made from some other material and added. Most of the materials listed above can be used to model replacement parts. Where large sections are missing (for example on mounted skeletons), replacement parts made of wood, cork or cut down pieces of modern bone, or carved pieces of matrix are common. The practice of improving the aesthetic appearance of specimens has been commonplace from when geological specimens began to have monetary value, and is still ongoing. The distinction between aesthetics and forgery is a fine one.

### Acknowledgements

The author would like to thank Nigel Larkin and Caroline Buttler for their comments at the reviewing stage of this paper.

### UK Suppliers

Acetone – conservation suppliers and chemical supply companies

Paraloid B72 granules – conservation suppliers such as Conservation Resources and Conservation by Design

Milliput – DIY, car repair and modelling shops

SP Systems glass bubbles – Conservation by Design sell three grades 0.34-0.4 particle size is recommended for fills.

[www.conservation-by-design.co.uk](http://www.conservation-by-design.co.uk)

Artists dry pigments – Cornellisen & Son sell 15ml pots for £2 or £3 each (depending on the type of pigment) and a starter kit of all their pigments for £72.90 including P&P. [www.cornellisen.co.uk](http://www.cornellisen.co.uk)

Sculpting tools – Tiranti Ltd sell a big range of tools [www.tiranti.co.uk](http://www.tiranti.co.uk)

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## **Insect Pest Control using low temperatures (not deep freezing)**

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### **Introduction**

In some areas of Canada, it used to be the farmers' practice to open the doors of the grain storage barns in winter and let the freezing cold air blow through. The result was that insect pests were killed, but the grain still remained viable to be planted and to grow the following season. This is the basis of using very low temperatures for insect pest control in museums. Conversely, we know that many insects happily survive very cold winters to emerge in the subsequent spring to live and breed. This phenomenon goes some way to explain why some museum low temperature treatments fail.

Low temperature insecticidal treatments on museum objects, should achieve 100% mortality on all insect stages – eggs, larvae, pupae and adults, without damage to the affected objects.

### **Low temperatures and insects**

Insects can adapt to lowering temperatures in a number of ways. They can find warmer niches deep inside materials such as in wood, where the very low temperatures do not penetrate; they can form anti-freeze chemicals that stop their body fluids from freezing; and in some circumstances some insects can survive some freezing of body tissues.

In almost all known circumstances, avoidance of low temperature problems involves a slow adaptation as the weather cools towards winter. As the weather cools, insects tolerant to cold, adapt by developing anti-freeze chemicals such as glycerol in their systems and slowing down their metabolism to a 'tick over' minimum state.

Insects are killed by low temperatures when the rate of cooling and the degree of cooling does not allow the self-defence mechanisms to develop. Therefore, fast cooling and low temperatures will have a greater tendency to kill all stages than slow cooling.

### **Low temperatures and objects**

Organic materials that may be vulnerable to insect and other biological attack can contain moisture of two different types. 'Free' or liquid water, and bound water where the molecules are securely 'bound' to the material. 'Free' water is found in living material and in freshly killed or felled materials in normal conditions, this liquid water will dry out (as in seasoning of timber) until the material is dry. Further drying will occur with the loss of the bound water until an equilibrium is reached with the relative humidity (RH) of the surrounding air. Changes in RH causes organic materials to absorb or lose 'bound' moisture and correspondingly to expand or contract, often damagingly.

Low temperatures can damage objects in a number of ways, including:

- At low temperatures (well below 0°C), free water can freeze, and the ice crystals formed can damage the material (as anyone who has tried to deep freeze soft fruit will know). Bound water does not freeze until very low temperatures and so ice formation is not a problem unless the object is damp for some reason.
- Many organic materials have a glass transition temperature, below which they lose suppleness and flexibility and become rigid, brittle materials. When this is combined with contraction due to the lowering of the temperature, fractures may occur. Thick paint layers (impasto) have been known to crack when cooled from 25°C to -30°C. Similarly, brittle materials such as ivory, could also be damaged.
- Condensation on the object on cooling or in the subsequent warming-up process can cause water related damage such as staining, dye migration and corrosion of metals. To prevent this, objects should be wrapped and sealed in plastic sheeting, and as much air removed as feasible.

Absorbent material such as tissue paper, cotton fabric and conditioned silica gel can be added to preferentially absorb any high RH's and condensed water.

### **Recommendations**

The recommended procedure for using low temperatures to kill insect pests is as follows:

(This summary is a general guide for freezing objects such as textiles, paper and wood. Where there is concern about the fragility of an object, advice should be sought from a conservator about the suitability of freezing. Another method, such as anoxia may be more appropriate.)

Freezer temperatures and exposures needed;

- -18°C to -20°C. Objects can be treated with 10 to 14 days exposure. This is the temperature of a standard domestic type deep freeze.
- -30°C. Objects need 3 days exposure.

It can take at least 24 hours for the centre of dense objects, such as rolled textiles, to reach the target temperature. It is advisable to place a temperature sensor in the centre of very dense objects to ensure that target temperatures have been reached.

### **Procedure**

- Objects should be wrapped in acid-free tissue.
- As a precaution, wrap any metal components in additional acid-free tissue.
- They should then be wrapped in plastic sheeting. If possible, avoid including a large amount of air in the bag.
- Large voids, such as between chair legs etc., should be filled with buffering material such as crumpled paper or cloth.
- If the object is fragile or an awkward shape, then it can be placed in a tray or an archive box which can then be wrapped in plastic sheeting.
- Seal the bag with tape, or a tie, and label it with the object's description, date and name of person responsible for the object.
- Place the object carefully in the freezer.
- Do not pack objects too tightly and ensure there is an air space around the sides of the freezer. Baskets can be used if they are supplied.
- Place a wood or foam spacer on the floor of the freezer before loading to ensure that there is an air space under objects to allow the cold air to circulate.
- Expose objects for the appropriate time.
- Remove objects carefully, many materials will be very brittle at low temperatures.
- Place objects on racking or on the floor, and allow them to recover to room temperature for a least 24 hours before they are unwrapped.
- Very dense objects should be left for at least 48 hours.

- Objects may be left wrapped for some weeks if there is a risk of them becoming re-infested.
- After recovery and unwrapping, the objects should be cleaned to remove dead insects and signs of infestation such as frass and webbing.
- The treatment of each object should then be documented.

**IMPORTANT NOTE:**

- If a -30°C freezer is used, then staff must use freezer gloves and avoid contact with surfaces to prevent freezer burn.
- If freezers are running continuously, objects can be placed immediately. If they are switched on for each treatment, they should be operating for 24 hours before objects are introduced.
- Auto-defrost freezers should not be used.

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## **Thoughts on the exploitation of geoscience collections**

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### **Introduction**

This article is related to a conference that I attended back in May called 'Exploiting Geoscience Collections'. The conference was organised as a joint effort between the Geoscience Information Group (GIG) and the Geological Curators Group (GCG) – of which I am a member – and was held in the Geological Society of London's (GSL) apartments. The conference lasted for two days and was well attended, with delegates travelling from all over the UK and as far a field as Canada and Russia.

When I first heard the title of this conference, I found the notion of 'exploitation' quite uncomfortable; words like exploitation are rarely heard in the museum sector. Why don't we exploit our collections? Why do we prefer to think of the collections being used? Should we exploit our collections? Like 'exploitation', the use of the term 'geoscience' also seemed somewhat puzzling; whatever happened to geology? Geoscience is also a word that is rarely used in the museum sector (at least in the UK), and seems more appropriately suited to an academic department than a museum storeroom. I will return to these issues later in the discussion section, but before I continue, it may be useful to clarify what is meant by 'geoscience collection'.

The Geological Society defines geoscience as: "...all the sciences (geology, geophysics, geochemistry) that study the structure, evolution and dynamics of the planet Earth and its natural mineral and energy resources" (The Geological Society 1999a). Geoscience collections are therefore all of the records, samples and digital data that are generated by these sciences. As the overwhelming scope of this definition would suggest, the papers presented at the conference covered a vast range of themes, of which I will only be mentioning a few. This is therefore not a comprehensive conference review, rather, my thoughts on themes arising from the conference. If, however, you would like more information about the rest of the conference, I strongly recommend either the conference website, the book of abstracts or reviews of the conference for the Geological Curators Group (Haycock, 2008) and The Palaeontological Association (McGowan, 2008).

The papers that I will be discussing are: How do we value geological collections? (Professor Richard Fortey - Keynote); The contribution of serendipity to the exploitation of geoscience collections (Dr Mike Howe); Managing collections for exploitation (Jeremy Giles); Old samples – New questions (Angela Ehling); and Collections management at the geological survey of Canada (Jean Dougherty). The first three papers address some of the more general issues arising from the exploitation of geoscience collections, whereas the final two papers focus on the practicalities. I will finish by mentioning some of the issues arising from the discussion that was held at the end of the first day, and this will also allow me to return to some of the issues raised by these papers.

### **Values**

Richard Fortey – president of the Geological Society of London - opened the conference with a candid description of the GSL's own collections (or lack thereof); despite being "the UK national society for geoscience, and the oldest geological society in the world" (The Geological Society 1999b), only 'odd bits' of the society's geological collections remain in Burlington House. Considering the fact that the society was transferring its collections to the BM(NH) as early as 1911, it would seem that - as far as 'deaccessioning' is concerned - the GSL was somewhat ahead of its time.

According to Fortey, the GSL's remaining collections have suffered from loss and neglect, and therefore, it would seem that for the GSL, the decision to transfer its collections was a smart one. Fortey went on to explain that the GSL is now concentrating on collections of a different kind with the Lyell Collection; an online collection of earth science literature containing the vast majority of the book and journal content published by the society over the last 200 years (The Geological Society 1999c). I will discuss this shift in focus, from specimens to data, in more detail in the discussion section, however, for now I will return to the matter of value – the theme of Fortey's paper.

Having spent over three decades working in London's Natural History Museum, Richard Fortey is well qualified to address the question of how we value geological collections. Placing particular emphasis on palaeontological material, Fortey highlighted some of the more 'special' features of geological collections, citing - amongst other things - a robustness that makes much material relatively immune to degradation (both natural and human-induced) over time. While geological material may have a head start in this sense, it is precisely because of this persistence that geological collections can be seen as a nuisance, thus the notion of permanence is the very feature that makes them vulnerable.

Often situated on prime real estate and taking up valuable storage space, these collections - sometimes remaining untouched since being accessioned - may contain hidden gems, unknown type specimens, historically important material, and who knows what else. Fortey's point is that the value of many geological collections is largely unknown and that in order to rectify this problem, specialist expertise are essential. As he noted, however, the subject specialist is a dying breed, and unless fundamental changes are made to the ways in which research is funded, their extinction seems immanent. For Fortey, this lack of expertise is at the heart of the problem; without the subject specialist, the value of our collections will remain unknown, and as he went on to explain, this lack of knowledge can seriously threaten survival of collections for future generations.

Fortey made his opposition to disposal (i.e. deaccessioning, downsizing, rationalising, streamlining or basically discarding of geological collections) quite clear, suggesting that the only real grounds for disposal were cases where: material is unlocalised, unlabelled, poorly preserved or commonly duplicated; disposal has been sanctioned by the original collector - i.e. due to the existence of duplicates or material of better quality; or material can be returned to those with a legitimate claim of title and where certain standards of curation can be guaranteed.

According to Fortey; "Disposal implies that the disposer is a scholar with a depth of knowledge (a) to recognise what is important from old collections (b) to anticipate the way science may move in the future" (Fortey, 2008). Fortey's concern for the lack of subject specialists is a genuine issue when it comes to the matter of disposal; the untrained eye may fail to recognise the distinction between material with unknown value and material with no value. Furthermore, it is doubtful whether even a specialist scholar can be expected to predict future directions of science, especially if - as Fortey suggests - the value of a collection is ultimately culturally justified.

So how do we overcome these very pressing issues? For Fortey, "the adage 'never throw anything away' is still a wise precaution" (Fortey, 2008). Fortey concluded his paper by reminding us that collections are more important than the scientists in charge of them. I believe that this little piece of wisdom is worth bearing in mind as we tackle these difficult questions of value and disposal.

### **Serendipity**

Mike Howe of the British Geological Survey (BGS) began his paper with a classic cautionary tale; the story of specimen number GSE13821 - otherwise known as the conodont animal. Despite the importance of conodonts to fields such as biostratigraphy and petroleum exploration, the origin of these tooth-like microfossils has perplexed palaeontologists ever since their initial description (Pander 1856) over 150 years ago. Thus the elusive creature became the source of endless debate and speculation amongst palaeontologists, retaining its status as an enigma for over a century. The mystery of the conodont animal was finally solved in 1982 by a palaeontologist named Clarkson who spotted the elongated-worm-shaped smudge (Briggs et al. 1983: p3) on a specimen belonging to the Institute of Geological Sciences (IGS) in Edinburgh (now the BGS).

The discovery of the illusive Conodont animal in a specimen that had been sat in a drawer for over half a century is often told as a classic tale of serendipity, and as Howe explained; "many key discoveries in the geosciences have depended on serendipity. There are numerous examples in palaeontology, many of these relating to the chance recognition of the true importance of historical specimens in collections" (Howe 2008: p10). This idea of recognising the 'true importance' of historical specimens is an interesting one, and one that requires further thought.

In the case of the conodont animal, the specimen is believed to have been collected during the 1920s by Mr David Tait (Briggs et al. 1983: p2) - "one of the [geological] survey's skilled fossil collectors" (Stubblefield 1965: p4) - from a site along the Granton-Muirhouse shore (near Edinburgh). Today, the site is no longer

accessible due to much of the site having been paved over, and the removal of "...the most fossiliferous sections of the Granton 'shrimp bed' ...to protect fossils of the conodont animal after the theft of several square metres of the bed in 1984 by a commercial collector" (Gordon et al. 2002: p218). The IGS retained the specimen because it had a particular value prior to Clarkson's visit in 1982 and prior to the loss of much of the remaining material from the site in 1984; this value relates to the original context in which it was collected.

To suggest that Clarkson recognised the 'true importance' of the specimen implies that importance is a fixed quality, and therefore, that specimen number GSE13821 is now simply the 'specimen that contains the first evidence of the conodont animal'. This is to ignore the other qualities that the specimen has had and may have in the future: the specimen still retains its historical association with Tait; its geographical association with Granton shore; its stratigraphic association with the 'shrimp band'; its faunal association with the shrimp *Waterstonella* (Briggs and Clarkson, 1987: p104); the list could go on and on. So for the conodont animal, it wasn't so much the 'chance recognition of the true importance' of the specimen, rather, the chance discovery of an additional value.

As Howe pointed out, the last 25 years have seen collections based research operating in an increasingly strategic, managed and standardized world, suggesting that the best way to increase the odds of serendipity (and therefore the potential value of material) is to increase access to both the samples and the data contained in our geoscience collections, and this is particularly important for our historical collections; "Numerous similar discoveries have been made, including early tetrapods and birds. All of these relate to material from localities that are now inaccessible or specimens that are extremely rare, so that geoscience collections provide the only realistic access" (Howe, 2008: p11).

While this discovery relied on the existence of an historical specimen and clearly demonstrates the potential value of existing collections, this serendipitous tale should not be mistaken for a reason never to throw anything away 'just in case': "Serendipity is a bonus to the perceptive, prepared scientist, not a substitute for hard work" (Abelson, 1963).

### **Exploitation**

The paper presented by Jeremy Giles (also of the BGS) titled 'Managing collections for exploitation', provided an insightful introduction to a more commercial approach to geoscience collections. The paper opened by asking what we mean when we talk about collections, a very basic question but one which is useful to revisit, offering the following definition of geoscience collections: "A group of geoscience objects, analogue and/or digital, that are assembled together, along with appropriate contextual data, for a specific purpose" (Giles, 2008a: p1). Of particular interest here is the notion of purpose; at a time when the cost of maintaining and managing collections is high, the purpose of our collections is increasingly called into question.

For Giles, the resources required for the ongoing care and management of our geoscience collections can no longer be explained simply in terms of their scholarly value; "Geoscience collections need to justify their societal value by contributing to the development of products and services that do at least one of the following: create wealth; reduce risk; improve quality of life; or improve quality of the environment" (Giles, 2008b: p5). Many of our geoscience collections serve no contemporary purpose, and this is closely linked to their treatment as a liability.

Giles explained that in order for collections to demonstrate their value they need a purpose, and this will often require reappraisal. Such reappraisal cannot be achieved if geoscience collections are seen and treated as a burden; clearly, a different mentality is required. As Giles explained, it is only through the treatment of geoscience collections as assets that it will be possible to exploit them: "Collections need to be recognised as an organisational asset which can potentially be exploited in the development of products and services" (Giles, 2008a: p17). Giles went on to clarify that; "Once collections are linked to specific income generating products and services, their strong scientific justification is also supported by a robust business case" (Giles, 2008a: p17).

Using the BGS's Borehole Records Collection as an example, Giles outlined the approach taken by the BGS to the management of collections for exploitation. Over 170 years, the BGS has amassed a collection of over 1.2 million paper borehole logs which were originally used to support geological mapping. These paper records were scanned and converted into TIFF format – a task that took 2 years to complete. By digi-

tising the records, BGS has transformed this collection into not only a well-used and valuable resource, but also a source of income.

I must admit that initially, I found much of this talk of exploitation, assets and business cases quite unsettling and rather overwhelming; the BGS collections are different from those contained in most museums in terms of content, volume, purpose and resources; much of what Giles was saying seemed quite irrelevant at first. However, as Giles continued, it became increasingly apparent that there is much to learn from the BGS’s approach to collections management – even if the end product is not the same. A particularly relevant aspect of this approach to collections management is the need to “understand the individual collections, why they were collected and how they can be used, re-used and repurposed” (Giles, 2008a: p17); an obvious part of the process but one which is vital in order to understand any limitations arising from the use of existing collections for new purposes. Linking back to the previous papers, this reinforces the point that keeping material because it may be useful one day does not constitute a purpose or sufficient justification for the ongoing costs of maintaining a collection.

**Against all odds**

So far, the papers that I have mentioned originate from the BGS and the Natural History Museum; institutions that clearly operate on a scale that is beyond that of the vast majority of non-national museums. The last two papers that I want to mention demonstrate that both the exploitation and effective management of geoscience collections can be achieved in less than ideal circumstances, offering a glimmer of hope and a source of inspiration.

Firstly, take Angela Ehling, the sole curator of Germany’s Federal Institute for Geosciences and Resources which comprises over 1.5 million specimens. Building on Giles’ point about the importance of purpose, Ehling’s paper – Old samples New questions – provided a refreshingly positive description of the contemporary relevance and use of historical material (Fig 1 and Fig 2).

The Federal Institute’s collections originate from the Royal Mining Academy’s collections which date back to the 1770s, and also incorporate material from other historical institutions including the Prussian Geological Survey. Like many geoscience collections contained in the Federal Institute of Geoscience and Resources, the vast holdings include many old samples from sites that are no longer accessible or that no longer exist. Faced with questions of the value of keeping such historical material, some of which dates back 150 years, Ehling explained that “New questions appear and some of them can be answered with the help of the old specimens” (Ehling, 2008: p4).



**Fig 1.** A view of the inside of the Federal Institutes Collections. Reproduced with permission from Angela Ehling.



**Fig 2.** A view of the inside of the Federal Institute. Reproduced with permission from Angela Ehling.

Ehling described a number of ways in which historical material is being actively used in ways that bear no relation to their original purpose, including the use of the institute’s sandstone collections as a reference for the analysis and matching of building stones. (For example sandstone samples at the Federal Institute of Geoscience and Resources comprises of less than 0.1% of the institutes collections, but generates 25% of the users). Of particular interest were the examples of unexpected and creative uses of the institute’s collections in fields outside of the geological sciences, and these included: the analysis of 35 cinnabar samples by art historians in order to demonstrate the possibility of provenance analysis on red pigment in paintings (University of Potsdam); the use of 50 copper samples to identify the deposit from which copper contained in the bronze age ‘Sky disc of Nebra’ , a bronze age artefact from the University of Halle (Fig 3); and finally, the contribution of specimens to the removal of war waste through the analysis of 600 laterite samples to allow for differentiation between land mines with low metal content and the naturally lateritic ground.

Ehling clearly demonstrated that historical specimens can still prove valuable sources of data in contemporary research across a variety of disciplines, and that even with just one full time member of staff, it is possible to create a purpose for otherwise redundant specimens.

My second example comes from Canada where Jean Dougherty introduced the Geological Survey of Canada’s (GSC) Collections Project. The project aims to protect collections whilst making them more accessible – a task that may seem fairly unremarkable until you discover the scale of the project. Geographically speaking - with a land area of about 37 times that of the UK - Canada is huge, and as you would expect from such a large country, the range and volume of earth materials in the nation’s collections is vast.

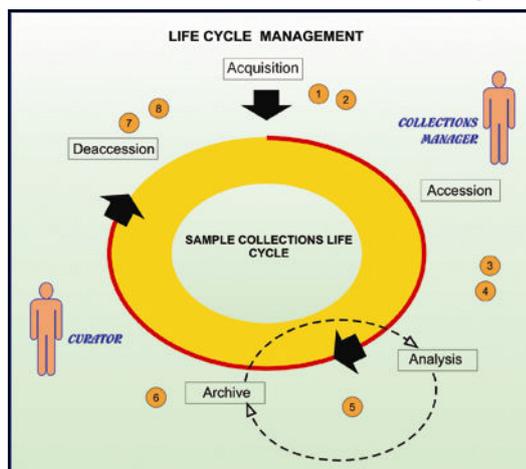
Until 2005, the management of the GSC’s collections lacked coordination and resources; the immense distances separating the regional offices had resulted in them becoming increasingly independent, each with various facilities, staffing levels, systems and methods, all working in isolation. 2005 saw the approval of the Collections Project by the GSC, and work started on devising a standardized and accessible system for the management of the GSC’s samples and data.

The very fact that the GSC approved this project was, for Dougherty, a great achievement, as it showed that the GSC recognised that collections are an information asset requiring ongoing funding and support. Dougherty, however, has faced a mammoth task; the GSC’s immense national collections are contained in just six facilities across the country, each with one member of staff, and with collections containing over fifty types of material; to describe this as a logistical nightmare is perhaps an understatement.

The project has generated a number of ‘tools’ which are based around the concept of collections ‘lifecycles’ (Fig 4). The lifecycle is initially managed using a collections policy which provides principles for handling the samples and data on entering the collection, and subsequent stages of the lifecycle are then managed by guidelines and standard operating procedures. Perhaps the most important tool for the implementation of this national collections management strategy has been a national database - the ‘Sample Management System’ (SMS) - which allows the integration of data from various regionally developed tools into one single system. The SMS has two functions; firstly it enables sample information and data to be tracked, and secondly, it tracks the movement of samples through their lifecycles.



**Fig 3.** Image of the ‘Sky of Nebra.’ Reproduced with permission from Angela Ehling.



**Fig 4.** Image of the Life cycle management of collections. Reproduced with permission from Jean Dougherty

Launched in spring 2007, the first version of SMS has proven a valuable tool for the GSC. As Dougherty explained; “With the launch of the new system, researchers will have efficient access to results, collections managers will have the necessary tools and information to manage their collections, and project managers will have access to timely information to efficiently manage the progress of their projects” (Dougherty 2008: p12). SMS has effectively provided a tool for the creation and maintenance of networks and links for people, samples and data across huge areas, saving both time and money.

### Discussion

The first day of the conference concluded with an interesting discussion about the importance of specimen collections and the treatment of digital collections. The majority of the papers presented at the conference focused on digital collections; this led to the question of whether the emphasis on digital collections meant that analogue collections were becoming redundant. It would appear not; Jeremy Giles summarised the discussion by explaining that “records are abstractions of information from real specimens and any record is just a personal abstraction”. A record may overlook or totally ignore some aspect of a specimen because of the context in which it is generated: Keeping ‘the real thing’ is a safeguard against this.

As described above, geoscience collections embrace both the ‘analogue’ and the ‘digital’ material. Returning to Fortey’s introduction to the GSL, it seems that the movement of the society’s collecting activities away from specimen collections and towards digital data, reflects a wider trend whereby the science of geology is becoming increasingly disconnected from its specimens. The shift from tangible specimen collections to intangible data collections reflects the transformation of the ‘old geology’ to the ‘new geosciences’.

The recognition that data falls within the scope of geoscience collections implies that digital collections are subject to the same treatment and standards as the tangible rocky material. This is apparently not the case; it came as quite a surprise to discover that for the BGS to reach its aspirational level of digitisation, it would take 600 years (if ‘business as usual’ activities are put on hold). This is clearly a problem: digital collections are growing at a rate that is far greater than their physical counterparts. Have we not learned from our mistakes?

The ongoing struggle we face with our geological collections is the result of years of poor management and a lack of standardization. Is it not obvious that even if we can’t touch the stuff, that digital data collections need the same levels of management that we now understand to be essential for physical material? This should come as no surprise to us; we are in the ‘digital age’, after all. On a more positive note; if anyone is in the position to sort this out, surely it is the curators who have had to learn to manage the mess that was left behind after years of mismanaged physical collecting.

### Notes:

For a list of geoscience disciplines, see: The Australian Museum, ‘Geoscience: Branches of geoscience’, <<http://www.amonline.net.au/geoscience/about/branches.htm>>, accessed 12 June 2008

Conference Home Page, ‘Exploiting Geoscience Collections’, <<http://www.exploitinggeosciencecollections.com/>>, accessed 1 March 2008. Slides from many of the papers can also be found at: [http://www.exploitinggeosciencecollections.com/pageID\\_5581386.html](http://www.exploitinggeosciencecollections.com/pageID_5581386.html)

The abstract book is available online: ‘Abstract Book’, *Exploiting Geoscience Collections: 12th and 13th May 2008, Burlington House, Piccadilly, London* <[http://www.exploitinggeosciencecollections.com/pageID\\_5893123.html](http://www.exploitinggeosciencecollections.com/pageID_5893123.html)>, accessed 20 April 2008

The Lyell Collection website is: <http://www.lyellcollection.org/>

A document containing Fortey’s presentation is available on the conference website: [http://www.exploitinggeosciencecollections.com/mediapool/63/637143/data/0101\\_Richard\\_Forty\\_-\\_How\\_do\\_we\\_value\\_geological\\_collections.pdf](http://www.exploitinggeosciencecollections.com/mediapool/63/637143/data/0101_Richard_Forty_-_How_do_we_value_geological_collections.pdf)

A document containing Howe’s presentation is available on the conference website: [http://www.exploitinggeosciencecollections.com/mediapool/63/637143/data/0111\\_Mike\\_Howe\\_-\\_Serendipity.pdf](http://www.exploitinggeosciencecollections.com/mediapool/63/637143/data/0111_Mike_Howe_-_Serendipity.pdf)

A document containing Giles’ presentation is available on the conference website: [http://www.exploitinggeosciencecollections.com/mediapool/63/637143/data/0106\\_Jeremy\\_Giles\\_-\\_Managing\\_Collections\\_for\\_Exploitation\\_20080512.pdf](http://www.exploitinggeosciencecollections.com/mediapool/63/637143/data/0106_Jeremy_Giles_-_Managing_Collections_for_Exploitation_20080512.pdf)

A document containing Ehling’s presentation is available on the conference website: [http://www.exploitinggeosciencecollections.com/mediapool/63/637143/data/0104\\_Angela\\_Ehling\\_-\\_Old\\_samples\\_new\\_questions.pdf](http://www.exploitinggeosciencecollections.com/mediapool/63/637143/data/0104_Angela_Ehling_-_Old_samples_new_questions.pdf)

A document containing Dougherty’s presentation is available on the conference website: [http://www.exploitinggeosciencecollections.com/mediapool/63/637143/data/0112\\_Jean\\_Dougherty\\_-\\_Collections\\_Management\\_at\\_GeolSurvey\\_Canada.pdf](http://www.exploitinggeosciencecollections.com/mediapool/63/637143/data/0112_Jean_Dougherty_-_Collections_Management_at_GeolSurvey_Canada.pdf)

The GSC uses the term 'earth materials' as it provides the most accurate description of the different types of material contained in their collections – ranging from rock, ice, sediment and soil to water.

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**Matching Minerals – News from the St. Aubyn Project**

In July, Helen Fothergill and Jess Shepherd from Plymouth City Museum and Art Gallery visited Saffron Walden Museum in Essex. Sarah Kenyon, the Natural Sciences Officer at the Saffron Walden Museum, had been in touch with Plymouth because they had 37 minerals that were donated to them by Sir John St. Aubyn in 1834. Whilst at Saffron Walden, Helen and Jess examined the minerals before taking them away on a loan and packing them ready for transportation to Plymouth.

Back in Devon, Jess has been looking through the loaned specimens, trying to match them up with the catalogues. Whilst studying the specimens, she noticed that some of the minerals looked very similar to other ones in the Plymouth collection. After going through the draws in the geology store, she managed to match two minerals from each museum so that they linked together (Fig 1 and 2). This has been a really exciting find, and the existence of labels along the joining line that date from roughly 1794–1815 show that these mineral halves may not have been placed next to each other for almost 200 years!



**Fig 1.** A geode of flint lined with chalcedony. Saffron Walden Museum segment (left), Plymouth City Museum segment (right)



**Fig 2.** Celestite on a base of amber, Saffron Walden Museum portion (left), Plymouth City Museum portion (right)

For further information about the St Aubyn project, please contact Jess Shepherd at; [st.aubyn@plymouth.gov.uk](mailto:st.aubyn@plymouth.gov.uk)

## **Book Review**

**Pinniger, R. 2009. *Pest Management – a practical guide*. The Collections Trust, 52pp. ISBN 1900 642 174**

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Long gone are the days when ‘pest management’ meant spraying everything in sight (including passing curators) with noxious chemicals. As the smell of naphthalene slowly fades from our collections, a more intelligent approach is needed to keep the pesky invaders at bay.

In this latest publication by the Collections Trust, David Pinniger outlines the essentials needed for effective pest management in heritage organisations.

The booklet is divided into seven short chapters, each dealing with a particular aspect of pest management.

After a brief introductory chapter, the booklet deals with a range of potential pests and how to identify them. Each species is accompanied by a selection of useful images to aid the identification process. The range of pests covered is not exhaustive, but the most common species are included. Although the book suggests contacting entomologists or pest control consultants for help with identification, I think that some recommendations for further reading would have been useful.

Chapter three covers potential ways to assess pest problems and the factors to consider when assigning risk to buildings and collections. The uses of insect/pheromone traps are discussed, and there are examples of logs and pest monitoring sheets. The following sections deal with preventative measures, eradicating pests and how to treat infested objects. These chapters successfully illustrate how pest management can work effectively to prevent large scale problems occurring.

The final chapters discuss the implementation of pest management programmes including staff training, documentation standards and health and safety issues. The booklet finishes with a ‘to do list’ for organisations wishing to set up a pest management programme.

This booklet provides a good introduction to pest management. The format is simple and easy to read and the text is very concise. The images used are very helpful although some would benefit from scale bars.

I would recommend this book to students and any other persons new to pest management. It would also be suitable for those who may have had some experience of pest management but require some guidance to ensure best practice is achieved.

At £20.00 this booklet seems extremely over priced, although I have no doubt that this guide will be a valuable addition to many collection libraries.

### **Letter to NatSCA**

In response to your call for opinion, so to speak, in the NatSCA newsletter regarding journals, we had quite a long chat about it and thought you might like to know!

In principal it is a great idea on many levels, especially raising the intellectual profile of NatSCA if nothing else. However, there are lot of science journals out there and in an already saturated market; would it just further dilute our output; in terms of how many people it would reach / what the audience potential is? Would it be better to invest the time and money into something that raises our profile by highlighting expertise and a stronger web presence?

Another thought though, something I have been thinking about for some time is to develop a forum for graduate dissertations / thesis or to even produce a journal of sorts (or at least an adjunct to the NatSCA newsletter). There are an increasing number of people taking Masters Courses in Museum studies (let alone biological and earth sciences) but what happens to their thesis? I was in a really good position at the Horniman because my internship there was to produce a report on the feasibility of housing live animals in museums. I then developed that into my thesis. That work has only been seen and used by the Horniman museum, but it has a worth in a wider context. Jo read my dissertation and said that it should be published in some form, which is where this idea came from. I am just using myself as an example, there must be lots more work out there that has just served as a means to an end in achieving a degree (at least at the Masters level, not so much PhD) but could actually make a wider contribution / be useful.

I just feel quite strongly about the churning out of research for research's' sake and it going nowhere. I think it would make for a diverse publication.

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