Journal of Natural Science Collections

ISSN 2053-1133 Volume 3 | 2016

NatSCA
Natural Sciences Collections Association

The Natural Sciences Collections Association

The Natural Sciences Collections Association (NatSCA) is a UK based membership organisation and charity which is run by volunteers from the membership.

NatSCA's mission is to promote and support natural science collections, the institutions that house them and the people that work with them, in order to improve collections care, understanding, accessibility and enjoyment for all.

Further information about NatSCA can be found online at: **natsca.org**

Membership

NatSCA membership is open to anyone with an interest in natural science and/or collections that contain natural materials. There are many benefits of being a member, including; availability of bursaries, discounted annual conference rates, discounted training seminars and workshops, participation in the natural science collections community, friendly and helpful network for information and skill sharing and subscription to the *Journal of Natural Science Collections*.

Membership rates:

UK personal	£20.00
Overseas personal	£20.00
Institutional (2 people)	£40.00

Join online at: **natsca.org/membership**
or contact our
Membership Secretary: membership@natsca.org

Journal of Natural Science Collections

The NatSCA Journal will be published once a year, at the end of the membership year. The Journal will appear online for free access one year after original publication. All papers in the Journal are fully peer reviewed by specialists with a knowledge of that particular subject.

The Journal focuses on papers which have been written by experts working with natural science collections every day; you. We encourage papers which will be beneficial to the membership in their day to day roles. We would like the Journal to accommodate users and researchers to publish their findings in the Journal.

Instructions for Authors

Papers should be submitted electronically either on disc or by email to the Editor (editor@natsca.org). All text should be in Arial, font size 9. Please supply all images separately, not embedded in your document, as tiffs/jpegs at 300 dpi. Images should be labelled Fig. 1., Fig 2., etc… All figure captions should be in full and in the main body of the text where the author wants the images to go.

The names of animal and plant species should be in Italics and the authority name given in full for the first time used, thereafter they may be omitted. All references should be given in full at the end of the paper using the Harvard referencing system (e.g. author, initial, date, title, reference, volume, page).

Full author guidelines can be found on the NatSCA website: **natsca.org/guidelines-for-authors**

Advertisements

		Commercial Rate	Museums & Member Organisations	
Adverts:	1/4 page	£ 40	1/4 page	£ 25
	1/2 page	£ 70	1/2 page	£ 35
	Full page	£ 120	Full page	£ 60
Inserts:		£ 100 + postage		£ 50 + postage

Opinions expressed in the Journal are not necessarily those shared by the NatSCA Committee, the Editor or the membership at large.

Front cover image: Asbestiform actionolite from Austria in the collections at Oxford University Museum of Natural History (OUMNH-Min9250)

charity number 1098156
registered in England and Wales

Editorial

Welcome to the third Volume of the *Journal of Natural Science Collections*. This volume covers a range of topics which can help those working with natural history collections.

The volume includes one paper from the 2015 NatSCA conference, *Museums Unleashed*. Here, colleagues in the Amgueddfa Cymru - National Museum Wales - provide a very useful case study on how a department as a whole can become involved with social media. This is a nice current article with many museums using social media and thinking about how we can work across departments to promote collections.

We have three interesting conservation articles, including moving a large fragile orangutan nest, transporting skeletons, and using Japanese tissue paper in conservation. These papers provide useful and practical advice for our daily work.

A fascinating paper by Rachel Jennings looks at Museums Studies qualifications and how useful they are in the museum sector: with very interesting results. A detailed paper on how to make a life size model of a barrel jellyfish for display provides information of the background to model making.

There is a very important paper on asbestos and it's management in museum collections. The paper covers identification of asbesiform minerals, and how to manage collections with the most up to date law and legislation.

All the images in the hard copy are in black and white. However, the authors all receive a colour PDF of their article. If you would like a full colour digital copy of an article in this Volume, please contact the author directly.

The Journal includes fully peer reviewed articles. I would like to thank all the reviewers of the articles, and in particular the continuing hard work of David Notton at the Natural History Museum, London, for his volunteer assistant editor role.

More informal pieces can be viewed on the NatSCA blog, which includes conference trips, exhibitions, and general natural history musings. There is an opportunity to write for the *News & Comments* section of the website: online articles that are more detailed than blog posts, including full references. A good example is an upcoming article focusing on the conservation of a bound archive volume that was an interesting project but doesn't include the detail for a peer reviewed article.

Jan Freedman (Editor)
January 2016

Submitting an article

The *Journal of Natural Science Collections* will be published once a year. We encourage our members working with natural history collections to submit articles for the Journal. The articles can cover conservation, specific collection projects, best practice, and education topics.

We would like the articles to be beneficial to all our members to assist with their day to day work. The Journal may also be an outlet for users of the collections, and researchers to publish findings they have discovered whilst working on natural history collections.

Deadline for submitting articles for Volume 4 is 30th July 2016.

For submitting posts for the NatSCA Blog, please email them to: blog@natsca.org

If you are interested in submitting an article, and may be unsure if it is suitable for the Journal, *Notes & Comments*, or the Blog, please contact the Editor:

Editor: Jan Freedman
Plymouth City Museum and Art Gallery
email: Jan.freedman@plymouth.gov.uk
tel: 01752 30 4765

Full guidelines for authors can be found on the NatSCA website:

http://www.natsca.org/

View From The Chair

This has been an exciting year for NatSCA, with a very successful conference in Bristol where we explored ideas about how to unleash the potential of museums using social and more traditional media. At the conference our hashtag #NatSCA2015 was trending in the UK – beaten only by Eurovision. This helps to illustrate how effectively NatSCA's members are engaging with social media to share their passion for natural science collections and raise the profile of our sector. This is a heartening prospect, since social media offers a remarkably powerful medium for advocating collections; an increasingly important activity as local authority museums in particular face deeper and deeper cuts.

The funding situation for museums continues to be an issue of concern for NatSCA and we have been working more closely with other Subject Specialist Networks (SSNs) to explore ways of building resilience in the sector. As part of this we have been involved in planning and delivering training to help support museum professionals whose role has broadened to encompass collections outside their areas of expertise, such as the Curating Human Remains workshop organised in collaboration with the Museum Ethnographers Group (MEG), the Society for Museum Archaeology and the Human Remains SSN. We have also delivered training for other SSNs, such as the Identifying Natural Materials course held in Exeter by MEG. Of course, we have also been delivering training more specifically for natural sciences collections professionals, such as the NatSCA Bone Day held in Cambridge. Skills and knowledge transfer is something that we see as being key to building resilience in the sector, so at the moment we are working on a joint funding application to Arts Council England (ACE) in partnership with the Geological Curators Group, to develop further training resources for professionals responsible for natural science collections. If all goes to plan we will be rolling out these resources over the next 18 months – so fingers crossed!

Finally, I want to offer a vote of sincere thanks to the volunteers that keep NatSCA running and to offer congratulations to two members of the NatSCA committee, Clare Brown and Isla Gladstone, on the new additions to their families. Our elected committee spend a huge amount of time and effort on making things happen, in particular our Treasurer Holly Morgenroth, who ends up being at the core of everything that we do. Of course, we also rely hugely on less visible, but no less important volunteers from the general membership. In particular I want to thank Justine Aw who has been both working for NatSCA in a paid capacity with funding from ACE and supporting us extensively in her own time, lending a hand with pretty much everything we do; Glenn Roadley, who has been supporting the committee by updating the jobs page on the NatCSA website (natsca.org/jobs) and helping with electronic bookings; Rachel Jennings who has been editing the NatSCA blog and Facebook page, with Emma-Louise Nicholls and Sam Barnett who have also been working hard to keep the blog regular and active; as well as David Notton, who works hard to support our Editor Jan Freedman in producing this Journal.

Paolo Viscardi
January 2016

Degrees of usefulness: How important are museum studies qualifications in recruitment to the museum sector?

Rachel Jennings

Horniman Museum & Gardens, 100 London Road,
Forest Hill, London SE23 3PQ

email: rjennings@horniman.ac.uk

Received: 21st Sept 2015
Accepted: 25th Nov 2015

Abstract

There has been considerable debate in recent years about the value of museum studies courses, but little formal study. This paper is based on a piece of research conducted in 2013 as part of a Museum Studies MA course undertaken by distance learning at the University of Leicester. The research aimed to provide data on the level of demand for museum studies qualifications from employers, and how qualifications are used as a criterion in recruitment. An analysis of job adverts was undertaken, to discover what percentage request a museum studies qualification, and employers were surveyed on their opinions of courses. The results of this study indicate that employers do not place a high value on museum studies qualifications when recruiting, and that demand for these qualifications has fallen over the last decade. The implications of these findings on the future of museum studies courses and entry-level training for the sector are discussed.

Keywords: Museum studies; Qualifications; Entry-level training; Recruitment; Employment; Employers; Vocational training; Traineeships

Introduction

Museum studies courses have played an important role in the museum sector since they began in the 1960s. However, some feel that the role of courses has changed over time, from being providers of professional development to providers of pre-entry training, resulting in a change in focus from practical skills to a more generalised approach with greater emphasis on formal teaching, critical museology, and theory (Dubuc, 2011; Lorente, 2012). While some see this as a positive step, shifting attention onto social issues and audience needs (Lorente, 2012), many feel that museums are now at risk of losing vital collections-based skills and knowledge (Johnson, 2005; Creative & Cultural Skills, 2008; Creative & Cultural Skills, 2011; Poole, 2011; Conlin; 2012; Mulhearn, 2013). Some employers and students now question the value of museum studies courses as entry-level training for the sector (Anon., 2006; Davies, 2007; Ashby, 2014).

In the current poor economic climate, having a postgraduate qualification in museum studies could theoretically provide an advantage to job-seekers over their competitors (Nightingale, 2012). However, there has been an explosion in the number of museum studies courses available in recent years, with around 30 UK Higher Education institutions now offering postgraduate courses relating to museums and heritage management (Museums Association, 2015). The University of St Andrews and the University of Manchester report that their courses are oversubscribed, while the University of Leicester and Nottingham Trent University have both seen yearly increases in the number of students (Nightingale, 2012). In the academic year 2009/10, Creative & Cultural Skills (2011) reports that there were 5739 domestic students taking courses in cultural heritage subjects in the UK, 2536 at postgraduate level. There are now more graduates than there are jobs available, and this has created intense competition (Miller, 2008), with many entry-level posts being enormously oversubscribed (Anon., 2006).

Jennings, R. 2016. Degree of usefulness: How important are museum studies qualifications in recruitment to the museum sector? *Journal of Natural Science Collections.* **3.** pp.3-18.

The role of museum studies courses in the modern sector has not been extensively studied. Most previous studies have focused on students' opinions of their courses, and their employment status following graduation (e.g. Davies, 2007; Holt, 2010). Davies (2007) did also perform a survey of employers' views on museum studies courses. He reported that employers were generally pleased with the quality of employees they were able to recruit, but were unsure of the value and quality of museum studies courses, and some suggested that courses are out of touch with the sector.

However, no study of museum studies courses and employers has yet been performed that focuses exclusively on recruitment. There is also currently no quantitative data available on how many advertised posts require a museum studies qualification, and for what types of job they are most requested. Davies (2007) estimated that 25% of adverts request a museum studies qualification, but with no data to corroborate. This is an important issue: the number of museum studies courses and graduates is rising, but there is currently no data available to determine if there is a demand for them from employers.

This paper reports the main findings of a piece of research conducted in 2013 as the dissertation for a Museum Studies MA course undertaken by distance learning at the University of Leicester. The research was designed to build on that of Davies (2007), and to investigate an idea that seems to be pervasive among newcomers to the sector, namely that a museum studies degree is needed for a career in museums because 'most jobs ask for one'. This study aimed to test whether or not this is true, and also to discover what role museum studies qualifications play in recruitment to the sector: why do employers ask for them, and what value do they place on these qualifications?

Definitions

Before proceeding, it is useful to define what is meant by a 'museum studies qualification' in this context. 'Museum studies' is used here as a generic term to refer to any academic qualification relating to museums, galleries, or cultural heritage. As a number of course titles are available, it is convenient to combine them all under the banner of 'museum studies'. The 'museum sector' is discussed throughout this piece of work. This refers to museums, art galleries, and historic houses.

Methods

A three-strand approach was used to examine the issues identified above:

- Training and background research Collection and quantitative analysis of job adverts to examine what proportion of jobs advertised require a museum studies qualification, and for what types of roles
- Survey of employers' opinions on the use and importance of museum studies qualifications in recruitment.
- Short interviews with several survey respondents to gain a more in-depth insight.

Job Adverts

An archive of summary job adverts (short adverts summarising the role and person requirements, but often lacking a full job or person specification) was obtained from the Jobs Desk website run by the School of Museum Studies at Leicester University. This archive contained more than 35,000 worldwide adverts, covering an 11-year period (2002 to 2012). Due to the quantity of data, it was decided to examine a sample of the total set. Three years were chosen – 2002, 2007, and 2012 – to allow analysis of trends over time. The adverts for these years were entered into a database, and filtered to remove those that did not fit the requirements of this study.

Analysis was restricted to UK adverts in museums, galleries, and historic houses, and paid positions only. Posts that are not directly sector-specific were not included in the analysis, as these are unlikely to require a museum studies qualification, and would only distort the data. This includes administration and customer-service roles, academic fellowships, and research posts not directly involving collections. Conservation roles were also excluded, as this is a highly specialised discipline requiring specific qualifications.

Posts in libraries and archives were excluded, with the exception of the British Library, as it houses collections of objects that are curated and exhibited. Relevant posts in non-museum institutions such as The National Trust, English Heritage, and The National Trust for Scotland were also included, as were relevant posts in sector bodies such as the Heritage Lottery Fund, Arts Council England, and Museums Association.

The job adverts were analysed to determine how many required a museum studies qualification, both overall and for different types of role. The data was also examined for trends over time.

Survey of Employers

A questionnaire was designed to gather the opinions of employers on the role of museum studies qualifications in recruitment. The questionnaire was

aimed at UK museum and gallery professionals who are responsible for the recruitment and line-management of staff (see Appendix I for a blank copy of the questionnaire).

The questions were based on a number of sources, and were intended to gather a mixture of quantitative and qualitative data on some of the key issues surrounding museum studies qualifications and recruitment. The survey was designed to take no more than 10 minutes to fill in, to encourage participation and for ease of analysis.

The questionnaire was produced as an online survey. A link to the survey, with a brief introductory letter, was circulated to 26 different Subject Specialist Networks (SSNs). It was decided to contact prospective participants through Subject Specialist Networks because they represent a wide variety of disciplines within the sector, and a large number of people.

The survey was open for one month, between May and June 2013. On closing, 110 respondents had completed the survey, with a further 15 having partially completed it. Only completed surveys were analysed.

Interviews

Follow-up interviews were performed, to expand upon the key issues raised by the questionnaire in more detail. 43 of the 110 survey respondents (39%) indicated a willingness to participate in an interview. Ten people were approached, representing a range of job types and institution types, of which six consented to an interview.

The interviews consisted of four questions (Appendix II), and lasted approximately 10 – 15 minutes each. Three of the interviews were conducted via telephone, and the other three in person. Detailed notes were taken during each interview, and the interviews performed in person were recorded with consent and transcribed in full. Once all interviews were complete, the answers given by each participant were codified, and examined using content analysis in order to identify common themes among the responses.

Results

Job Adverts

10% of the jobs advertised on the University of Leicester Museum Studies Jobs Desk in 2012 requested a museum studies qualification, of which 7% were as an essential criterion (Fig 1). This is probably an underestimate, as the job advertisements analysed were largely short summaries, and missing data was a problem: 21% did not include a person specification at all.

A larger proportion of curatorial posts (18%) and collections or documentation posts (14%) required a museum studies qualification than the average for all job types. Around 10% of management and exhibitions posts advertised in 2012 required a museum studies qualification. This fell to 8% for education and outreach roles (Fig 1).

The proportion of posts requesting a museum studies qualification decreased considerably between 2002 and 2012, from 17% to 10%. This downward trend was even more dramatic in some job types: demand for museum studies qualifications fell from 32% to 18% in curatorial roles, and from 31% to 14% in collections and documentation roles (Fig 2).

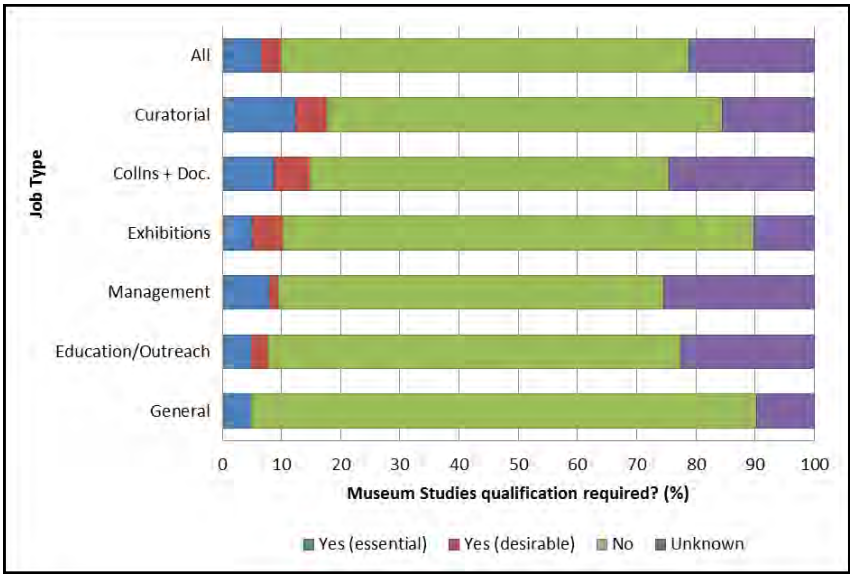


Fig. 1. Percentage of core roles advertised on the Museum of Leicester Museum Studies Jobs Desk in 2012 that requested a museum studies qualification.

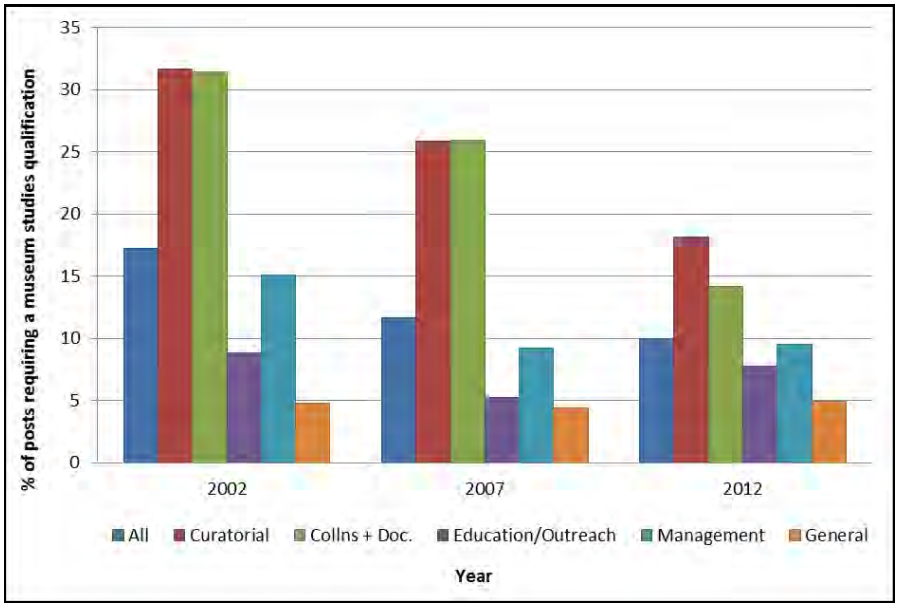


Fig. 2. Change in the percentage of posts requiring a museum studies qualification over time.

Survey

The employers surveyed had mixed opinions of museum studies courses. The majority (60%) felt that the number of courses available is too high, compared to 37% who stated that it is about right, and 2% who thought it is too low (Fig 3). 34% felt that museum studies courses are out of touch with museums, but 25% disagreed with this statement, and 41% were unsure (Fig 4).

37% of respondents thought that the ratio of theory to practical work in courses is too high, but a larger proportion (46%) felt that it is about right (Fig 5).

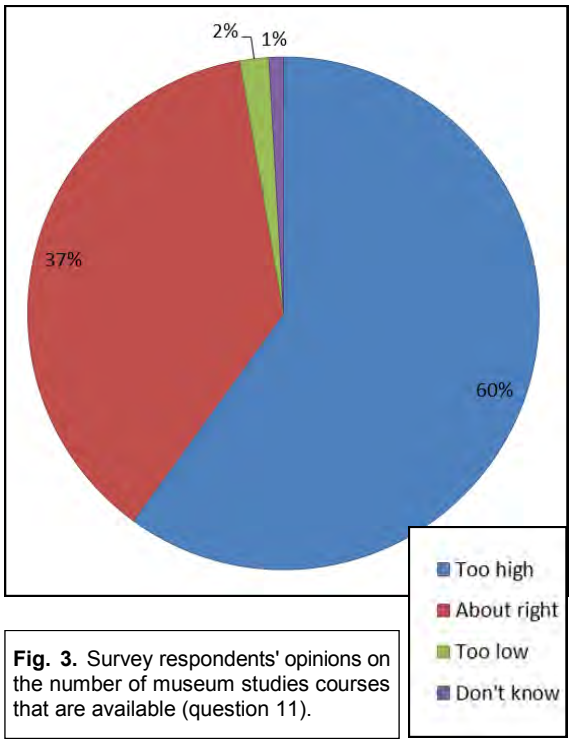


Fig. 3. Survey respondents' opinions on the number of museum studies courses that are available (question 11).

Hands-on experience is something that survey respondents felt strongly about. When asked what the role of work experience placements should be in museum studies courses, many stated that they should provide opportunities to put theory into practice. A number of respondents felt that courses encourage unrealistic expectations of what museum work is like, by focusing on best practice in idealised situations, and that placements should expose students to the realities of working pragmatically with limited resources. Some respondents also stated that students should undertake placements in at least two different types of institution to gain wider experience, and one suggested that more teaching should occur within museums.

The majority of survey respondents (73%) agreed that the purpose of museum studies courses is to prepare students for employment within the museum sector (Fig 6). Interestingly, a much higher proportion of respondents who had undertaken a museum studies qualification themselves felt this to be the case: 85%, compared to only 56% of respondents who did not have a qualification (Fig 6).

When it came to recruitment, the employers surveyed did not place a high value on museum studies qualifications. They were asked to rank four potential qualities in job candidates – museum studies qualifications, subject specialist qualifications, work experience, and transferrable skills – in order of importance. Work experience was felt to be the most important, followed by transferrable skills, a subject specialist qualification, and, lastly, a museum studies qualification (Fig 7).

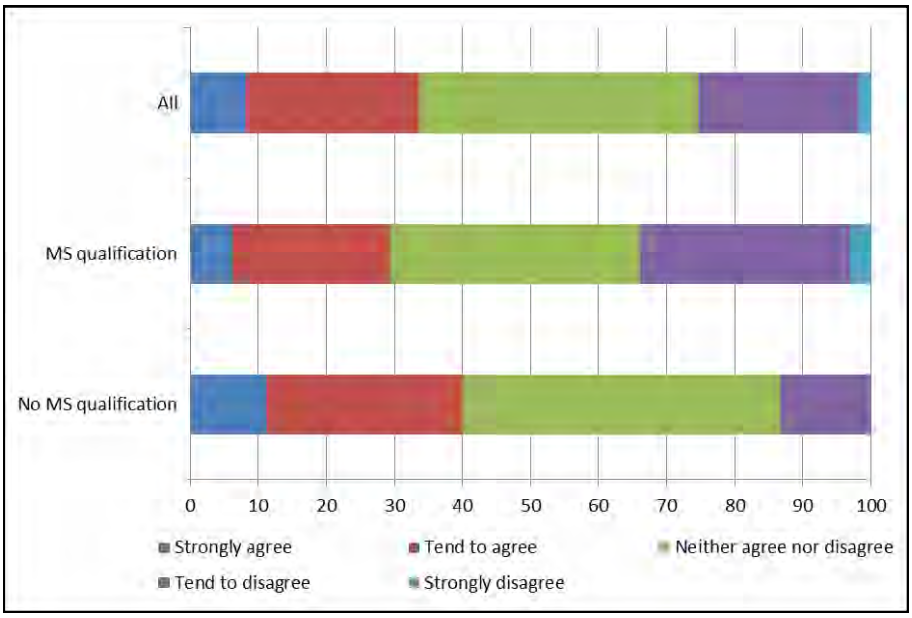


Fig. 4. Change in the percentage of posts requiring a museum studies qualification over time.

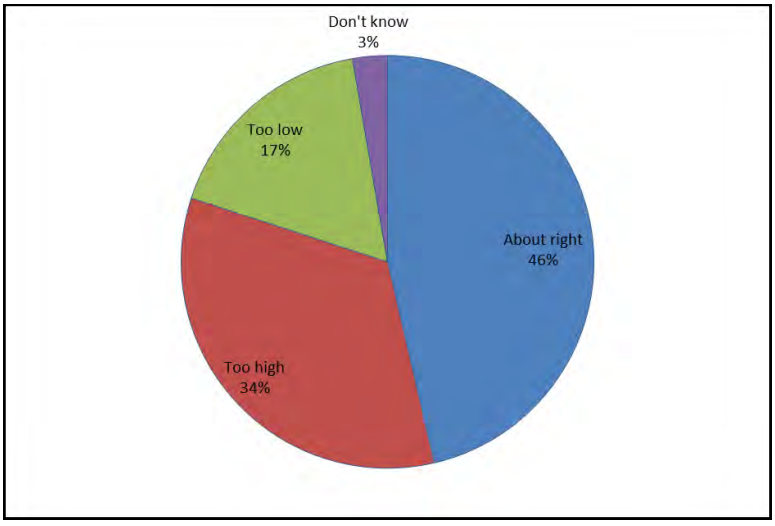


Fig. 5. Opinions of survey respondents on the balance of theoretical to practical work in museum studies courses (question 13)

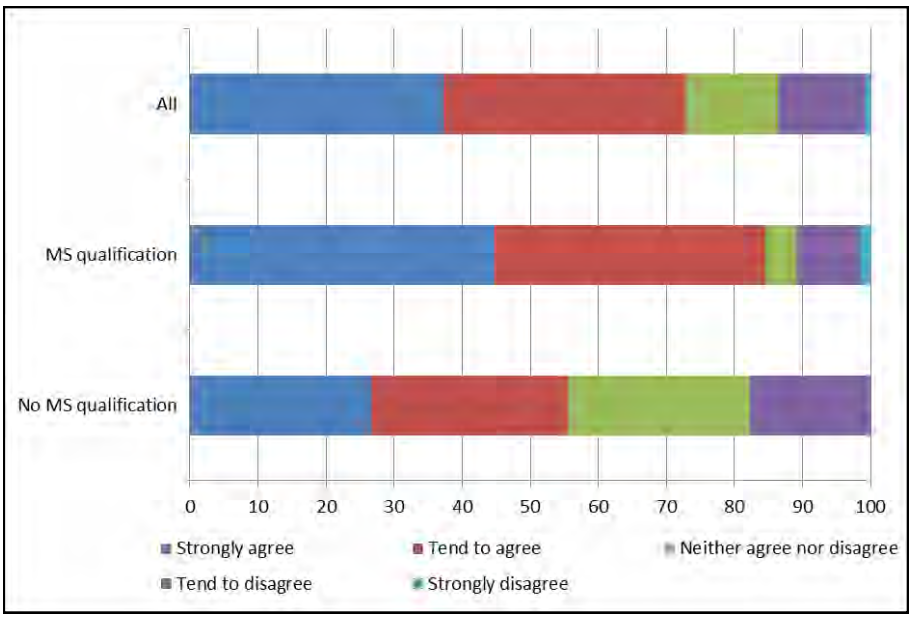


Fig. 6. Percentage of survey respondents agreeing and disagreeing with the statement 'The purpose of Museum Studies courses is prepare students for employment within the museum sector' (question 17).

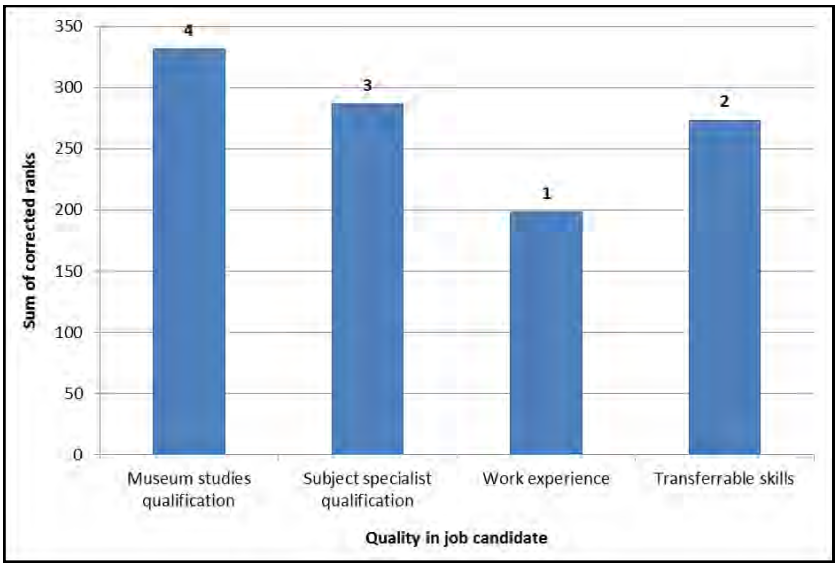


Fig. 7. Preferred qualities in job candidates: aggregate ranks, after correction for ties (question 5).

The majority of employers surveyed do use museum studies qualifications as a criterion when recruiting: 34% stated that a qualification is always or often required, 32% that it is sometimes required, and 35% said that they rarely or never ask for a qualification (Fig 8). When asked the reason for the inclusion of museum studies qualifications as a criterion, only 10% stated that it is because the qualifications prove candidates have a certain level of knowledge and skills, and 24% that the qualification is essential to the post. 36% stated that qualifications are requested because they provide evidence of passion and commitment to the sector, and 17% of respondents stated that museum studies qualifications are used to filter and reduce the number of candidates (Fig 8).

Interviews

There were mixed opinions among the six employers interviewed on whether or not museum studies courses provide the right skills and knowledge. Two felt that courses provide a good basic level of priming in museum theory, and valuable practical experience through placements, but three of the interviewees felt that courses don't provide enough practical experience. Four of the interviewees echoed the survey respondents, in stating that they think courses raise the expectations of students unfairly, and provide an unrealistic view of what working in museums is really like.

The employers had mixed views on the importance of museum studies qualifications in recruitment. Two felt that courses can be a useful criterion, as

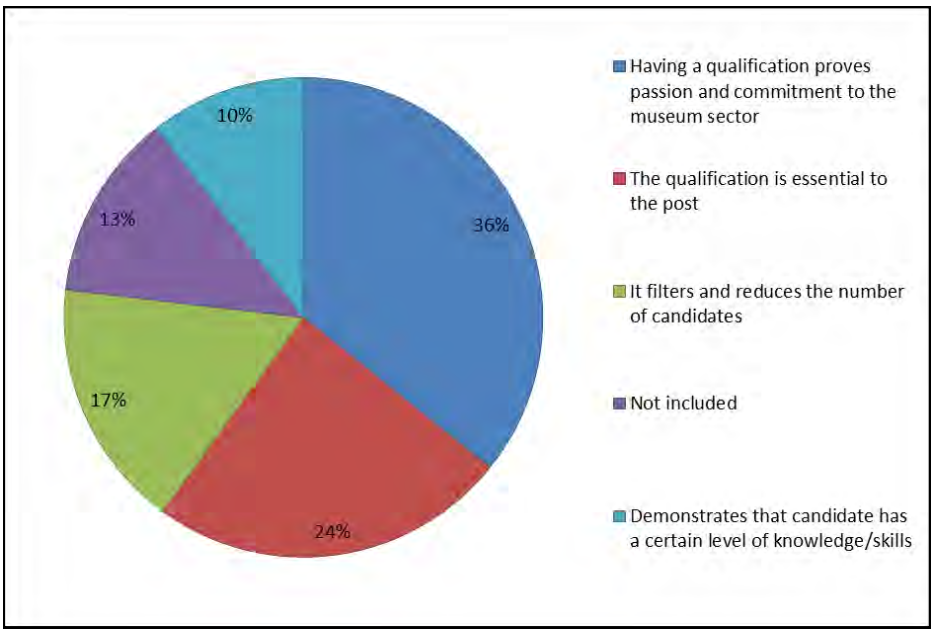


Fig. 8. Reasons given by survey respondents for the inclusion of a museum studies qualification in recruitment (question 7).

they demonstrate a theoretical grounding and a certain level of practical experience through placements. However, two interviewees stated that they thought the main reason employers request a museum studies qualification is to 'weed out' candidates when there are too many applicants, and that courses have little value beyond this. Three of the employers stated that practical experience is more important than whether or not a candidate has a museum studies qualification:

'When I look at an application form, I will always go to their actual work experience first. I would check that they've got a degree in a relevant subject, and I might note that they've got a museums qualification, but that wouldn't be one of the top priorities for me...although a museums qualification is useful in lots of ways, it's not something that I would necessarily shortlist somebody on.'

When asked what qualities they think are most important in job applicants, the most common responses were:

1. Enthusiasm
2. Willingness to learn
2. Team-working skills
3. Ability to engage with objects
3. Knowledge of collections management and conservation
3. Experience of working with the public

None of the interviewees discussed qualifications among the qualities that they look for in candidates.

Discussion

The results of this study indicate that museum studies qualifications are less important in recruitment than they are generally perceived to be. A low proportion of core museum posts advertised in 2012 requested such a qualifications: only 10% of those analysed. As already noted, this is probably an underestimate, but it provides a baseline that can be improved upon with additional data. This figure is also lower than the estimate of 25% quoted by Davies (2007). The data presented here does demonstrate that there has been a decline in demand for museum studies qualifications from employers over the last decade, particularly in curatorial, collections and documentation roles. While museum studies qualifications were still requested for these job types more frequently than average in 2012, demand had fallen by around half since 2002.

The observed decline in demand may be partly due to a loss of confidence in the quality and relevance of teaching due to the proliferation of courses in recent years. The employers surveyed acknowledged that museum studies courses do have positive outcomes for students, providing a theoretical grounding in museum practice and practical experience through work experience placements. However, they expressed reservations about the quality of course content, and were uncertain of the value of museum studies courses to the sector as a whole. This echoes sentiments expressed by Davies (2007) and Creative & Cultural Skills (2010).

The majority of employers stated that they do ask for a museum studies qualification when recruiting at least some of the time, but it was not a high priority in terms of qualities sought in potential employees. Of far more importance were experience, enthusiasm, and transferrable skills. When asked why they include museum studies qualifications as a criterion in recruitment, only 34% gave reasons that were role-related (that it is essential to the post, or because it proves candidates have a certain level of knowledge and skills). The majority of survey respondents used museum studies qualifications as either a marker to demonstrate commitment to the sector (36%) or as a tool to 'weed out' candidates when shortlisting (17%). This is highly problematic, because it leads to employers overspecifying roles simply to reduce the number of applicants. With many roles being heavily oversubscribed (Anon., 2006), this is understandable, but it is also unethical and discriminatory to include as an essential requirement a criterion that is not essential to the role. Employers are obligated to ensure that their recruitment process is fair and transparent. Also, while undertaking a museum studies qualification does provide good proof of a candidate's commitment to the sector, it is not affordable for all. Course fees are rising year-on-year, and at a fast rate: between 2011 and 2015, course fees at 11 UK Higher Education institutions rose by between 11% and 74% (see Table 1). For example, the EU full-time student fees for the MA Museum Studies course at University College London (UCL) has risen from £5,170 in 2011 to £9,015 for entry in 2015 (Museums Association, 2011; University College London, 2015a).

Limitations of this study

This piece of research was a small-scale study produced for a dissertation, and as such has some

Course Provider	Course	2011 fee	2015 fee	% Increase
Bishop Grosseteste University	Heritage Education MA	£4,000	£6,750	69%
City University London	Culture, Policy & Management MA	£6,000	£9,000	50%
Courtauld Institute of Art	Curating the Art Museum MA	£5,625	£8,220	46%
University of East Anglia	Museum Studies MA	£4,500	£7,150	59%
Ironbridge International Institute for Cultural Heritage	Heritage Management MA (2011) / International Heritage Management (2015)	£4,650	£6,840	47%
Kingston University, London	Curating Contemporary Design MA	£5,305	£5,900	11%
University of Leicester	Museum Studies MA	£5,110	£6,835	34%
University of Lincoln	Design for Exhibition & Museums MA	£4,150	£6,880	66%
University College London	Museum Studies MA	£5,170	£9,015	74%
Norwich University College of the Arts	Curation MA	£3,900	£5,500	41%
Nottingham Trent University	Museum and Heritage Management MA	£4,300	£5,100	19%

Table 1. Postgraduate course fees for museum-related courses, for full-time EU students, compared between 2011 and 2015 (2011 fees as reported by Museums Association, 2011; 2015 fees as published on course providers' websites [Accessed 25 October 2015]).

limitations. Only a single source of data was used to analyse job adverts, and as already discussed, missing and incomplete data were a considerable problem because full adverts with person specifications could not be obtained. The data showing a decline in demand for museum studies courses should also be treated with caution, as only three years were examined out of a data set spanning 11 years. One or more of the years analysed could have been anomalous, possibly due to economic factors. However, this study provides the first real data available on the number of jobs requesting a museum studies qualification, and as such represents a valuable step forward. Further research examining new job advertisements from multiple sources over a period of time would resolve these issues.

The data gathered from employers through the survey and interviews cannot be treated as representative of the views of the museum community as a whole, as it is a small, self-selected sample. Those who agreed to participate may have done so because they hold particularly strong views about museum studies courses, whether positive or negative, and so bias is a possible factor in their responses. This could be resolved by circulating the survey more widely to obtain a larger number of responses, and performing a larger number of interviews.

Conclusion: The future of museum studies?

Despite placing little value on museum studies qualifications in recruitment, the majority of employers surveyed saw the primary purpose of courses as preparing students for work in the museum sector. Employers view courses as entry-level training, but appear to have little confidence that students are being provided with the knowledge and skills that they need to enter the sector. But, as already noted, not all courses aim to provide entry-level training: some have shifted their focus towards critical museology and theory (Lorente, 2012). If a museum studies degree is intended to prime students for museum work, greater dialogue may be required between employers and course providers to ensure that the needs of the sector are met. The future of museum studies courses could see closer collaboration between course providers and museums, with more hands-on teaching occurring within a museum environment (Johnson, 2005; Davies, 2006; Holt, 2006; Leitch, 2006; Creative & Cultural Skills, 2008; Dubuc, 2011).

An alternative to museum studies courses as a route into museum employment is a traineeship or internship. These vocational schemes usually focus on core skills such as curatorial and collections management practices, and often offer a bursary towards living expenses. This makes them a more affordable route into museums than museum stud-

ies courses, and they have proven popular: a traineeship scheme advertised at the British Museum in 2012 was 300 times oversubscribed, with over 1300 applications received for 20 places. Other traineeships offered in the same year also reported being hugely oversubscribed (Steel, 2012).

The focus of traineeships of practical experience appears to be attractive to employers: the Heritage Lottery Fund (HLF) programme 'Skills for the Future' reports that 76.5% of the first cohort completing their traineeships between 2010 and 2013 were employed in the heritage sector within six months of completion, 24% of them at their host institution or a partner institution (Heritage Lottery Fund, 2013). The employment rates of those completing traineeships also compare favourably with museum studies graduates: the University of Manchester reports that 63% of MA Art Gallery and Museum Studies graduates in 2013 were employed in the sector within six months of graduation (University of Manchester, 2015). 52% of UK full-time Museum Studies MA students at Newcastle University graduating between 2011 and 2014 were employed in the sector within six months (Newcastle University, 2015), and UCL report that 90% of Museum Studies MA graduates are employed in the sector within six months of graduation (University College London, 2015b).

'Do I need a museum studies degree?' is a question that many new entrants to the sector ask themselves at some point. The answer is complicated: qualifications provide valuable professional development, and can give you a foot in the door by helping you through the shortlisting process. However, employers do not always request qualifications for the 'right' reasons, and are generally much more impressed by practical experience and enthusiasm. The future of entry-level training may lie in widening routes into museums, and greater investment in vocational training. This would greatly benefit the sector, and those who work in it.

Acknowledgements

Thanks must go firstly to my colleagues for all their help and support, and for giving me the idea for this research. Special thanks go to Paolo Viscardi, for being an honest sounding board and for providing much-needed advice.

Thanks also go to members of the faculty in the School of Museum Studies at the University of Leicester: Jim Roberts, for kindly supplying me with the archive of job adverts, and my dissertation supervisor, Alison Duce, for her support and advice.

I must also thank everyone who took part in my survey or circulated it to others, and all who offered to participate in interviews, for their generous and extremely valuable contributions to my research.

References

Anon. 2006. *Entry level jobs symposium at UEA*. [Online], http://www.museumsassociation.org/news/12268 [Accessed 7 April 2013]

Ashby, J. 2014. *Does a museum studies degree help you get a job in museums?* [Online], http://blogs.ucl.ac.uk/museums/2014/10/16/does-a-museum-studies-degree-help-you-get-a-job-in-museums/ [Accessed 27 July 2015]

Conlin, J. 2012. Ditch the reticent object and all its master narratives. *Museums Journal* 112 (12): p.21

Creative & Cultural Skills. 2008. *The Cultural Heritage Blueprint: A workforce development plan for cultural heritage in the UK*. London: Creative & Cultural Skills.

Creative & Cultural Skills. 2010. *Creative & Cultural Skills: Sector Skills Assessment for the creative and cultural industries. An analysis of the skills needs of the creative and cultural industries in the UK*. London: Creative & Cultural Skills.

Creative & Cultural Skills. 2011. *The Qualifications Blue print: A qualification strategy for the creative and cultural industries*. London: Creative & Cultural Skills.

Davies, M. 2006. Just the job. *Museums Journal* 106 (5): pp.16 – 17.

Davies, M. 2007. *The Tomorrow People: Entry to the museum workforce. Report to the Museums Association and the University of East Anglia*. [Online], http://www.museumsassociation.org/ careers/13582 [Accessed 6 March 2012]

Dubuc, É. 2011. Museum and university mutations: the relationship between museum practices and museum studies in the era of interdisciplinarity, professionalisation, globalisation and new technologies. *Museum Management and Curatorship* 26 (5): pp.497 – 508.

Heritage Lottery Fund. 2013. *Interim Evaluation of Skills for the Future, Cohort 1: Project manager and trainer surveys*. [Online], http://www.hlf.org.uk/skills-future-evaluation [Accessed 15 November 2015]

Holt, J. 2010. Learning curves. *Museums Journal* 110 (6): pp.32 - 35.

Johnson, N. 2005. Wanted: new breed of curator. *Museums Journal* 105 (6): pp.16 – 17.

Leitch, S. 2006. *Prosperity for All in the Global Economy - World Class Skills. Final Report*. London: Her Majesty's Stationary Office.

Lorente, J-P. 2012. The development of museum studies in universities: from technical training to critical museology. *Museum Management and Curatorship* 27 (3): pp.237 – 252.

Miller, S. 2008. New entrants to the museum world need to help themselves if they want to get ahead. *Museums Journal* 108 (3): 18.

Mulhearn, D. 2013. Facing Extinction. *Museums Journal* 113 (4): pp.24 – 29.

Museums Association. 2011. *Postgraduate fees table*. [Online], http://www.museumsassociation.org/download?id=323698 [Accessed 19 October 2015]

Museums Association. 2015. *Courses guide: Developing a career in museums*. London: Museums Association.

Newcastle University. 2015. *Destinations of Leavers from Higher Education*. [Online], https:// internal.ncl.ac.uk/careers/secure/dlhe/reporting/index.php [Accessed 26 October 2015]

Nightingale, J. 2012. Starting out. *Museums Journal* 112 (10): pp.30–35.

Norfolk Museums Service. 2014. *Learning from the Past – Skilled for the Future. The impact of the training programmes at Gressenhall Farm & Workhouse and the Museum of East Anglian Life*. [Online], http://www.museums.norfolk.gov.uk/view/NCC159383 [Accessed 2 August 2015]

Poole, N. 2011. *The Rise and Fall of the Curator*. [Online], http://www.collectionstrust.org.uk/the-rise-and-fall-of-the-curator/ [Accessed 19 April 2013]

Steel, P. 2012. Traineeship initiative is 300 times over subscribed. *Museums Journal* 112 (4): p.5

University College London. 2015a. *Fee Schedule: Post graduate Taught 2015-16*. [Online], http://www.ucl.ac.uk/current-students/money/2015-2016_fees/2015-16_postgrad_taught [Accessed 19 October 2015]

University College London. 2015b. *Museum Studies MA*. [Online], https://www.ucl.ac.uk/prospective-students/graduate/taught/degrees/museum-studies-ma [Accessed 25 October 2015]

University of Manchester. 2015. *MA Art Gallery and Museum Studies Alumni*. [Online], http://www.alc.manchester.ac.uk/icp/postgraduate-study/agms/alumni/ [Accessed 25 October 2015]

Woolf, F., & Betjemann, N. 2012. *Strengthening Our Common Life: Final Evaluation Report*. Felicity Woolf Associates and Consultancy.

Appendix I: Sample copy of questionnaire

Museum Studies Qualifications: Employers' Perspectives Survey

11/05/2013

Dear participant,

Through this questionnaire I will gather data for my research project 'Degrees of Usefulness: How Important are Museum Studies Qualifications in Recruitment?'. The research seeks to develop a better understanding of the role that museum studies courses play in recruitment, and how important having a museum studies qualification is to gaining employment in the museum sector. Through this questionnaire I will be able to find out about the attitudes of employers towards museum studies courses and graduates. The outcomes of this survey will be presented in my dissertation for the University of Leicester distance-learning Museum Studies MA degree course, and may be published in the Museums Journal or similar publication in due course.

The questionnaire is administered to personnel in UK museums, galleries and other heritage institutions who are responsible for the recruitment and management of staff. The questionnaire should take no more than 10 minutes to complete.

Please note that your responses will be fully anonymised, and no identification information will be gathered. Any details you provide that might be used to identify people, places or situations will be suitably modified to protect your and others' identities.

By completing and returning the questionnaire, you agree that:
- Your responses are interpreted and used for the purposes stated above
- Any presentation of your responses will be fully anonymised
- As responses will be anonymised and I will not have access to your individual responses, it may not be possible to withdraw from the study once you have completed the questionnaire.

If you have any questions about the ethical conduct of this research please contact the Museum Studies Research Ethics Officer, Giasemi Vavoula, gv18@le.ac.uk.

If you are happy with the above and have the time and willingness to assist, please select 'I agree' below, and proceed with the questionnaire.

I agree

Thank you for your participation.

Rachel Jennings
Museum Studies MA student (distance-learning)
School of Museum Studies
University of Leicester

1. What type of institution do you work for?

National Museum ☐
Local Authority ☐
Trust ☐
Private ☐
Other (please specify) _____

2. What is your job title and in which department do you work?

_____

3. Are you responsible for line-managing staff, and if so how many?

_____

4. Do you have a Museum Studies qualification?

Yes ☐
No ☐

5. Please rank the following as to their importance in a job candidate?

1 = most important, 4 = least important. Please rank the options 1 - 4, using each number once.

	1	2	3	4
Museum Studies qualification	☐	☐	☐	☐
Subject specialist qualification	☐	☐	☐	☐
Work experience	☐	☐	☐	☐
Transferable skills	☐	☐	☐	☐

6. When recruiting new staff, is a Museum Studies qualification included in the person specification for entry-level posts in your institution/department?
Choose the one option that most applies:

Always ☐ Rarely ☐ Often ☐
Never ☐ Sometimes ☐

7. When a Museum Studies qualification is included, is this because:
Choose the one option that most applies:

The qualification is essential to the post ☐
Having a qualification proves passion and commitment to the museum sector ☐
It filters and reduces the number of candidates ☐
Other (please specify) _____

8. How do you prefer candidates to have taken a postgraduate qualification?

Full-time ☐
Part-time ☐
Distance Learning ☐
No preference ☐

9. Would you be willing to provide support for staff wanting to take a Museum Studies qualification while working?

Yes (go to q. 11) ☐

No (go to q. 10) ☐

10. What factors influence this decision?

Lack of time ☐

Lack of money ☐

Feel it is unnecessary ☐

Other (please specify) _____

11. Do you think the number of postgraduate Museum Studies courses available is:

Too high ☐

About right ☐

Too low ☐

12. Do you think that the increase in the number of Museum Studies graduates over the last few decades has aided the professionalisation of the sector?

Yes ☐

No ☐

Don't know ☐

13. Do you think the balance of theoretical to practical work in Museum Studies courses is:

Too high ☐

About right ☐

Too low ☐

14. What do you think the role of work experience placements should be in Museum Studies courses?

_____

_____

15. Do you currently host student placements?

Yes ☐

No (go to q. 16) ☐

16. Would you be willing to host student placements and if not why?

Yes

No _____

17. To what extent do you agree with the following statement?

'The purpose of Museum Studies courses is prepare students for employment within the museum sector'

(Paraphrased from Davies M., 2007. The Tomorrow People: Entry to the museum workforce. Report to the Museums Association and the University of East Anglia)

Strongly agree ☐ Tend to agree ☐

Neither agree nor disagree ☐ Tend to disagree ☐

Strongly disagree ☐

18. To what extent do you agree with the following statement?

'Museum Studies courses are out of touch with museums'

(Paraphrased from Davies M., 2007. The Tomorrow People: Entry to the museum workforce. Report to the Museums Association and the University of East Anglia)

Strongly agree ☐ Tend to agree ☐

Neither agree nor disagree ☐ Tend to disagree ☐

Strongly disagree ☐

19. Would you be willing to participate in a telephone interview to discuss these issues further?

Yes (go to q. 20) ☐

No ☐

20. If yes, please provide a contact email address:

_____

You have now finished the survey. Thank you very much for your participation, it will make a valuable contribution to my research.

The questionnaire will be open until the beginning of June, after which I may contact several people who have indicated that they are willing to participate in a telephone interview. If you decide that you would rather not be contacted, please let me know.

Rachel Jennings
Museum Studies MA student (distance-learning),
School of Museum Studies, University of Leicester

Appendix II. Interview questions

Question 1. As an employer, what qualities do you think are most important in a job applicant?

Question 2. How important do you think museum qualifications are in recruitment, and why?

Question 3. There's been a lot of debate in the literature over the past few years about whether or not museum studies courses adequately prepare students for museum work. From your experience as an employer, do you find that graduates have the right skills and knowledge when they come in to work, and do you think that courses provide enough practical experience?

Question 4. In the current climate, do you think that museum studies qualifications will become more or less important in the future.

A departmental face to social media: Lessons learnt from promoting natural history collections at National Museum Cardiff

Kate Mortimer*, Harriet Wood &
Jennifer Gallichan

Department of Natural Sciences, National Museum Wales,
Cathays Park, Cardiff, CF10 3NP

*Corresponding author: Katie.Mortimer@Museumwales.ac.uk

Received: 21st Sept 2015
Accepted: 20th Nov 2015

Abstract

The Natural Sciences Department at Amgueddfa Cymru-National Museum Wales has been using social media to highlight its collections, research and events since 2011. Since then various platforms have been utilised, such as Twitter, Facebook, Storify, blog pages and Flickr to increase profile through social media. Over the last two years a change in working practices have ensured an increased following and consequently a raised awareness of the collections by followers. Information has been successfully inter-connected across different social media platforms and linked to more traditional media sources such as web pages, on-line databases and catalogues. Effective monitoring of outputs has enabled efforts for the presence of the whole department on social media to be streamlined, efficient and produce a wide range of successful products.

Keywords: Social media; Public engagement; Natural history museums; Twitter; Storify; Flickr; Blogs; Advocacy; New audiences

Introduction

The Natural Sciences Department at Amgueddfa Cymru-National Museum Wales has been using social media since 2011 to highlight its collections, research and events. Since then, its presence on social media has increased; not only in line with a global change in awareness of different social media platforms, but also due to a museological and cultural change encouraging staff to become more involved in social media activities. The power of social media in education, science communication and in connecting people has been clearly shown (Wilcox, 2012).

Although blogging via the Museum's web pages was the starting point for departmental social media activities, the springboard to a greater presence came from using Twitter. Originally the @CardiffCurator Twitter account was set-up for personal/sectional use, and as such focused on an area of interest towards taxidermy and birding.

However, in 2013, the decision was taken by the new @CardiffCurator twitter account manager, to transform it into one representing the whole department, its work and natural history collections, in a bid to broaden its appeal, and to spread the workload between curators. This transformation, although slow initially, has brought about huge knock-on effects associated with the number of people engaging with content.

During the first two years as a personal/birding account there was a steady increase in followers to around 100, whilst in the following two years after transformation, numbers rose more rapidly to over 2000. This rise was attributed to increased interest in the wider diversity of content being posted, covering all aspects of zoology, botany and geology. This was noted due to the change in composition of the audience (moving away from a mainly birding audience), which followed the account, and a change backed-up from demographic data from Twitter Analytics.

Mortimer, K., Wood, H., & Gallichan, J. 2016. A departmental face to social media: Lessons learnt from promoting natural history collections at National Museum Cardiff. *Journal of Natural Science Collections.* **3.** pp.18-28.

The following paper discusses the benefits of posting material on social media as a department, rather than from a personal perspective, and also details lessons learnt throughout this process for a large organization.

Methods

Framework

Posting material on social media via a department of over 30 staff members and additional honorary fellows poses unique issues in terms of organization. Therefore, the curators within the department adopted a tiered approach, having a lead curator to oversee the account, and champions within each section to help promote the supply and organization of content from other colleagues. A structured framework was additionally adopted to organize material in preparation for posting on social media platforms. This consists of:

a) Social media folders on shared computer drives, allowing participants across the department to provide material.

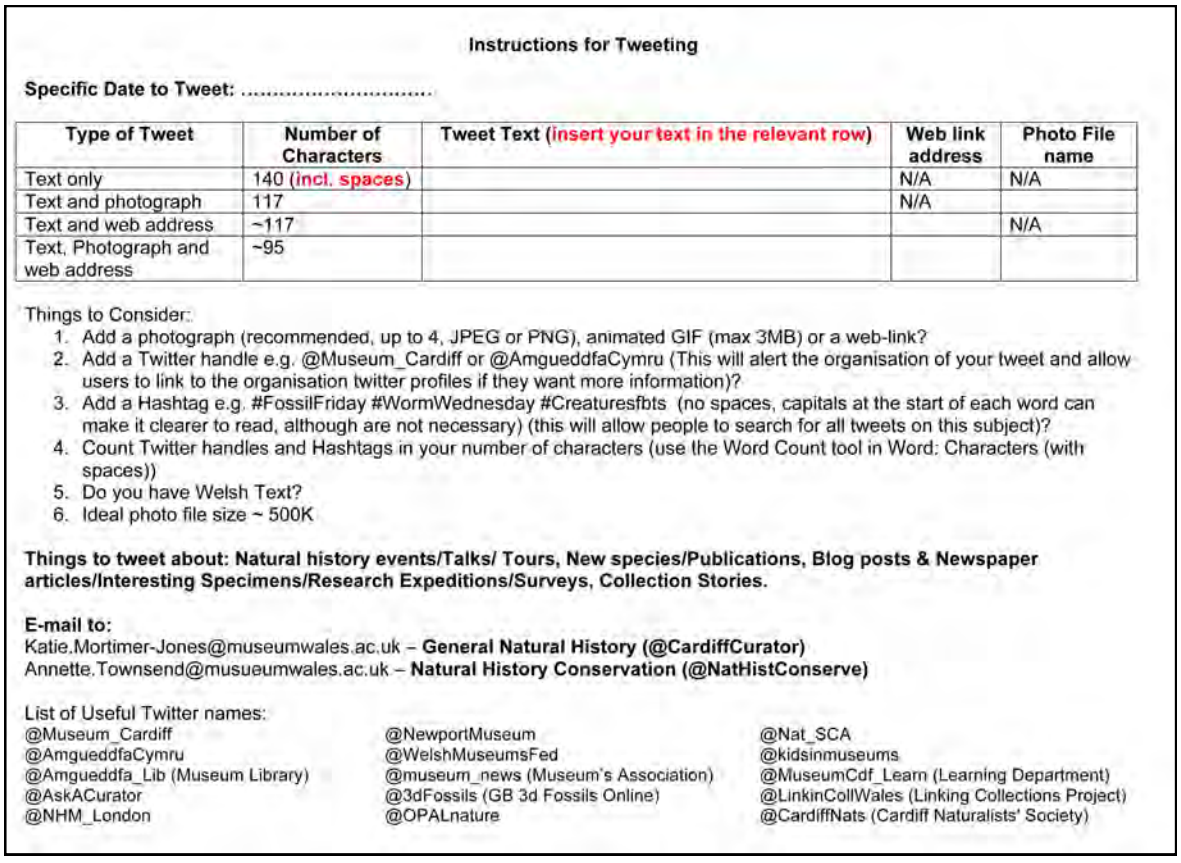
b) Basic 'Tweet Guides' (Fig 1) to provide information to those less familiar with social media and to give advice on tweet construction (e.g., number of characters, image formats etc.), hashtags and twitter handles/usernames.

c) Standardized forms (Fig 2) allowing users to provide batches of tweets that can be tweeted over a period of time by those who have direct access to the account.

d) A 'Tweet Diary' that lists events and days throughout the year and encourages staff to prepare material in advance. This includes occasions such as public holidays and celebrations (Easter, advent, Chinese New Year, Saint's days, Valentine's Day etc.), museum events, historical coincidences (#BornOnThisDay, #DiedOnThisDay, #PublishedOnThisDay) and National Days. These types of events have proven to be extremely good vehicles to highlight our collections, in an engaging way that audiences can relate to. This has also been shown for other museum social media accounts e.g. the weekly Tate weather feature (linking objects in the collection to the weather in London) allowing the public to engage with museum collections in a different way (Guerra & Pansters, 2014).

Hashtags

The usefulness of using hashtags in allowing users to find or aggregate information on a particular subject is well documented (for example, see Zambonini, 2010). They can be particularly useful for events and conferences, allowing delegates and those unable to attend to follow what is happening for the duration. This can often lead to those



Instructions for Tweeting

Specific Date to Tweet: .....

Type of Tweet	Number of Characters	Tweet Text (insert your text in the relevant row)	Web link address	Photo File name
Text only	140 (incl. spaces)		N/A	N/A
Text and photograph	117		N/A	
Text and web address	~117			N/A
Text, Photograph and web address	~95			

Things to Consider:

1. Add a photograph (recommended, up to 4, JPEG or PNG), animated GIF (max 3MB) or a web-link?
2. Add a Twitter handle e.g. @Museum_Cardiff or @AmgueddfaCymru (This will alert the organisation of your tweet and allow users to link to the organisation twitter profiles if they want more information)?
3. Add a Hashtag e.g. #FossilFriday #WormWednesday #Creaturesfbts (no spaces, capitals at the start of each word can make it clearer to read, although are not necessary) (this will allow people to search for all tweets on this subject)?
4. Count Twitter handles and Hashtags in your number of characters (use the Word Count tool in Word: Characters (with spaces))
5. Do you have Welsh Text?
6. Ideal photo file size ~ 500K

Things to tweet about: Natural history events/Talks/ Tours, New species/Publications, Blog posts & Newspaper articles/Interesting Specimens/Research Expeditions/Surveys, Collection Stories.

E-mail to:
Katie.Mortimer-Jones@museumwales.ac.uk – **General Natural History (@CardiffCurator)**
Annette.Townsend@musueumwales.ac.uk – **Natural History Conservation (@NatHistConserve)**

List of Useful Twitter names:

@Museum_Cardiff
@AmgueddfaCymru
@Amgueddfa_Lib (Museum Library)
@AskACurator
@NHM_London
@NewportMuseum
@WelshMuseumsFed
@museum_news (Museum's Association)
@3dFossils (GB 3d Fossils Online)
@OPALnature
@Nat_SCA
@kidsinmuseums
@MuseumCdf_Learn (Learning Department)
@LinkinCollWales (Linking Collections Project)
@CardiffNats (Cardiff Naturalists' Society)

Fig. 1. Basic tweet guides utilised to help staff construct tweets.

Tweet Text	Web link address	Photo File name	Theme	Date to tweet
Murex scolopax - Indian Ocean. Described by the Welsh naturalist L. W. Dillwyn in 1817. Lectotype. #MolluscMonday #MTC	N/A	M_scolopax_type	Types	
Lewis Weston Dillwyn mollusc collection @AmgueddfaCymru #MolluscMonday	http://www.museumwales.ac.uk/2755/		Collections	
Newest mollusc holotypes @AmgueddfaCymru, *I. mackayi* & *T. scotiae*. Indicators of cold seep at Hatton-Rockall Basin.	http://wwwnews.live.bbc.co.uk/news/uk-scotland-highlands-islands-25528522		Types	

Fig. 2. Tweet forms, allowing staff across the department to provide material for posting on social media.

hashtags trending on the Twitter homepage; for example, the General Meeting of the American Society for Microbiology (Bik & Goldstein, 2013), and recently the NatSCA 'Museums Unleashed' conference at MShed in May 2015 (#NATSCA2015).

Hashtags have been very effective for increasing engagement with natural history subjects too. Popular weekly hashtags such as #FossilFriday show how hashtags can increase engagement opportunities for Museum tweeters, and this certainly has been the case for the @CardiffCurator account. Tweets containing weekly hashtags such as those listed below often make up the Top Tweet or Top Media Tweet of the month, as recorded by Twitter Analytics. The popularity and success of weekly hashtags is also evidenced by the proliferation of natural history hashtags for every day of the week, for example:

#MineralMonday	#BotanicMonday
#MolluscMonday	#TrilobiteTuesday
#WormWednesday	#WeevilWednesday
#ThinSectionThursday	#FungusFriday
#SpiderSaturday	#ScienceSunday

Of course, there are also hashtags and events which come up yearly, such as #AskACurator and #MuseumSelfieDay, which have a global following. Additionally we have found that utilising subjects/ hashtags that are currently trending on Twitter to highlight collections can increase the audience viewing our tweets.

The added benefit of using hashtags is that they often give tweets longevity, something which is particularly useful given the 'here today, gone tomorrow' pace of platforms like Twitter. Often, tweets that include hashtags are retweeted days or weeks after their first appearance, as users search for particular subjects.

Storify

Another useful tool for giving longevity to information on Twitter is through the use of Storify. This platform allows you to create cohesive stories and timelines through the aggregation of tweets, images, videos, blogs etc. from a variety of different social media platforms and web-links. Elements used in Storify must already be accessible online; so, for example, unpublished images required for a story must be made publicly available first, although text can be added directly. It is particularly beneficial for preserving tweets before they become archived by Twitter (Bik & Goldstein, 2013). It is also a valuable tool for evaluation purposes, bringing together peoples' opinions on a particular topic to highlight achievements. For examples of how it can be used in a natural history museum perspective to highlight specimens and collections, see Mortimer *et al*. (2014; 2015). Finally, Storify can also be used to highlight public engagement activities and conferences by aggregating live tweets.

Flickr

Amgueddfa Cymru-National Museum Wales have had a presence on Flickr since 2008, but more recently a Natural History album under the umbrella of the organization's account has been produced, to show stories and objects from the collections and research. As Flickr is an image and video hosting website, the stories chosen for inclusion have a strong visual focus. One of the advantages of using Flickr is that more information can be added to image captions than is possible on other platforms. Links to hashtags/twitter campaigns, blogs and web -links can also be included, thus connecting material across the social media network. Flickr is also a useful tool for embedding images for use with other social media platforms such as Storify (see above).

Blogs

Although blogging has been the social media format that the department has been involved in longest, it is perhaps the one that needs a higher level of engagement to build up a following. Blog posts are published through the Museum's web pages, and on average natural history blogs are currently posted around 1-3 times a month. Blogging provides an opportunity to add more content than is possible with other platforms such as Twitter, however, blogs are often more time consuming to con-

struct. Often blogs are more fitting for certain types of engagement such as fieldwork diaries, reports on outreach events, new projects, social history stories detailing collectors, specimen stories and new acquisitions to name but a few. Members of staff from each section within the department have the capacity to post blogs, thus providing greater opportunities and ease for blogging across the department. There has been a notable increase across the institution in the number of blogs being written now that blog posts are advertised on the homepage of the organization's webpage.

Connected face

The department has endeavoured to connect material on different platforms across the social media network (Fig 3). For example, tweets are amalgamated and published on Storify, linking in relevant information from websites and images (e.g. from Flickr) to make a more cohesive story. The posting of these stories can then form the basis for blogs and further tweets, producing an interconnected network. However, the content and nature of the material published is altered depending on the nature and audience associated with the relevant platform. In this case one size really doesn't fit all; different platforms have varying demographics associated with them and thus material should be tailored to suit (see for example, Duggan *et al.,* 2015: 5). This approach ensures a wider range of coverage, and reduces the amount of work needed by adapting previously existing content. In other cases where there is a target audience in mind, it is beneficial to select specific platforms that are known to have a high number of users from this audience. Young adults for instance have a tendency to use different social media platforms than those used by older adults (Lenhart *et al.,* 2010).

Vehicles for engagement

A variety of vehicles have been successfully used to promote the natural history collections at Amgueddfa Cymru-National Museum Wales. The first is by utilising a Natural Sciences mascot called Arthur the *Arthropleura*, a model of the largest invertebrate ever known to have lived on land. Museum mascots (#MuseumMascots) have been successfully used by several natural history collections as a way of engaging audiences e.g.
@OisinTheDeer,
Diplodocus carnegii (@NHM_Dippy),
George the Gorilla (@George_Gorilla),
Tolson Half Pig (@TolsonHalf_Pig).

Unlike these mascots Arthur does not have his own individual account, however, he is utilised to promote galleries and exhibitions (even crossing over disciplines, Fig 4), external events such as the Royal Horticultural Society (RHS) show in Cardiff, and internal activities such as open days (Fig 5), and parts of the natural history collections. His adventures have produced a lot of attention both from followers of our social media outputs but also from the media (published on BBC Wales online for example) and are a way of engaging new and more varied audiences.

Analysis

Good analysis has been vital in gaining a greater and more successful presence on social media. Through understanding what aspects have been successful, future content has been adapted and streamlined, and has been a fundamental part in increasing engagement rates and followers. For instance retweets have risen by 370%, tweet favourites by 511% and followers by 1900 over the last two years for Twitter alone. The department have been actively monitoring and analysing our social media outputs for several years.

Initially, data collection for our Twitter account was done by hand, looking at number of retweets, favourites and potential audience figures (i.e. the number of followers of those that retweeted us +

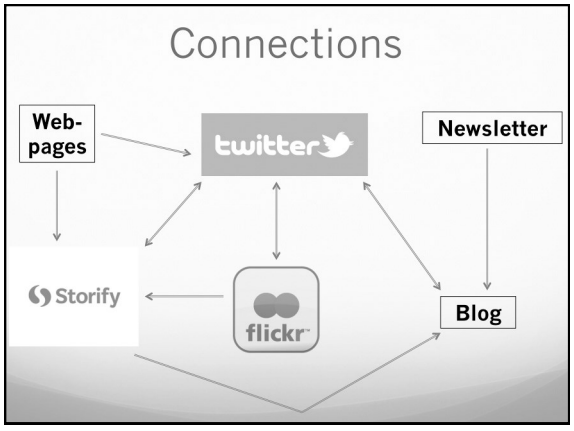


Fig. 3. The connected network of social media outputs posted by the department.

Fig. 4. Arthur the *Arthropleura* on his adventures, promoting different parts of the Museum.

Fig. 5. Arthur the *Arthropleura,* being used to promote external events such as the RHS show, Cardiff.

the audience of our account). Whilst this was useful in giving an insight into those tweets that had a greater number of impressions (the times a user is served a Tweet in timeline or search results), it did not provide insight into how/whether people were engaging with content, outside of retweeting or adding the tweet to their favourites list. The advent of social media analytics has enabled us to delve deeper into the analysis. Examples are the Twitter Analytics Dashboard that started in 2014, a free resource from Twitter enabling users to look at the performance of tweets; and Google analytics for web analytics. This has enabled us to look at, for example, whether tweet construction (e.g. number/ type of pictures, presence of web-links/hashtags, text style etc.) and day/time of day of tweeting, impacts the number of engagements. The data is then benchmarked against twitter accounts across the organization, via the Digital Media Department. Tweet bulletins and tweet-ups (an event whereby people who use Twitter get together) help to share best practice ideas across the organization.

The @CardiffCurator twitter account currently has the largest number of followers of any of the departmental accounts at Amgueddfa Cymru and the lessons learnt over the last two years have been shared and followed by other accounts as a case of best practice. Benchmarking options are available with some analytical packages (such as Google analytics), allowing comparison of effectiveness with those in the same industry. However, some analytical options are only available in premium analytical packages and as yet this is not something that we have investigated ourselves.

The impact of changes to the account can also be assessed, e.g. when changing profile text or images it is possible to see whether this increases or decreases the number of engagements. Analytics vary between platforms and this means that comparisons between platforms can be difficult. At present, 'number of views' is the only metric that we calculate for both Storify and Flickr. However, the successfulness of material on Twitter often reflects whether it is used on other platforms. Blog metrics are collected by the Digital Media Department using Google Analytics.

The data has been additionally useful in encouraging more people to provide content (i.e. showing the reach of social media) and in evaluation of the benefits, against time inputted into social media activities. This is often important for justification of time spent to management. Analytics also enables account administrators to understand the profile of their followers, and to see who is engaging with content. For instance, 64% of our Twitter audience enjoy sport, so tweets that connect our collections with major sporting events have often led to high numbers of engagements (e.g. 10.7% engagement rate for a tweet highlighting the start of the Six Nations 2015). Knowing the locality of followers, allows you to select times when the target audience is on-line. Seventy-two % of our Twitter followers are UK based, but 9% are from the USA, so tweets celebrating the 4th of July for instance would be time-shifted to meet the American market.

Whilst automatically calculated metrics have enabled us to delve deeper into understanding how people are engaging with our content, hand calculated statistics have given us a deeper insight into

Number of Images	Average number of Impressions	Average number of engagements	Average engagement rate %
0	275.5	6.6	4.08
1	1201.5	37.7	3.31
2	1251.6	29.6	2.84
3	1393.9	54.7	3.56
4	1684.3	50.9	3.22

Table 1. Average number of impressions, engagements and engagement rate (%) for tweets containing between 0-4 images tweeted during July 2015 from the @CardiffCurator Twitter account.

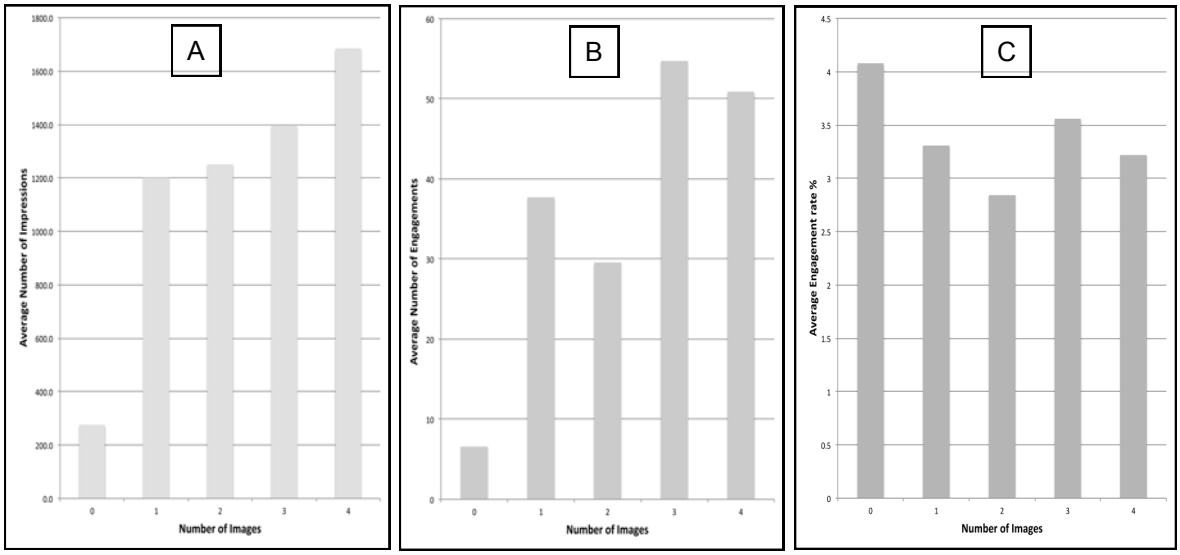


Fig. 6. (A) Average number of impressions, (B) engagements and (C) engagement rate (%) for tweets containing between 0-4 images tweeted during July 2015 from the @CardiffCurator Twitter account.

who is engaging with content and additional reasons as to why some tweets are more successful. Thus, we have found it prudent to add additional data to the metrics provided by automated analytics (see Appendix 1), detailing for example, the tweet composition (whether any media is attached and in what format e.g. number of images etc.) and examples of accounts that retweeted us, which may have an impact on the success of the tweet. This has allowed contributors to look for reasons why engagement rates may be higher or lower for some tweets.

Whilst it is too early to say definitively which tweet compositions are the most successful, certainly the addition of images seems to increase engagement rates hugely. This enables tweets to stand out more clearly on a user's timeline, which is important given the often fast pace of viewing. Stadd (2014) found that users engaged at a rate 5X higher when an image was included. Similarly, recent data collected in July 2015 from our Twitter account found a much higher number of impressions and engagements for tweets that included a picture than those that didn't (see Table and Figs 6a and 6b). However, the average engagement rate for the latter was actually higher (Fig 6c), indicating that a large proportion of those seeing the tweets actually engaged with them. This may be explained by that fact the majority of tweets without images from the @CardiffCurator account tend to be related to enquiries and their answers. Therefore they may not have a broad appeal but those directly interested in the enquiry were more likely to engage with them. However, it should be noted that the number of tweets without images included in this analysis was relatively small.

Anecdotal evidence from collating statistics seemed to suggest that the addition of more images also increased engagement rates e.g. in order to view all images easily users will click on images to expand them. Our data (Fig 6) shows that the average number of impressions gained is highest for tweets containing four images, whilst the average number of engagements and average engagement rate (excluding those without images) suggests that having three images per tweet is slightly better. At present this is based on a relatively small data set, and this will continue to be analysed. Whilst bright and colourful images do seem to attract attention, the importance of a tweet's wording shouldn't be overlooked. Table 2 contains data for four sample tweets, which utilised engaging angles or non-natural history related text to introduce the specimens and objects. All four tweets received relatively high engagement levels, which highlights the importance of good text alongside good images. Image orientation can also affect engagement rates, for instance, when we tweeted an image of a diatom in a landscape orientation with Welsh language text (812 impressions and 28 engagements) after the same image in portrait orientation with English text (570 impressions and 14 engagement) it received higher engagement rates. Twitter analytics shows that we generally receive a greater number of impressions for English language tweets than those in the Welsh language, indicating the image orientation was likely to be the contributing factor to the higher number of engagements. Although image orientation is something that could be tested further, anecdotal evidence (pers. comm. Sara Huws) supports this. This is therefore an important consideration with Twitter given that pictures in a portrait orientation will be displayed in a landscape letterbox, often obscuring important parts of the image.

Since using an integrated metrics system over the last six months, retweets have risen by 69%, favourites by 77% and number of followers by 27%. Whilst automatically calculated analytics are ex-

Tweet Text	Tweet Link	Impressions	Total Engagements
Food of the dinosaurs, a Jurassic cycad	https://twitter.com/CardiffCurator/status/523009522672361472	2,764	76
An evolutionary champion for #FossilFriday. 170 million year old Ginkgo, and one from our car park @Museum_Cardiff	https://twitter.com/CardiffCurator/status/492566426117734400	682	113
Candy-striped mint humbugs? No, Cretaceous corals from Cambridge! Smillotrochus angulate for #FossilFriday	https://twitter.com/CardiffCurator/status/568689695254835200	15,426	365
19th Century fossil bryozoan slides from the Victorian bryozoologist and corset-maker George R. Vine #FossilFriday	https://twitter.com/CardiffCurator/status/505252162931556352	2713	88

Table 2. Total number of impressions and engagements for sample tweets from the @CardiffCurator Twitter account.

tremely important for producing data, the addition of data by hand does give an added benefit and level of understanding. Although more time-consuming, it gives a greater sense of who is engaging with content. It is important to analyse the time spent on additional analytics compared to the benefits gained, to decide whether it is beneficial. On average, 1-2 hours per month are spent on analytics for the @CardiffCurator account, the associated benefits of which have been deemed to make it worthwhile. Twitter analytics has shown that it is important to look at a variety of metrics to determine how successful your presence on Twitter is. For instance, whilst number of followers of an account is important, it is more important to look at the number of people actually viewing material and engaging with it.

Day and time posted and inclusion of hashtags and Twitter handles undoubtedly have a great effect on engagement rates. We have found that early mornings, lunch times and evenings can often be busy periods with a lot of people both tweeting and viewing tweets. Whilst busy times may increase the level of engagements due to the number of people on Twitter, it can also mean that tweets are lost in the high volume of material being posted. Although daytime and weekends are often slow, fewer tweets are generally posted so tweets can have a high number of impressions and engagement rates. Seeing engagement rates in real time via analytical software, such as the Twitter Analytics Dashboard, is important for observing the effect of timings for different accounts. Whilst this pattern has been observed for @CardiffCurator, it is likely that different accounts will have varying demographics and different audience patterns.

Thinking and working in new ways

There is a great potential for much of the work that goes on behind the scenes in museums to be highlighted on social media. See for example, Freedman (2015) for examples of how and why NatSCA members use Twitter for promoting collections, networking with colleagues across the museum community and also opening up the often hidden world of museum stores and conservation labs. Museum professionals do not necessarily foresee how interesting and engaging even simple day-to-day activities are to those outside the confines of the museum walls. However, the success of tweets (in terms of engagement rates) highlighting these areas emphasises the public's interest in what we do. 'Careers and the world of work' and 'How scientists work' are important threads in the science curriculum (see, Department for Children, Education, Lifelong Learning and Skills, 2008 page 9 for instance) and presenting what goes on behind the scenes via social media is a great way of promoting this. Mortimer (2015) and Plant (2015) illustrate ways that the Department have promoted the work of scientists at the Museum.

Benefits of tweeting as a department

There are several benefits of tweeting as a department, as opposed to having individuals tweeting from different accounts. The main benefit is that once the system is set up, it reduces the amount of time and effort on any one individual and ensures that there is a constant stream of tweets, rather than flourishes of tweets fitted around the workload of individuals. It ensures that tweets are constructed by individual curators, who are specialists in a particular area rather than generalists, and ensures a variety of topics and styles are utilised to interest different demographics. If support is available to individuals who are less confident in the use of social media (i.e. those less likely to have their own Twitter accounts), it means that they are more likely to provide material, which adds to the diversity of content on the account. Certainly, for us, adopting this methodology has increased the number providing content significantly. Tweeting via a known or recognised department can often give credence to material being posted and a professional slant. It is also important that care is taken to give each curator an individual face and voice through their contributions, by allowing them to write their own tweets, post their own photos and by letting them choose the subject matter.

This method of departmental tweeting has been useful and beneficial for our department of over 30 members of staff, however, alternatives such as allowing individuals to use their personal Twitter accounts to share information about collections and their research are often utilised in other museums (often under the umbrella of organizational social

media policies providing guidance). Whilst this option may be preferable and more efficient in smaller organizations, it may not be the ideal option in larger organizations, particularly where there are limits on the number of accounts allowed. Large numbers of accounts can make it difficult to monitor what is being tweeted about/from the organization, and also in calculating the impact/success of using social media to highlight collections. Additionally, it can be tricky to successfully blur or separate the lines between employee's work and personal lives, so departmental accounts can give a viable option for institutional tweeting.

A further benefit of setting up a departmental account is that the account stays with an organization and is not effected by the movement of staff to and from roles. If personal accounts are utilised to build up the twitter presence of collections, this can be lost if the account holder moves to a new organization. Thus new staff may have to restart the process of developing an audience for the collection.

Helping hand

Setting up a departmental account can be problematic initially, particularly for those new to social media. There is often a lack of knowledge of the best way to create material (e.g. how to construct a tweet of 140 characters, how to make content engaging/relevant to the target audience and more successful), what is suitable for each platform and a lack of understanding of the importance and usefulness of social media. There are also practicality issues such as finding time to produce content and adapting methods to deal with the flow of content between curators and those posting material. Thus getting everybody involved and on-board takes time. Providing good support can make a huge difference to bridging this gap during initial stages. This can be done effectively using social media champions to impart training/knowledge (for instance, guidelines from Guerra & Pansters, 2014: 31 about constructing tweets) and feedback, and having a framework in place to organize material as discussed above. Once people are on-board it is important to keep momentum by providing feedback on the effectiveness of posts via analytics. This is done for the @CardiffCurator account by making data available in a readily accessible format each month for staff across the department and providing regular updates at departmental meetings to discuss best practice and ideas.

Conclusions

The journey to having a departmental face on social media has been challenging but has highlighted the huge benefits of using these platforms in promoting collections and their importance, research and events. The Twitter account for example, regularly receives between 150,000 and 175,000 impressions each month, acquainting to some 5,000 per day. Whilst not all users will engage with content, it is clear that this provides us with a large audience that potentially may not otherwise engage with our collections physically, either through museum visits or loans.

Additionally, it is an effective vehicle to answer enquiries and an ideal way to become connected with a variety of different communities (other museums, our local community or natural history societies for example). Many enquiries received are from people outside of the museum network from broad demographics. It is a great way to communicate with different audiences and a good way to look at the interdisciplinary facets (such as art, social history etc.) of our collections. This can be clearly shown from the variety of followers engaging with content, something that can be ascertained when calculating metrics by hand. Often the different angles that we look at collection objects from via social media is one that engages broad audiences. #SciArt is just one example of how people from different backgrounds can share a common interest in the same specimen as specimens are often both beautiful and interesting. Learning what audiences find engaging on social media also provides insight for other engagement activities such as open days and behind the scenes tours.

Effective teamwork, good communication and togetherness are vital to build a departmental profile. It is also prudent to link in with other departmental accounts across the organization in addition to the main institutional account(s) to get feedback, share good practice ideas and benchmark. Effective and strong branding is important for raising profiles, and this can be achieved by promoting logos on T-shirts, tablecloths and advocacy cards.

This case study provides information about techniques that have been beneficial for a departmental account in a National Museum promoting natural history collections. Whilst this may not be totally applicable to individuals working with smaller collections, many of the vehicles and techniques used may be useful.

Acknowledgements

The authors would like to thank members of staff in the Natural Sciences Department of Amgueddfa Cymru-National Museum Wales who contribute daily to social media content. In particular our social media champions Katherine Slade, Caroline Buttler and Andrew Haycock whose tireless efforts in support and providing content are vital to the success of outputs. Also to Annette Townsend and Julian Carter who run the @NatHistConserve Twitter account, which details all of the conservation activities within the Natural Sciences Department. The authors would additionally like to thank Sara Huws (Digital Content Officer) at the museum for increasing our skills and knowhow and also for her endless encouragement via Tweet-ups, Twitter Bulletins and support, and the two reviewers whose comments greatly improved this paper.

References

Bik, H. M. & Goldstein, M. C. 2013. An introduction to social media for Scientists, *PLOS Biology*, 11(4): pp.1-8.

Department for Children, Education, Lifelong Learning and Skills. 2008. *Science in the National Curriculum for Wales*, Cardiff: Welsh Assembly Government, 26.

Duggan, M., Ellison, N. B., Lampe, C., Lenhart, A, & Madden, M. 2015. *Social Media Update 2014* [Online], http://www.pewinternet.org/2015/01/09/social-media-update-2014/ [accessed 11 August 2015].

Freedman, J. 2015. *Social media – unleashing museum collections and their curators* [Online], http://advisor.museumsandheritage.com/industry/social-media-unleashing-museum-collections-and-their-curators/ [accessed 20 November 2015].

Guerra, R. & Pansters, F. 2014. *Museum Analytics Action Research Project (ARP)*. Utrecht: INTK, p.39.

Lenhart, A., Purcell, K. Smith, A. & Zickuhr, K. 2010. *Social media and mobile internet use among teens and young adults*, Washington: Pew Internet & American Life Project, p.37.

Mortimer, K. 2015. *Worms that Dig* [Online], http://www.museumwales.ac.uk/blog/2015-02-24/Worms-that-Dig/ [accessed 11 August 2015].

Mortimer, K., Mackie, A. S. Y. & Darbyshire, T. 2015. *Worms for Wednesday* [Online], https:// storify.com/CardiffCurator/worms-for-Wednesday [accessed 5 June 2015].

Mortimer, K., Wood, H. & Gallichan, J. 2014. *Magnificent Molluscs* [Online], https://storify.com/ Cardiff Curator/monday-for-molluscs [accessed 5 June 2015].

Plant, A. 2015. *Adrian in the Amazon - final part* [Online], http://www.museumwales.ac.uk/blog/2015-05-01/Adrian-in-the-Amazon---final-part [accessed 11 August 2015].

Stadd, A. 2014. *Tweets with photos drive much higher engagement across all metrics* [Online], http://www.adweek.com/socialtimes/tweets-with-photos/495601 [accessed 10 August 2015].

Stewart, E. P. 2010. Twitter and your organization, in *Twitter for Museums: Strategies and tactics for success. A collection of Essays*. Edinburgh: Museums Etc: pp.44-63.

Wilcox, C. 2012. Guest Editorial: It's Time To e-Volve: Taking Responsibility for Science Communication in a Digital Age, *Biological Bulletin*, 222: pp.85-87.

Zambonini, D. 2010. Starting out with Twitter, in *Twitter for Museums: Strategies and tactics for success. A collection of Essays*. Edinburgh: MuseumsEtc: pp.64-89.

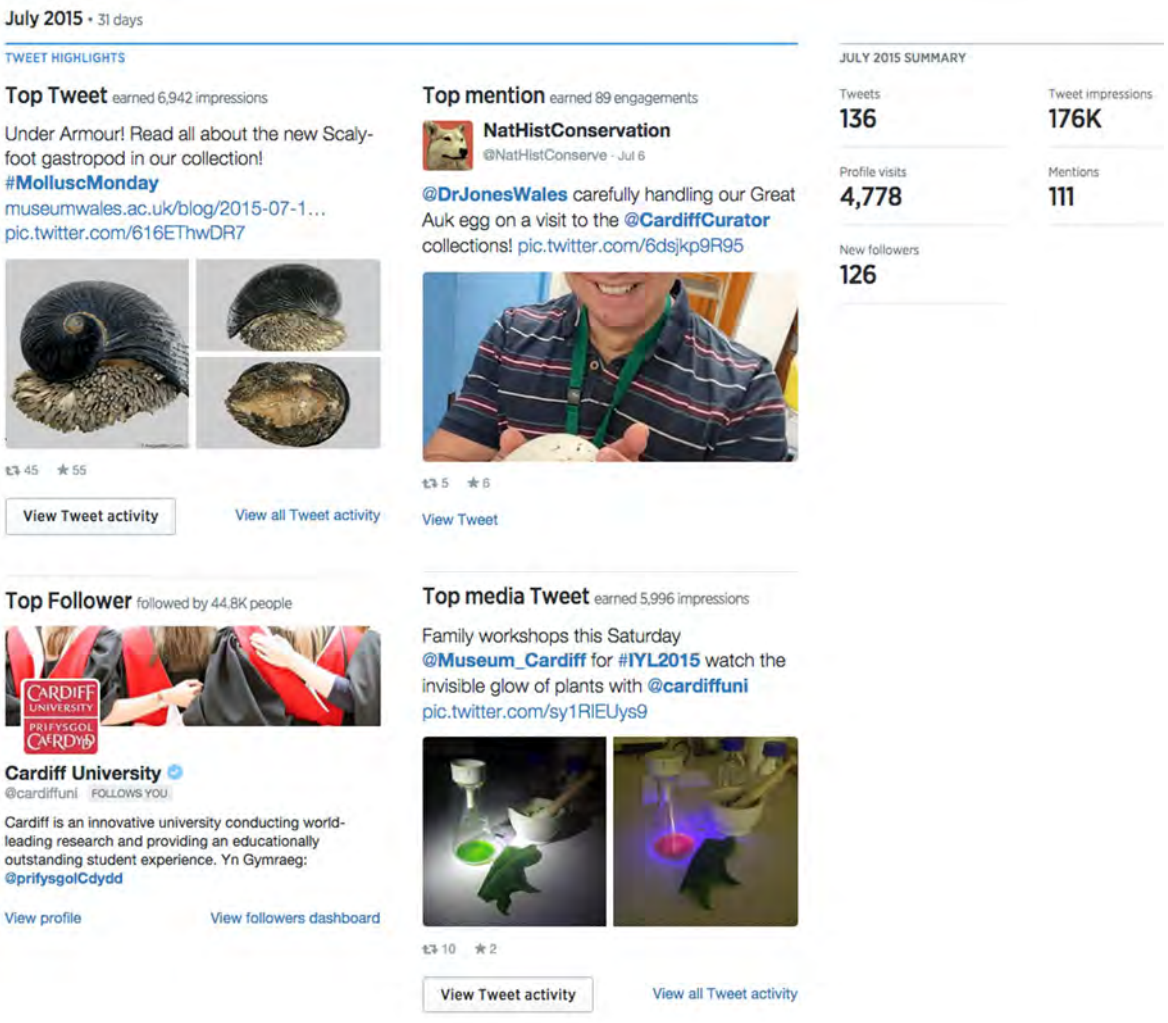
Useful links:

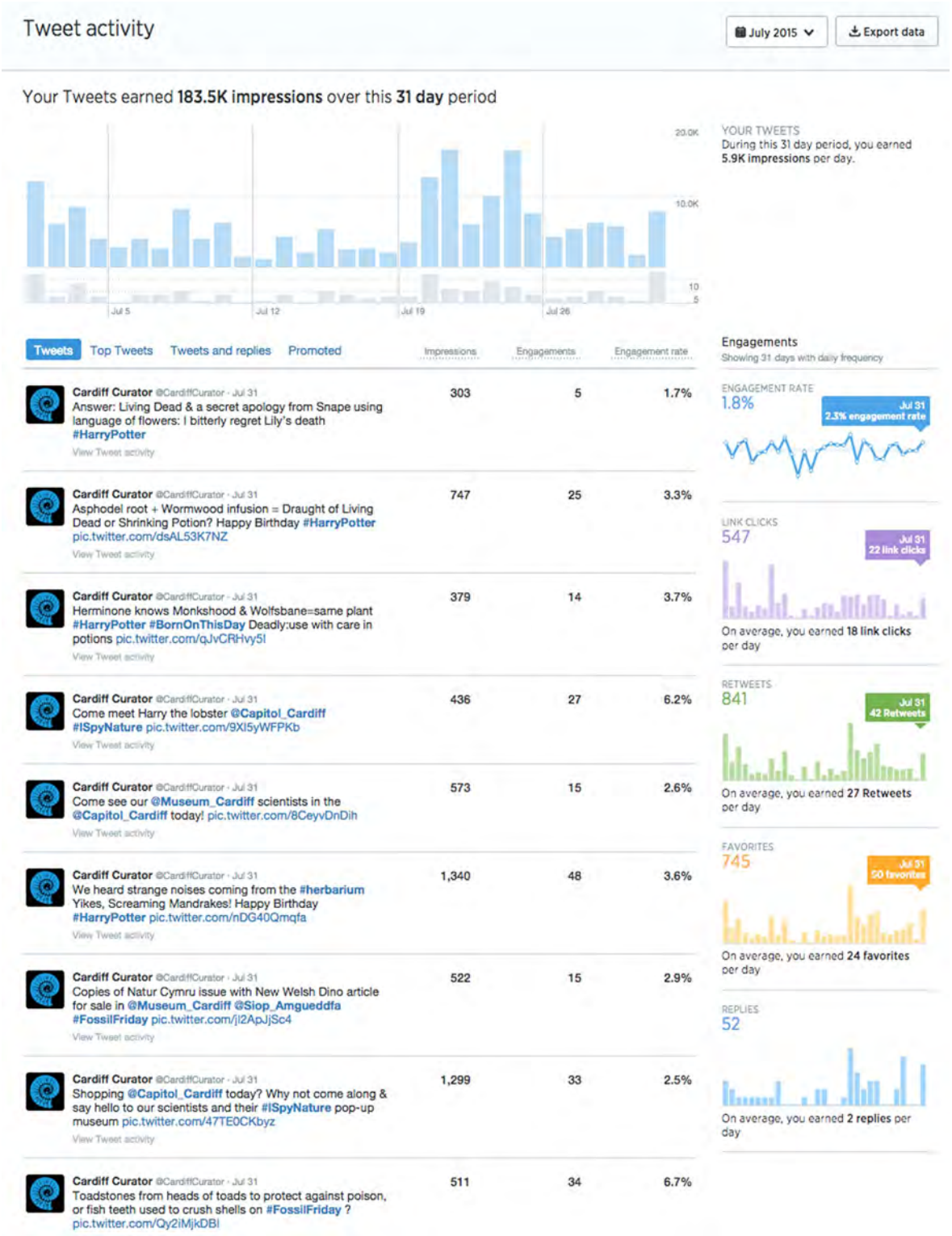
Google Analytics: https://www.google.co.uk/analytics/
Twitter Analytics: https://analytics.twitter.com

Appendix

Part of the Tweet Metrics for the @CardiffCurator Twitter account from July 2015 generated through the Twitter Analytics dashboard with added information on the number of images included in each tweet, and details of certain accounts that retweeted us. Spread sheet formatted for easier consumption by departmental staff.

Information from the Twitter Analytics dashboard for July 2015 for the @CardiffCurator Twitter account




Tweet activity
July 2015
Export data
Your Tweets earned 183.5K impressions over this 31 day period
20.0K
10.0K
10
5
Jul 5
Jul 12
Jul 19
Jul 26
YOUR TWEETS
During this 31 day period, you earned 5.9K impressions per day.
Tweets
Top Tweets
Tweets and replies
Promoted
Impressions
Engagements
Engagement rate
Cardiff Curator @CardiffCurator · Jul 31
Answer: Living Dead & a secret apology from Snape using language of flowers: I bitterly regret Lily's death #HarryPotter
View Tweet activity
303 5 1.7%
Cardiff Curator @CardiffCurator · Jul 31
Asphodel root + Wormwood infusion = Draught of Living Dead or Shrinking Potion? Happy Birthday #HarryPotter pic.twitter.com/dsAL53K7NZ
View Tweet activity
747 25 3.3%
Cardiff Curator @CardiffCurator · Jul 31
Herminone knows Monkshood & Wolfsbane=same plant #HarryPotter #BornOnThisDay Deadly:use with care in potions pic.twitter.com/qJvCRHvy5I
View Tweet activity
379 14 3.7%
Cardiff Curator @CardiffCurator · Jul 31
Come meet Harry the lobster @Capitol_Cardiff #ISpyNature pic.twitter.com/9XI5yWFPKb
View Tweet activity
436 27 6.2%
Cardiff Curator @CardiffCurator · Jul 31
Come see our @Museum_Cardiff scientists in the @Capitol_Cardiff today! pic.twitter.com/8CeyvDnDih
View Tweet activity
573 15 2.6%
Cardiff Curator @CardiffCurator · Jul 31
We heard strange noises coming from the #herbarium Yikes, Screaming Mandrakes! Happy Birthday #HarryPotter pic.twitter.com/nDG40Qmqfa
View Tweet activity
1,340 48 3.6%
Cardiff Curator @CardiffCurator · Jul 31
Copies of Natur Cymru issue with New Welsh Dino article for sale in @Museum_Cardiff @Siop_Amgueddfa #FossilFriday pic.twitter.com/jI2ApJjSc4
View Tweet activity
522 15 2.9%
Cardiff Curator @CardiffCurator · Jul 31
Shopping @Capitol_Cardiff today? Why not come along & say hello to our scientists and their #ISpyNature pop-up museum pic.twitter.com/47TE0CKbyz
View Tweet activity
1,299 33 2.5%
Cardiff Curator @CardiffCurator · Jul 31
Toadstones from heads of toads to protect against poison, or fish teeth used to crush shells on #FossilFriday ? pic.twitter.com/Qy2iMjkDBI
511 34 6.7%
Engagements
Showing 31 days with daily frequency
ENGAGEMENT RATE
1.8%
Jul 31
2.3% engagement rate
LINK CLICKS
547
Jul 31
22 link clicks
On average, you earned 18 link clicks per day
RETWEETS
841
Jul 31
42 Retweets
On average, you earned 27 Retweets per day
FAVORITES
745
Jul 31
50 favorites
On average, you earned 24 favorites per day
REPLIES
52
On average, you earned 2 replies per day

A method to safely move mounted skeletons

Nigel R. Larkin

Cambridge University Museum of Zoology,
Downing St, Cambridge, CB2 3EJ, UK

email: nrlarkin@easynet.co.uk

Received: 19th Sept 2015
Accepted: 20th Nov 2015

Abstract

Mounted skeletons in museums need to be moved occasionally for a variety of reasons. Sometimes within the museum site, but sometimes extensive road travel is required. In all instances it is best to at least partly disassemble the skeleton but all bones should be cleaned, labelled and photographed first in situ and extensive notes should be made as the skeleton is taken apart to aid re-assembly at a later date. However, dismantling should also be kept to the minimum possible to prevent unnecessary over-handling and damage being done to the bones in the process of taking them apart and reassembling them later. For instance as a minimum the skull, mandible, cervical vertebrae, tail and limbs would normally be removed but the skull and mandible might still be kept wired together and the bones of each limb may stay completely on its supporting mount, depending on how the specimen is mounted. Some bones will have been secured to the metalwork with irreversible methods in the past that may preclude some disassembly anyway. A good method for moving the complete ribcage (ribs, sternae and associated vertebrae plus the pelvic bones) is to build a wooden frame around the whole skeleton at the start and suspend the ribcage from a central beam using cotton tape, securing it to the uprights of the frame as well. This allows supporting limbs to be removed. Specimens should be transported on foam to absorb some vibrations, and the wooden frame can usually be secured to the side of the van. However, with road transport as much attention should be paid to the route taken and how the vehicle is driven as to how the specimen is packed.

Keywords: Skeleton; Bone; Conservation; Packing; Transport

Introduction

An articulated skeleton in a museum may need to be moved to another location for a variety of reasons: it can be sent out on loan; it may require conservation treatment by an external specialist; the pose may need to be adjusted by a mount-maker to suit a new exhibition; or a redevelopment project may mean that all specimens have to be moved off site or at least elsewhere on site.

Whatever the reason for removing a skeleton from display or storage, and whether the specimen only has to move a few hundred yards or needs to be transported hundreds of miles, it will be subjected to a series of processes that could inflict harm: partly or completely dismantling the specimen; packing the specimen; moving the specimen; and all the manhandling involved in moving a specimen across a museum site or getting a specimen to a vehicle and into the vehicle, then getting it out again. At every stage mistakes can be made that can potentially have long term consequences.

Larkin, N. R. 2016. A method to safely move mounted skeletons. *Journal of Natural Science Collections.* **3.** pp.29-37.

There are descriptions in conservation literature of how to pack fluid-preserved specimens, taxidermy specimens and some other natural history objects (e.g. Carter & Walker, 1999). Apart from one good description of how to move a mounted fossil Miocene skeleton (Brown and Seevers, 1990) there is very little guidance published as to how a fully mounted or partially mounted medium-sized or large modern or historical skeleton could or should be moved and transported. This article attempts to address this by giving examples of how some skeletons have been packed and moved either in to temporary storage or been transported by road.

Dismantling skeletons

The process of even just partly dismantling a specimen is when harm might first be inflicted, both immediately and in the long term. If handled incorrectly bones can easily be broken during the dismantling process. If individual bones are not adequately labelled or not enough photographs are taken before dismantling mistakes might be made when remounting the bones at a later date. Sadly there are very rarely any records in museums detailing exactly – or even vaguely - how a skeleton was mounted in the past to provide a guide as to how it should be taken apart. You are faced with a complex and sometimes very fragile three-dimensional puzzle and you have to figure out how the skeleton comes apart and in what order. Therefore the specimen should first be dusted with a soft brush and vacuum cleaner with the nozzle covered in gauze (Fig 1) so that the clean skeleton can then be carefully studied and photographed from all angles before the dismantling process starts. This means that the details in the photographs will be clearer and also you will not be breathing in the dust during the dismantling process.

It is best practice to label the bones with clear legible handwriting on tie-on labels whilst the bones are still mounted, to avoid any confusion (rather than labelling them after their removal). Information on the label should include the specimen's unique number as well as what the element is e.g. '*Pongo pygmaeus* GMZ409: rib 15, right'. It is also worth taking photographs of the bones and their labels whilst the bones are still in situ on the specimen. To make the remounting process even easier at a later date, detailed notes should be made about how the specimen is mounted, with further photographs taken of details of the metalwork, and also diagrams should be drawn to explain the notes and photos. This is necessary even if you expect to be remounting the skeleton yourself in a matter of weeks: plans change, projects get shelved and people move jobs.

The metalwork that bones fit on to should also be labelled adequately. If parts of the supporting armature have to be removed they should certainly be labelled (again not just what part they are but what animal the armature belongs to), then photos should be taken of the mountwork with the labels legible (as they can become detached). It may also be worth recording the exact positon of the armature being removed e.g. how far away one end is from a nearby bone, and maybe even take photos of the tape measure in use, showing the items being measured and what the measurement is.

Depending on why you are dismounting a skeleton, it may well be best not to dismantle all the bones of the specimen and remove them from the metal mount unless you really have to. Whole limbs removed from skeletons might be easily and suitably packed as they are, without the need for individual bones to be removed (Fig 2). The less you dismantle the skeleton from mountwork and the less handling of the bones the better. Minimal handling of the bones leads to less physical damage being inflicted and removing fewer bones will certainly reduce the scope for bones being muddled up. This is usually the case with ribcages and associated vertebrae if all the ribs are wired together and wired to the vertebrae and to the sternum. It would not

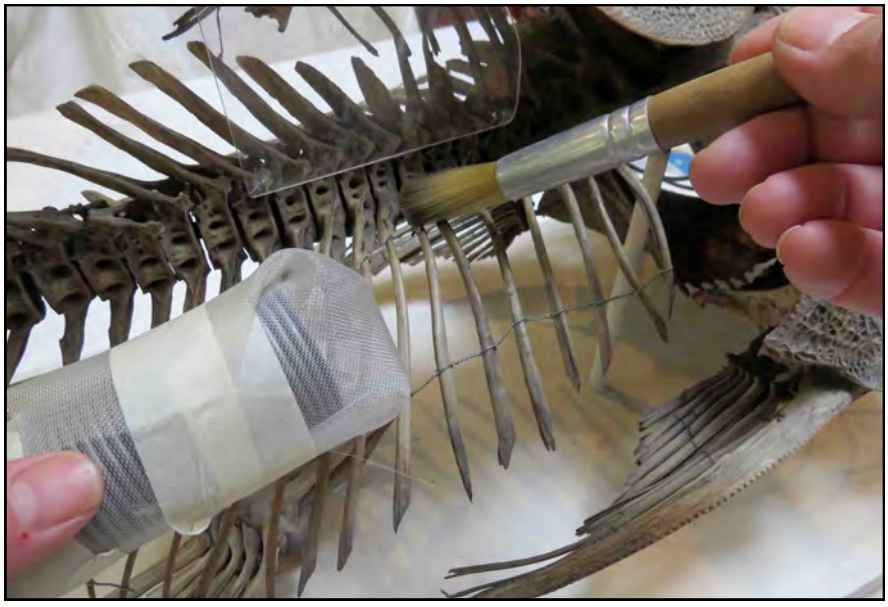


Fig. 1. Gauze taped over the end of the vacuum cleaner's nozzle whilst cleaning a skeleton with a soft brush. This prevents any small pieces entering the vacuum cleaner if they become detached.

only be very easy to damage the long thin ribs during the lengthy unwiring process but also when handling them and when wiring them up again later. There is a very successful alternative to all that unwiring and wiring up again, which is described below.

Be aware from the outset that in the past some people did not really think in the long term. Many specimens were mounted in a way that clearly would not allow for easy dismantling later on. They must have assumed these displays were never going to be changed and that curators would be happy with these exact poses for many years to come. An articulated skeleton may have had bones broken and then glued together again around the metalwork with non-reversible resins. Some bones may have simply been glued to the metal mount – again with irreversible resins – such as vertebrae adhered to a horizontal vertebral pole to stop them slipping and rotating. Unpainted metalwork may have rusted badly and in the process become firmly attached to bones. In these cases the metalwork cannot be removed and re-shaped and this may thwart your plans to completely dismantle a specimen or change the pose.

Some bones may be held in place with blank-headed coach bolts which makes undoing them much more difficult as you cannot hold one end still with a screwdriver or spanner whilst undoing the nut on the other end. And/or this nut and bolt may be rusted together and/or have their thread bunged up with several applications of paint. Rust is relatively easy to deal with by applying a lubricant such as WD40. Spray a little WD40 into a jar and then apply it exactly where it is needed with a cotton bud or a small brush, wiping away any excess so that it does not drip onto bones or onto the plinth. It is best to apply it a day or so before you need to undo the nuts so it can sink in, and it may need to be applied a couple of times. Paint in the thread of a bolt might be removed with a combination of scalpels and wire brushes but otherwise you can try very carefully applying a paint-stripper product. If it can be done safely you may need to resort to a boltcutter if no bones will be damaged in the process. There may not be room for this and a hacksaw might be necessary but bear in mind that the sawing action can make the skeleton sway a considerable amount so this should be done once as many bones as possible have been removed and it is useful to have someone else hold the mount steady. Ideally hacksaws and boltcutters would not be needed as it is best to re-use all the old mountwork as long as it is still fit for the job, down to the nuts, bolts and washers as they are part of the historical mount.

The good thing is that if you have to dismantle many articulated skeletons in a museum, once you have done the first one or two you often find the others are mounted in exactly the same way so the process becomes easier and quicker.

Fig. 2. The forelimbs of a finback whale at Cambridge University Museum of Zoology, being packed complete without further dismantling after some metal brackets had been removed, cleaned, repainted and replaced. Each limb was stored on several layers of acid-free tissue paper on bubblewrap rolls shaped to provide a snug fit for the bones. This was all on a thick layer of Plastazote foam inside a wooden crate which was easily carried by two people.

Packing bones removed from skeletons

When packing bones that have been removed from a skeleton it is best not to completely wrap them. Bones can be damaged when rolling them out of packing materials, even tissue paper, because their fragility cannot be appreciated until they are unwrapped and the physical unwrapping leads to overhandling. An alternative is to place the bone or articulated bones the safest way round onto a few sheets of acid-free tissue paper lying on a suitable amount of bubblewrap. Pick up the specimen and its bubblewrap and tissue all in one go and place into the packing box or crate, which may already be lined with more bubblewrap or Plastazote foam. Next, arrange the packing material so that the bone/bones is/are fitting snugly in the crate and only touching the tissue. Add more bubblewrap or acid-free tissue underneath and around the specimen as required and add more bones suitably packed until the specimens are sitting well protected in the crate and will not move in any direction. You will easily be able to see exactly what bones are in the box or crate, and hopefully also be able to read their labels (Fig 3). If you want the specimens covered, you can add layers of acid-free tissue, then bubblewrap and/or fluted polypropylene

Fig. 3. On the left is a hippo skull upside down (the safest way to store it) in a wooden crate. On the right are four feet of a diprotodon skeleton packed in a large, sturdy, stackable polypropylene Eurocrate. In both cases the bones sit on several sheets of acid-free tissue under which bubblewrap has been arranged to provide comfortable snug nests in which the bones are held securely. The bones have not been overwrapped, meaning they will already be visible before the unpacking process starts. Lids can be placed on top to keep off dust and prevent accidents.

display board (commonly known by the trade name 'Correx'). Some bones will be too big for standard crates and boxes and should not be handled and moved on their own but should be moved and stored on suitably sturdy bespoke pallets or in bespoke wooden crates lined with appropriate conservation packing materials (Fig 4). This cuts down on over handling and consequent accidental damage during loading, unloading, transport and storage.

If a skeleton is being partly dismantled and stored it is best to keep all the bones together if possible and to cover the specimen to protect it and keep off dust. This is easily done with simple tools and a combination of wooden batons, plywood, screws, cotton tape, Plastazote foam and either Correx (Fig 5) or more plywood. If you are in the midst of a large decant project and you do not know where the specimen is going to be stored, always pack it securely enough that it can safely undergo road transport if need be. Photographs of the specimen can be attached to the outside of the box so that staff moving it are aware of exactly what is inside. However, in the case of ivory, rhino horn or other high value items you may not want to draw attention to the contents.

Preparing skeletons for road transport

Something as small as a python skeleton might still be easily transported in off-the shelf storage media such as a large Euro crate if it is suitably lined with

Fig. 4. This Asian elephant skull is ready for transport. It sits on a bespoke pallet made with batons and plywood, lined with Plastazote foam and with two 'handles' (the batons) sticking out at either end to make it easy for two or four people to carry it. The top of the skull is covered in acid-free tissue so that the cotton tape does not damage the skull. The cotton tape is applied in many directions, and was staple-gunned to the pallet, to help prevent the skull from rolling off the pallet during transport. Also, either side of the skull blocks of Plastazote foam are glued to the foam the skull is sitting on to help hold it in place securely.

Fig. 5. This Ganges river dolphin was partially dismantled (the skull and mandible removed) and packed for temporary storage whilst the Cambridge University Museum of Zoology underwent redevelopment. Note: the skeleton is hanging from the central horizontal beam of a frame made of wooden batons; the protective sides are made of fluted polypropylene display board ('Correx'); the front side is hinged with polypropylene cable ties so the specimen can be accessed (this side is tied back in place, upright, with cotton tape); the skull and mandible lay on a Plastazote-lined plywood base and have Plastazote foam glued in place around them so they cannot move; and the forelimbs are also held in place with blocks of Plastazote foam glued to the base. If this specimen required transport by road, the forelimbs would have also been removed.

Plastazote foam and well packed with lots of small pieces of Plastazote foam and acid-free tissue underneath and around the bones so that the specimen does not 'bounce' and damage the spine. Most larger skeletons will require specific bespoke solutions to be transported and these can probably simply be different versions of the same basic arrangement: a sturdy well-made wooden baton frame with central lengthways beam to which the skeleton can be attached and from which the vertebrae can hang.

After carefully removing the skull, tail and possibly the cervical vertebrae (suitably cleaning, labelling and photographing them first) to reduce the chances of them being damaged, a wooden frame just a bit larger than the remaining skeleton should be made out of batons (square timber in cross section, about 2" x 2" or approx. 4cm by 4cm in size). Four lengths of batons are required, plus four uprights and four widths (Figs 6, 7 & 8). It is best to use small metal right-angle brackets (just visible in Fig 6) to secure these batons to one another at the corners, and have some extra wooden bracing externally at the corners (Fig 6). One more length of baton should be placed along the midline on top of the two upper widths, secured in place with more right-angled brackets.

Tie several loops of cotton tape so that they go under the vertebrae and over the central beam so that they are snug but not overtight, and well spaced from one end to the other. These will take the weight of the specimen once the legs are removed, so use plenty of cotton tape loops to spread the weight. Once this is done the legs, pelvis and their supporting metalwork can be dismantled and suitably packed away, leaving the ribcage, sternum and associated vertebrae hanging within the wooden frame. If the pelvis cannot be removed, make sure this is strung up in place with the cotton tape as well before the rear legs are removed.

Obviously you do not want this ribcage to be swinging from side to side when on a trolley or in the back of a vehicle, so use more cotton tape to tie it to the four uprights, in every direction, and you can also tie it to the lower lengths of wood. The tape should not be slack, nor overtight. This should stop most side to side and back and forth movement. For additional security, you can add more batons or planks to the side of the frame at the widest point of the ribcage and pack further with Plastazote foam and tissue paper etc, or you can use a sheet of Tyvek to sling underneath and around the ribcage, securing this to the upper beams either side with a staplegun (Figs 6 and 7). This will hold the rib cage very securely, provide some support and catch any pieces that fall off (which would be a very rare occurrence). The cotton tape usefully absorbs some of the vibrations during road transport.

If you make a rigid plywood base for the frame, this could be lined with Plastazote foam and the limbs, skull, mandible, tail and cervical vertebrae etc. could all be stored and transported on this below

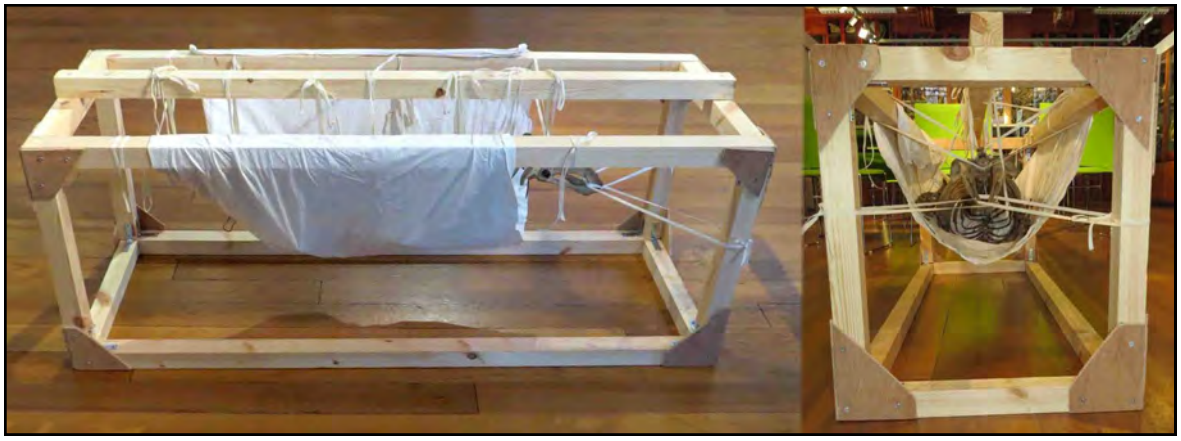


Fig. 6. A seal skeleton ready for transport in its wooden frame after its skull, mandible and rear limbs have been removed. It is suspended from the central beam with cotton tape running underneath several vertebrae and cotton tape is also used to tie the skeleton to the upright batons in the corners to stop it from moving backwards and forwards and side to side when in transit. The ribcage is also held securely in place with Tyvek staple-gunned to the frame. The image on the right shows the additional external wooden bracing in the corners.

the ribcage. You can add plywood sides for extra security, depending on requirements.

When using a hired van for larger specimens, one advantage is that they are usually boarded-out with plywood already. This means that simple shelf brackets can be used (Fig 8) to hold your specimen in place securely, screwing the wooden frame to one side of the van so that it cannot move backwards, forwards or sideways and will not sway within the van. If necessary, a large beam can be secured across the van widthways in the same way to help hold larger specimens (Fig 8). The framework should always be positioned on a large piece (s) of soft foam, to absorb as much vibration from the road as possible. Even the largest set of giant deer antlers can be transported this way, held comfortably in position in a giant web of cotton tape. Unless you are certain that the specimen will only be moved across perfectly smooth floors to and from a waiting vehicle it is best not to put wheels under this frame (which would put it at risk from unwanted vibration from a rough floor) but instead have enough people to carry it safely to and from the vehicle at either end of the journey. To make this easier, cut two planks or batons of wood slightly longer than the wooden frame and securely screw these to the frame at a height that will make it comfortable to lift and carry the specimen (Fig 8), especially bearing in mind the height of any doorways *en route*. Covering the whole specimen and its travelling frame with Tyvek would be useful if there is no loading bay and rain is expected, but it also catches the wind like a sail. If a tall or large specimen is being moved by hand this can make it very awkward. It is also very useful to be able to see how the bones are moving when carrying the skeleton to and from a vehicle, so that people can be slowed down or asked to move differently if bones are swinging or vibrating too much. Therefore too much Tyvek covering the specimen can be a bad thing. However, Tyvek is so easily added to the frame with a staplegun that the decision can literally be left until the last minute.

Driving with skeletons on board

Obviously, if you have a partially mounted skeleton or fragile giant deer antlers in the back of your vehicle you will need to drive very carefully e.g. avoiding potholes and raised ironwork in the road, taking corners and roundabouts gently and slowly and not braking sharply. However, it is also worth thinking about what route you should take to get to your destination. If you happen to know the roads it is

Fig. 7. A quagga skeleton with its plinth and upright metal supports held securely within a wooden frame ready for transport after the skull, mandible, tail and limbs have been removed. An extra central plank holds the upright metalwork securely in place whilst the pelvis, vertebrae and rib cage are all held securely in place with cotton tape tying them to the central beam and corner uprights. Tyvek staple-gunned to the horizontal beams provides additional security for the ribs.

Fig. 8. The ribcage of an adult rhino skeleton in the back of a van, ready for transport. Note the whole specimen and its frame is sitting on foam mattresses and the frame is secured to the sides of the van (the white shelf bracket at top left is clearly visible, the one at top right is screwed in behind the beam). Also, planks have been screwed to the side of the frame low down to act as handles so that the specimen is carried at a more comfortable height to and from the vehicle.

worth avoiding those that have particularly bad surfaces or that involve a lot of traffic lights and roundabouts and all the associated stopping and starting and going round bends. In this respect taking a longer route via a motorway would usually be preferable rather than shorter routes along 'A roads' and through town centres. There are exceptions, however: as an example, the raised section of the M6 motorway through Birmingham is built in sections and there is a sharp jolt experienced as a vehicle travels over the join in the road surface. Over just a few miles this adds up to hundreds of unnecessary jolts when the much newer and smoother M6 toll road could be used instead. Some of the worst roads are those of the inner cities such as central London, full of poorly patched trenches making an extremely uneven road surface in some areas. These roads have to be travelled with extra caution and at a greatly reduced speed to minimise swaying and bouncing of the bones in the back of the vehicle, particularly in vans where the swaying motion experienced is greater than that of cars as the vans are higher off the road and the uneven nature of the road surface gets exaggerated. Whatever the destination and the route taken, always make sure well in advance that the specimen and the driver – whether a member of staff or an external contractor - are insured for this sort of journey.

Not moving skeletons

Sometimes it is simply less risky, although at first maybe counterintuitive, not to move a specimen. For instance although the Zoology Museum at the University of Cambridge was going to be refurbished between 2014 and 2016 and would be a building site for a couple of years and the whale skeletons hanging from the ceiling would be at risk directly from builders and also the dust they generate, it would also have been quite a risk to try to dismantle the skeletons and take them down. They were hanging 12m above the gallery floor, weighed a lot and were very fragile. The relative risks had to be weighed against one another. The compromise was to remove the skulls, mandibles and limbs from the whales as these extremities would be the most vulnerable to damage as well as being the most useful taxonomically. This was easier said than done: the bones were cleaned, labelled, photographed and removed when standing on a platform swaying about ten metres above the gallery floor (Fig 9) and the space around the skeletons was limited by the size of the scaffolding platform. All the skulls, mandibles and limbs were packed for storage with the exception of the largest and heaviest skull which was deemed too unsafe to be removed under these conditions, especially considering it would have to carried all the way down the scaffolding tower as well. So this skull was left in place. It and all the other bones left at height (mostly just vertebrae and ribcages) were wrapped with acid-free tissue, then bubble wrap and Tyvek to protect them as best as possible from the building work.

Similarly, back down on the gallery floor the largest skeletons (including the African elephant and giraffe) were partially dismantled with their skulls, mandibles, tails and legs removed but their rib cages left intact. These remained on their metal frames on plinths which were totally enclosed within very sturdy wooden crates on wheels. These were covered in plastic sheets to protect them from water and taped-up to protect them from the inevitable ingress of dust and were left on site with instructions that they were only to be moved by museum staff. This saved a huge number of person-hours undertaking further dismantling work, reduced the chances of damage from all the extra unwiring of ribs etc and then the subsequent wiring back up again later on, plus reduced the chances of the plinths and the metalwork being damaged, muddled or lost when being taken to temporary storage and being returned and remounted.

Fig. 9. The author at the top of a 10m high scaffolding tower wrapping a large whale's ribcage and vertebrae (that hang from the ceiling) with acid-free tissue, bubblewrap and Tyvek after removing the more vulnerable bones. In the foreground is another whale already wrapped for the duration of the redevelopment project at Cambridge University's Zoology Museum (photograph courtesy of Matt Lowe, UCMZ).

Health and Safety

The immediate and long-term safety of specimens is always a central concern to professionals working in museums but this must never be at the expense of those working on or around the specimen. Mechanical handling equipment should be used where possible rather than undertaking manual handing, and training should be given in manual handling when it is required. Risk assessments should always be undertaken, especially when working at height even when just using a stepladder. Personal protective equipment appropriate to the task in hand must always be worn. If scaffolding towers of any height are to be used please be aware that they can only be legally assembled by staff or contractors licensed to do so. For the redevelopment project at Cambridge University Museum of Zoology several people including the author attended a PASMA scaffolding course run by HSS Hire. PASMA stands for Prefabricated Access Suppliers and Manufacturers Association. The standard 'Tower For Users' PASMA training course takes one day and attendees have to pass an examination to be awarded a licence valid for 5 years. This course teaches not only how build and operate a scaffolding tower, but very usefully how to identify when hire companies have sent defective or simply wrong parts which became apparent is a worryingly common occurrence.

Conclusions

If you need to move a skeleton more than a short distance (e.g. within a storeroom or gallery) it is best to at least partly dismantle it first to reduce the chances of an accident and reduces the seriousness of potential accidents. However, do not expect any dismantling of a skeleton to be straightforward. It is unlikely that there will be a record of how the skeleton was originally mounted and some bones may have been glued to the mount with irreversible resins so that the metalwork cannot be removed. If your intention is to get the metal mount adjusted this inability to remove some of the bones from the metalwork so it can be re-shaped will compromise your intended project. If at all possible, do not move the skeleton but remove the most vulnerable pieces. If it has to be moved, move it the shortest distance possible as long as it is left in a safe place, well protected. If a specimen is really large but would be vulnerable if moved yet a decant project is underway, consider leaving the specimen on site in a sturdy builder-proof crate, well labelled.

However, it is normally relatively easy to partially dismantle a skeleton enough to prepare it to be moved safely, even by road. The likelihood of having problems with remounting the specimen at a later date can be reduced if the bones are labelled before their removal from the skeleton and if extensive notes and numerous photographs are taken before and during the dismantling process to record in detail exactly how the skeleton is mounted and how it should be put back together. If articulated sections of the skeleton – such as a complete limb, or the vertebrae of the tail - can be removed as single units without risking damage to the bones, this is preferably to removing all of the individual bones one by one and over handling them and removing all the their connecting metalwork.

In particular, rib cages and their associated vertebrae and sternae that have been wired together would be quite vulnerable to damage if they were unwired to be totally dismantled and then were wired-up again at a later stage. Unless they have been wired together badly and the opportunity should be taken to redo the job, it would be best to leave them wired together as they are. The whole ribcage can be safely transported suspended by numerous lengths of cotton tape within a wooden baton cage, maybe with Tyvek holding it snugly from below and from the sides as well, but always placed on a foam mattress and secured to the inside of a van. A wide variety of specimens, even very large sets of giant deer antlers, have been moved safely this way without any breakage being incurred.

It is easy to forget that projects such as those described above appear very unusual, surreal or even exotic to members of the public. They are highly visual and can easily be exploited for publicity via 'social media' and more traditional means such as newspapers and local TV and radio news. Videos of time lapse photography and/or blog posts and twitter feeds of the process as it happens in real time are gold dust to public engagement, especially when a museum is closed to the public but needs to remain engaged with its audience. Using such methods will show what is going on behind the scenes and will help to explain why a project takes so long. They can also enhance the recorded history of a specimen and could even be useful when it comes to re-articulation.

Acknowledgements

The transport, cleaning, re-mounting and conservation of the python, seal, quagga and rhino skeletons used as examples was part of the University College London Grant Museum of Zoology's 'Bone Idols' Project (funded by NatSCA, Arts Council England's Museum Development Fund and various members of the public). Thanks are due to staff of the Grant Museum for their assistance and for permission to use images of their specimens in figures 1, 7, 8, 9, and 10. The finback whale, Ganges river dolphin, elephant skull and the whales hanging from the ceiling were cleaned, dismantled and packed as part of the University of Cambridge Museum of Zoology's redevelopment project and images of their specimens (Figs 2, 3, 4, 5, 6 and 11) are used with their permission. Thanks are due to the whole team at UCMZ for their assistance especially the Collections Manager Matt Lowe. Thanks are also due to the organisers of the NatSCA event at Cambridge in September 2015 'Bone collections: using, conserving and understanding osteology in museums', for inviting the author to present a talk 'Bones of Contention', part of which this paper is based on. Thanks are also due to the anonymous reviewers for their comments on the paper.

References

Brown, G. W. & Seevers, K. 1990. A method for safely moving mounted skeletons, *Journal of Vertebrate Paleontology*, SVP Abstracts of Papers, Vol. 10, Supplement to No. 3: 15A-16A.

Carter, D. J. & Walker, A. K. (eds.) 1999. *Care and conservation of natural history collections*, Oxford: Butterworth Heinemann.

Cleaning, packing and moving a 115 year old taxidermied adult male orang-utan, stuck in a very fragile old nest of leaves in a tree with other nests

Nigel R. Larkin

Cambridge University Museum of Zoology,
Downing St, Cambridge, CB2 3EJ, UK

email: nrlarkin@easynet.co.uk

Received: 19th Sept 2015
Accepted: 20th Nov 2015

Abstract

For many years the Cambridge University Museum of Zoology has had on display a taxidermy specimen of an adult male orangutan sitting on a 'nest' it had made. This was still situated within the original branches and these also held two other orangutan nests. The orang-utan, branches and nests were at least 115 years old, making the leaves, twigs and branches very fragile indeed. Unfortunately, as part of a major refurbishment project, the specimen unavoidably had to be cleaned, packed-up and moved into temporary accommodation elsewhere on site. The cleaning of the fragile nests had to involve as little contact as possible so as not to damage the leaves or interfere with their arrangement, and precautions had to be taken in case the specimen had been treated with pesticides historically. The orangutan, branches and fragile nests all had to be packed securely so that they would not get damaged when decanted to the new store. No advice was found in existing literature so suitable methods were devised including: the use of a 'puffer' camera lens cleaner to blow dust off the specimens; wrapping the nests in acid-free tissue and Tyvek; and holding the branches and orang-utan in place with batons lined appropriately with Plastazote foam and secured to the sides of a bespoke wooden crate.

Keywords: Orangutan; Taxidermy; Conservation; Cleaning; Packing; Moving

Introduction

A taxidermy specimen of an adult male Bornean orangutan (*Pongo pygmaeus* [Linnaeus, 1760]; museum number E.7107.H; accessioned in 1899) has been on display in the Cambridge University Museum of Zoology for decades. The specimen sits on a nest of bent branches and leaves of a small tree that also contains two other (empty) orangutan nests (Figs 1 and 2). The museum's documentation states that the nest in which the Orangutan sits is thought to have been made by it to offer some protection against the wind according to the donor, Dr C. Hose.

It is believed that this is the only specimen on display in the UK of an orangutan sitting on a nest it has made. There used to be one at the Natural History Museum in London but it now sits only on a branch and is used for temporary exhibitions (pers. comm. Roberto Portela Miguez, 2015).

As the leaves and branches of the nests are at least 115 years old they are extremely delicate, brittle and fragile and crumble easily. Any cleaning of the orangutan specimen, the nests or the tree should be undertaken extremely carefully and minimally, if at all.

Larkin, N. R. 2016. Cleaning, packing and moving a 115 year old taxidermied adult male orang-utan, stuck in a very fragile old nest of leaves in a tree with other nests. *Journal of Natural Science Collections*. **3.** pp. 38-42.

Fig. 1. The orangutan (museum number E.7107.H) sitting on its nest within the branches, with two more nests below. Front view, behind display case glass.

Fig. 2. The orangutan (museum number E.7107.H) sitting on its nest within the branches, with two more nests below. Side view.

Not just because the material is very old, very fragile and very difficult to replace but also because it is covered lightly in a black powder that may well be a historical pesticide such as arsenic (samples of the dark black powder were kept for possible analysis at a later date). Similarly, the whole specimen should not be moved at all unless absolutely necessary because: it is top heavy with the orangutan sitting on the topmost nest (it cannot be removed as it is attached firmly to the upright pole that supports the tree and it would have to be taken apart to find out how it is attached) making it awkward and more prone to damage if moved; moving it anyway would risk damaging the specimen even if it was not top heavy; and because before the moving process could begin the specimen would have to be cleaned before any packing, to reduce the chances of pesticides being inhaled, ingested or absorbed - and cleaning the specimen, as already stated, would itself pose a risk of damaging the specimen.

However, in 2013 museum staff had to begin preparations to decant all the museum's c.4,000,000 specimens to new stores on site – including all the material on display – as the whole building in which the museum was located was to become a construction site. Not only did the six-storey 1960's building badly need complete refurbishment, the area it occupied was to become the new 'Cambridge Conservation Initiative', a unique collaboration between the University of Cambridge and the Cambridge-based cluster of leading conservation organisations as well as the Museum of Zoology. The incidental and unavoidable complete refurbishment of the Museum of Zoology meant that exciting new displays could be planned as well as the re-interpretation of all the old favourite beasts, with the opening planned for the Autumn of 2016. However, this construction project did mean that all the display specimens – including the orangutan – would indeed have to be packed up and moved into temporary accommodation due to the extreme nature of the work required on site. The specimen in theory only needed to be moved a few hundred yards but this would have to happen twice (there and back again) and methods had to be devised to clean, pack and move the fragile specimen without inflicting any damage at all, and leave it in temporary storage for about two years.

Cleaning the specimen

The orangutan, branches and leaves were all lightly covered in an unusual very fine black dust, as well as the more normal brown and grey museum dust and fluff. As the specimen was accessioned in 1899 and had no conservation notes on file as to what treatment it had received in the past to prevent pest infestation the safest course was to assume that this was a pesticide powder. In the past many museum specimens were directly sprayed or dusted with insecticides such as Lindane or dichlorodiphenyltrichloroethane (DDT) and mammal skins in particular had arsenic applied (Carter & Walker, 1999). In fact this was happening until quite recently (Hawks & Williams, 1986; Knapp, 2000). Even if

Fig. 3. Close-up of the empty nest to the specimen's left.

the suspicious looking dark dust had not been spotted on this specimen, it would have been cleaned while wearing disposable gloves and dust-masks as a matter of course to avoid the inhalation or absorption of the pesticides, which must be assumed to have been used on this specimen in the past. Extra precautions were taken, however, to make sure that the dust did not spread during the cleaning process. A vacuum cleaner with a good (HEPA) filter was used continuously to tidy up scrupulously, and no-one else was working nearby. Also, the glass doors to the display cabinet were kept shut unless work was underway.

The leaves and twigs of the nests (Fig 3) had to be cleaned as they were. They could not be removed and cleaned individually as not only would this disrupt their order and the integrity of the nest but the leaves were far too fragile to touch as they would crumble so easily. In fact they had to be cleaned without being touched, not even by a brush. A vacuum cleaner could not do the job, even a gentle museum vac would destroy the leaves instantly if it was held close enough to remove the dust on its own. The solution was to deploy a rubber 'puffer' such as used to clean camera lenses (Fig 4). The bulb of the puffer was squeezed to produce a gentle jet of air in a controlled manner and this blew the dust off the individual leaves as required. The twigs, branches, upright supporting pole and the plinth were also brushed gently with a very soft artist's brush at the same time as using the puffer, as was the orangutan. In retrospect, cleaning the orangutan itself could have been undertaken with a low-suction museum vacuum cleaner although the hoses of these tend to be relatively short and the specimen sits high up on the branches so this could have been awkward. Also, using the puffer was a more gentle method. The process of cleaning using the puffer started at the top of the specimen, the orangutan's head, and worked downwards. At all times a vacuum cleaner was held nearby, close enough to catch all the dust that was blown towards it but not so close that its suction presented a danger to even the smallest of the fragile leaves.

Packing the specimen

Once the specimen had been cleaned as much as practicable, the process could begin to give it adequate support so that everything stayed in place when it was moved. At the time of packing, it was not clear where the specimen was going to be stored so it was packed to cover all eventualities, even robustly enough to survive road transport if need be. The intention was that no branch would sway or vibrate, and no leaves would be disturbed. This could only be achieved by making a bespoke wooden crate that completely enclosed the specimen, with wooden batons running from side to side within the crate holding the branches in place securely so that they could not move as the case was being moved to the new store. This would mean that the top-heavy specimen would not sway like an upside-down pendulum and that the nests would not be disturbed. Where the wooden batons were close to the specimen they were lined with white Plastazote foam (a chemically inert, low density, closed cell, cross-linked polyethylene foam of archival quality) tied or screwed securely into position, holding the specimen gently but securely in place (Figs 5 and 6). For further protection, and if road transport was intended, an even less abrasive material than Plastazote foam could be used between the branches and the foam such as acid-free tissue, PTFE film or Tyvek (pure spun-bonded polyethylene olefin fibres).

It would have been preferable to remove the orangutan from the tree and treat it separately but it had been very well secured to the upright supporting pole and how to remove it could not be identified. It would also have greatly disturbed the very fragile nest material it was sitting on. It was there-

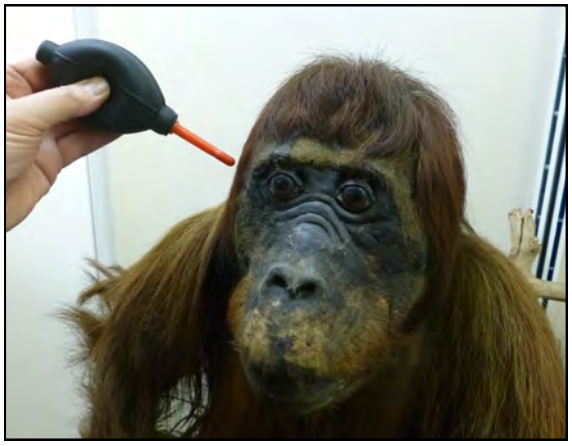


Fig. 4. The puffer used to clean the orangutan (this was posed for the photograph, and gloves were not worn).

fore decided that less damage would be inflicted if the orangutan remained sitting in the nest as long as the whole specimen was moved extremely carefully.

As the branches presented quite an unusual off-centre three dimensional shape a plumb-bob was used to work out exactly the size of the crate required. This would be just slightly bigger than the specimen whilst bearing in mind that it would have to move through several doorways and up a ramp, whatever its final route was. It was so tall (the external dimensions of the crate were 1590mm cm long, 940mm wide and 1870mm tall) that fitting it through doorways was going to be an issue, as it would also have to be on suitable wheels.

The crate was made from 8 sheets (1220mm x 2440mm) of sturdy 12mm think plywood and 23m of batons (35mm x 45mm) including several batons underneath the crate so that fingers could get underneath to move it. Once the base, rear and one side of the crate had been made elsewhere in the room, away from the specimen to reduce the chance of accidents, it was slid very carefully into place so that the specimen was inside. Then two more sides (that had been pre-made) were carefully screwed on. The front and top were left open so that access could be gained to screw the wooden batons in place along with the Plastazote foam. These were positioned to hold the branches in place securely from all sides and also positioned under the nests, so that nothing could move independently when the whole crate was being moved.

The nests presented a unique problem. So fragile that they could hardly be touched, they needed to be held in place so that the leaves did not shift and fall out when the crate was being moved. The solution was to use a combination of acid-free tissue, 6mm wide cotton conservation tying tape, masking tape and Tyvek. Sheets of acid-free tissue were cut to size and placed gently in the concavity of the empty nests and then sheets of acid-free tissue were crumpled and placed gently on top until they made a convex pile within the nest. Then sheets of acid-free tissue were carefully wrapped around the nest, held in place with small pieces of masking tape. Tyvek sheets were then cut to size and wrapped around the nests and were tied gently but securely in place with cotton conservation tape looped around the bundle in all directions. This meant that the leaves within the nests could not move and the nests were also tied to the wooden batons – and had wooden batons and Plastazote foam underneath them – so that they could not move. Completely wrapping the nests to the point where they could not been seen while the specimen was moved was of some concern but if they were not contained the leaves would have moved. Also, the undersides of the nests could not be 'wrapped' on their own without wrapping the top side as otherwise there would not be anything safe on the top side to secure the materials used for the underside. Only by wrapping up and over can you get the packing materials to stay in place. The same procedures were used for the orangutan and the nest it sat in (Fig 6).

Moving the specimen

The front of the crate was left off so that the specimen inside could be watched whilst it was being moved. If there was any swaying or vibration the process could be slowed down or stopped and the

Fig. 5. The base of the branches, showing Plastazote foam tied in place so that the branches do not rub against the wooden batons.

Fig. 6. The cleaned and packed specimen ready for removal to the stores, but with the top and front of the crate not yet screwed on.

method of transport changed. The crate and its contents were carefully lowered from the display case onto wheeled dollies using a manual stacker with forks. The shallowest dollies were used as there was not much clearance (in the end, less than 1cm) between the top of the crate and the lintels of the lowest doorways. Several people were required to slowly push the crate, steer, hold open doors and watch the doorway lintels. The move appeared to go well and there was no obvious vibration or swaying of the specimen. However, this was a decant project and the specimen is still in storage and will not be unwrapped until it is moved back in to the museum for redisplay. When the specimen was placed in its temporary location in the new museum stores, the front panel of the crate was screwed back on and a label attached warning people not to move it without the specific permission of the collections manager.

Discussion

Whilst there are some interesting and detailed articles available describing how orangutans have been taxidermied and put on display (e.g. Ritchie, 2012), there is no record in the conservation literature of how to approach cleaning and moving such a specimen when it is situated within an ancient nest of leaves within branches, with other fragile nests nearby. Therefore it is worth recording the system devised during this project as it seemed to work well.

Specimen records were checked for previous treatments including the use of pesticides but none were listed. However, the assumption had to be made that both the orangutan and the leaves of the nests – and possibly also the branches - had been treated at some point in the past with some sort of pesticide. Therefore a mask was worn when cleaning the specimen and disposable gloves were worn when handling the material and hands, arms and face were washed immediately afterwards each time. Care was taken to clean the whole area around the specimen after work was undertaken. The specimen was labelled with signs to warn people of the risks of contamination with pesticides when unpacking the material in a couple of year's time. This risk was also noted on the specimen's database records.

To reduce any risk of back injury a mechanical stacker on wheels was used to lift the partially assembled wooden crate to the right height beside the specimen so it could be slid into the crate easily. This was a two-person job, for safety's sake. The specimen did not have to be lifted, just gently manoeuvred. The stacker was later used to lower the packed and crated specimen onto the wheeled dollies.

The following are approximate amounts of materials used for the project:

For the crate: eight sheets of 12mm thick plywood (1220mm x 1440mm); 23m of 35 x 45mm batons; and approximately 110 screws.

For cleaning and packing-up the specimen: a camera lens 'puffer' cleaner; 11m of assorted wooden batons; 80 sheets (500 x 750 mm) of acid-free tissue paper; 1.5 sqm of white LD24 Plastazote foam 10mm thick plus various thicknesses of old offcuts; approx. 25m of Tyvek sheet at 1m wide; 32m of unbleached cotton tying tape 6mm wide; and some masking tape to hold the sheets of acid-free tissue and Tyvek in place whilst they were tied with cotton tape.

The whole project from start to finish took approximately five working days. The technique of using a hand-operated puffer to gently clean very fragile material might be of use to other natural history conservators who do not wish to touch a specimen but it will only remove loose dust, dirt, fluff and hairs etc rather than provide a deep clean. It is preferable to using a compressor as it is more subtly controllable, it does not involve hoses that might interfere with and damage a specimen, and there is less potential for disaster as a compressor could be used on the wrong setting.

Conclusions

This was an unusual task (one of many within the wider decanting project) with no precedence in the published conservation literature. It would have been made much easier if the taxidermy specimen could have been removed and treated separately. There might be other ways the project could have been undertaken but the system devised had to cover all possible eventualities and seems to have worked well.

Acknowledgements

Many thanks to Matt Lowe (Collections Manager, Cambridge University Museum of Zoology) for providing the author with another interesting and challenging project, as well as for assistance in moving the specimen plus providing information about it. Other museum staff are thanked for their assistance with moving the specimen and the anonymous reviewer is thanked for their comments.

References

Carter, D. J. & Walker, A. K. (eds.) 1999. Care and conservation of natural history collections, Oxford: Butterworth Heinemann.

Hawks, C.A. and Williams, S. 1986 Arsenic in natural history collections, *Leather Conservation News*, 2 (2): pp.1-4.

Knapp, A. M. 2000. Arsenic Health and Safety, *Conserve O Gram*, September, 2000, number 2/3.

Linnaeus, C. 1760. *Amoenitates Academicae; seu Dissertationes variae physicae, medicae, botanicae, antehac seorsim editae, nunc collectae et auctae-cum tabulis aenaeis*. Volumen Quintum.

Ritchie, F. 2012. The Investigation and Conservation Treatment of a Mounted Juvenile Orangutan. Association of North American Graduate Programs in the conservation of cultural property, Presented at the 2013 Annual Student Conference hosted by the UCLA/Getty Program in Archaeological and Ethnographic Conservation.

Making a life-size model of a *Rhizostoma pulmo* (Barrel Jellyfish) for the Amgueddfa Cymru – National Museum Wales marine displays

Annette Townsend* & Julian Carter

Department of Collection Services,
Amgueddfa Cymru – National Museum of Wales,
Cathays Park, Cardiff CF10 3NP

*Corresponding author: Annette.townsend@museumwales.ac.uk

Received: 15th July 2015
Accepted: 11th Nov 2015

Abstract

Rhizostoma pulmo, commonly known as the barrel jellyfish, is a large enigmatic jellyfish commonly found off the southern and western shores of Britain. It has a thick domed bell of variable colour from whitish to blue, which can be up to 90cm in diameter, with four pairs of oral arms. It frequently comes to the attention of the public as it can end up washed onto beaches in large numbers. The marine gallery at AC-NMW contains specimens and objects which represent both the work of the museum scientists and the habitats and species from the local Welsh environment. In 2012 the Department of Natural Sciences chose to commission a life size model of the *Rhizostoma pulmo* to include in the marine displays. This paper documents the materials and techniques used to create the life-size replica jellyfish and also the practicalities faced in the preservation of real jellyfish specimens.

Keywords: Displays; Scientific models; Jellyfish; Fluid preservation; Moulding; Casting

Introduction

During 2010/11 the National Museum Cardiff closed all of its West Wing galleries to replace the roof and to develop new contemporary art gallery spaces. The works extensively affected one of the Natural History spaces below due to the removal of a main staircase. This provided the opportunity for the Natural History team to redevelop a section of the displays in this area. As the affected gallery already housed key display specimens such as the humpbacked whale skeleton and the leatherback turtle, it was decided to further develop the display to celebrate marine biodiversity. The redevelopment needed to take best advantage of the gallery's height, so the decision was made to use large impressive hanging specimens or models that would help capture the beauty and wonder of the marine world. Some sort of large jellyfish model was proposed since jellyfish are an important part of the biodiversity and ecology of the marine environment found around the coasts of Wales.

Rhizostoma pulmo was chosen as it is one of the largest jellyfish, a familiar visitor, and because of the impact it would make in the gallery. Jellyfish are also one of the reasons seasonal visitors such as the leatherback turtle and sunfish visit our Western shores as they follow and feed upon the jellyfish populations. Thus the proposed model would link well with the AC-NMW leatherback turtle specimen which was already on display in the gallery.

Preserving shape, colours and texture can be very difficult with many biological specimens. Initially the preservation of natural history material was only possible with dry inert materials such as horn, bone, skin, shells, corals, or robust insects (Reid, 1994). It was not until the development of the use of fluid preservation techniques that it became possible to preserve moist, soft biological material, such as specimens of jellyfish.

Townsend, A & Carter, J. 2016. Making a life-size model of *Rhizostoma pulmo* (Barrel Jellyfish) for the Amgueddfa Cymru - National Museum Wales marine displays. *Journal of Natural Science Collections.* **3.** pp.43-49.

The preservation challenges of real specimens

The history of modern fluid preservation effectively dates back to 1644 when Croone presented to the Royal Society two whole puppies preserved in the 'spirit of wine' (Birch, 1756-57). Since this time the general principle of using some form of alcohol solution as a preservative has not fundamentally changed, although during the 20th century the use of formaldehyde started to become widespread (Simmons, 2014).

Today fluid preserved biological museum specimens are prepared broadly in two ways;

- Fixation: The arrest of post mortem changes to stabilize biological tissue and prevent autolysis.
- Preservation: The long-term method used to store and protect the specimen.

Fixation and preservation can be distinctly separate processes e.g. a specimen may be chemically fixed in formaldehyde, and then stored in an ethanol solution for its long-term preservation. The two processes can also be the same e.g. a specimen may be fixed and preserved in an ethanol solution. The choice of process will depend on the type of specimen and the methods that will be used to study it. The long term aim is to preserve, as best we can, the chemical structure and morphology of a specimen.

Whilst some of the specific histochemical changes caused by many of the standard methods of preservation have been actively researched in the last 50 years (Steedman, 1976; Pearse, 1980), the overall effect of preservation treatments on biological material is still relatively poorly understood. The development of many of the methods currently used for collection preservation has been a result of trial and error, and pure chance. Fixation and preservation techniques have changed little since their discovery (Reid, 1994; Simmons, 2014), and have not been developed by hard scientific research. Many of our existing methods of preservation have significant drawbacks, as in practise it is not possible to preserve all of the components that form an organism. Fixatives such as formaldehyde form crosslinks across a range of cellular components such as proteins and nucleic acids, a process that causes significant chemical change along with tissue swelling.

Acidity is also a key long term problem with the use of formaldehyde. Alcohols such as ethanol work differently by dehydrating biological tissues which causes tissue shrinkage along with changes to the structural chemistry of proteins, although functional group chemistry remains relatively unchanged. This is a key reason why ethanol can preserve biomolecular data such as DNA (Carter, 2003). Colour loss is a significant issue with both chemical processes. Pigments are either chemically changed or extracted from the specimen. Subsequent colour loss can also occur from oxidative and hydrolytic effects. Attempts have been made to develop techniques to preserve colour, notably the use of the Kaiserling's and Wentwood methods, but none of these methods adequately preserve colour in the long term (see Simmons, 2014 for further information).

Research continues today to attempt to improve on the methods used for fluid preservation. Andries van Dam (2003) proposed a set of criteria for evaluating fluid preservatives. One chemical that has arisen from these investigations is the 'formaldehyde releaser' DMDM-hydantoin as a safer alternative to formaldehyde, and shows good potential for preserving the form, though not the colour, of soft bodied marine animals such as jellyfish. Research also confirms that DMDM-hydantoin chemical action is similar to formaldehyde making it a poor alternative for the preservation of research collections due to the inadequate preservation of components such as DNA (Carter, 2012). Research is ongoing in this field.

Soft-bodied animals such as jellyfish and sea anemones loose much of their shape and colour when preserved in fluid preservatives such as alcohol or formaldehyde, thus museum exhibitions have long tried to capture the life like form and colour of such animals through the use of illustrations and models (Fig 1). In the latter half of the 19th century the German glass-worker and naturalist Leopold Blaschka devised a solution to this problem. Together with his son, Rudolf, he established a successful business supplying glass models, mostly of marine animals, to museums worldwide, and their work is still greatly admired today. Model makers remain important even in today's digital age as a means of linking the real specimen to its size, colour and form in life, or reconstructing animals and plants of the past. Given the challenges in preserving a large jellyfish such as *Rhizostoma Pulmo* in a lifelike state it was felt that a model would better reflect the colour and form of these beautiful creatures. In addition there are many new and historic marine models on display in the AC-NMW galleries,

Fig. 1. An example of a formaldehyde preserved specimen of *Physalia physalia* (the Portuguese Man o' war) showing associated loss of colour and overall form.

including examples from the Blaschka collection. A model of *Rhizostoma Pulmo* would be an excellent addition to these displays and would demonstrate the important role 3D modelling still plays in modern natural science displays.

Making the model: Research and design

Moulding and casting is a process which is regularly used for many different projects at AC-NMW but the production of such a large translucent object presented entirely new challenges. Annette Townsend, the Department of Biodiversity and Systematic Biology's part time Scientific Artist and Assistant Conservator was commissioned to create the model using in-house funds. Annette had already created several models in the Natural Science galleries, had significant expertise in moulding and casting and a flexible schedule which allowed her to work on site alongside the scientific staff. Unfamiliar casting and laminating materials had to be researched, sourced and tested for performance and compatibility; also cost and health and safety played a major factor in the final choice of product. There seemed to be very little information available online about using clear resins so advice was sought from colleagues in the model making industry and from technical staff at distribution companies.

A selection of resins were ordered and tested along with different fibreglass products to see what results could be achieved. Some companies aided this process by providing small free quantities of their products. Epoxy, polyurethane and polyester resins were all considered in both laminating and casting versions and the advantages and disadvantages of each were noted.

Epoxy

Epoxies are the choice material for many museum conservators when making replicas due to their mechanical properties and resistance to environmental degradation, low shrinkage during cure and ease to work with. They are incredibly versatile so it is easy to find a product to match an application. Some disadvantages are that they can be very expensive, they pose health and safety risks and can yellow significantly over time. Most epoxies are amber in colour and there are very few colourless products available to buy; however a 'Resoltech WWA clear epoxy casting system' was found and tested. Although totally clear in terms of transparency, it initially appeared to be clear in colour when cast in thin sections but then showed a distinct yellow appearance when cast in thicker parts, so it was discounted.

Polyester

Polyester resins are probably the most common type of casting and laminating resins. They are two -component systems in which a pre-polymer resin dissolved in styrene is mixed with a peroxide catalyst. They are inexpensive and versatile, the setting times can be controlled by adding varying amounts of catalyst. Laminating polyesters are combined with fibreglass tissue and matting to create strong thin layups and casting versions can be used alone for thicker sections. The disadvantages are that they shrink considerably, are highly flammable and pose significant health and safety problems. Great care has to be taken in the working environment to deal with the styrene fumes. Polyesters are marketed as water clear rather than crystal clear and sometimes have a green or purplish tinge to them. They also discolour slightly over time. A general purpose clear casting resin was tested with good results, but the product was unpleasant to work with and concerns were raised about using large quantities of polyester in the conservation workspace. Therefore the product was discounted.

Polyurethane

Urethanes are a huge family of resins with a variety of applications. They can be purchased as foam, rigid or flexible formulas. They show very little shrinkage during cure and can set in a matter of minutes if required. Their remarkable flexibility and toughness means that they can be cast in thin sections without the need of fibreglass support. Some polyurethanes are truly crystal clear and do not appear to yellow over time. Polyurethane is a versatile material for the model maker as cured pieces can be reheated and reshaped into new positions. The disadvantages are that they are expensive, have some serious health and safety issues and are incredibly sensitive to moisture. If any moisture is present the polyurethane will froth up so it can be very difficult to obtain bubble free clear casts without the use of a vacuum. 'Poly Optic series 14' was tested with excellent results. The product set quickly and was crystal clear and strong. There were some small bubbles in the cast but it was felt that they would not be visible when the model was hanging in the gallery, therefore the polyurethane was chosen to cast the bell of the jellyfish.

Sculpting and moulding

Sculpting began with the jellyfish bell. A very basic shape was built up using bundles of bubble wrap taped around a large inflated exercise ball (Fig 2—3). This was then covered with chicken wire and coated in a Jesmonite (water based, two component, acrylic polymer/mineral resin system) and jute fabric to make a solid base to work on. It was placed on the base of a wheelie chair so the sculpture could be spun around and worked on evenly (Fig 4). Finally a layer of fine wet modelling clay was applied to the surface and flattened with water and modelling tools to achieve a smooth surface finish. A single piece silicone mould and three piece support casing were chosen for the mould design. This meant that no seem lines would be visible on the jellyfish bell cast from the silicone and the outer casing would be supportive but easy to remove. The modelled clay was kept wet during the process to prevent cracking and a first layer of RTV (room-temperature vulcanizing) silicone rubber (Tinsil 70-25) was applied to the entire surface. Subsequent layers of silicone with a thixotropic additive were brushed on and smoothed down using a touch of

Fig. 2. Inflated exercise ball used as a base shape for the jellyfish bell) (Figure 3: Exercise ball covered with bubble wrap and chicken wire.

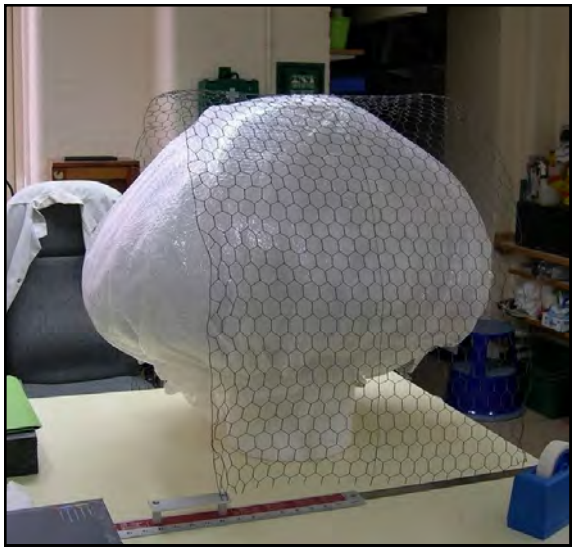


Fig. 3. Exercise ball covered with bubble wrap and chicken wire.

washing up liquid. Once completely set, flat walls of wet clay were laid on the surface of the silicone to define the separate areas for the outer support casing, then layers of Jesmonite and jute were built up on top. Once the first section of Jesmonite had set, the clay strips were removed and a separating agent (Maguire's miracle wax no. 8) applied to the seam. This process was repeated until all three sections were complete. Once dry, holes were drilled into the edges of the Jesmonite support case so it could be bolted back together after disassembly. Next the outer case and silicone mould were peeled off and the wet clay sculpture was discarded (Fig 6).

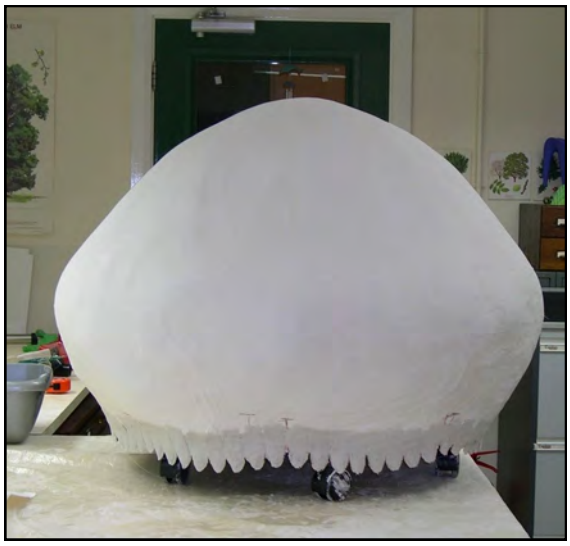


Fig. 4. Jellyfish bell coated with Jesmonite and placed on a wheelie chair for even sculpting.

A similar process was used to sculpt and mould the remaining parts of the jellyfish model. The oral arms required the greatest amount of detail to model. The clay was applied in a thicker layer and covered with plastic sheeting when not being worked to prevent drying and cracking. As four pairs of oral arms were needed, it was decided to create multiple copies from just one mould, so time was spent modelling one piece in detail (Fig 7). The silicone mould was made in two sections this time so that the cast could be created in parts then joined together afterwards (Fig 8). Jute and Jesmonite were again used to make the outer support casing and the modelled clay was discarded once the mould was removed.

Fig. 5. One part silicone mould and three part Jesmonite support case. Holes were drilled into the edges to bolt the sections together.

Fig. 6. The cured single piece silicone mould being peeled off of the wet clay sculpture.

Making the casts

Although the Tinsil 70-25 RTV silicone rubber which was used is perfect for moulding on wet surfaces such as the modelling clay, it is not the best choice for casting clear resins. The alcohol and moisture that remain in the mould can inhibit the cure of the clear resin and leave the surface of the cured cast sticky. An addition cure silicone could have been considered as an alternative moulding material, but the supplier advised against its use in this situation. There are mixed reviews about the performance of addition cure silicones when in contact with wet sculpting clays, so this material was avoided. Therefore there were problems to overcome when casting the clear Polyoptic resin in the Tinsil 70-25 moulds. A colleague from the modelling industry advised that RTV silicone moulds should be baked in an oven to dry them out. The technical team at Mouldlife supplies did not think this would be effective but the decision was made to go ahead and test the method. Unfortunately the jellyfish mould was too large to fit in an oven so a plastic cover was created and the mould was heated manually with a hairdryer (Fig 9). When the mould had been treated, a first layer of the Polyoptic 14 series polyurethane resin was brushed onto the inner surface and left to set. Then further layers of resin were applied along with sheets of fine fibreglass tissue to make the cast very strong and fit for public display. Finally a purple coloured dye was mixed into the resin and painted onto the edges of the jellyfish bell to give a realistic finish. When the resin cast was removed from the mould it had set perfectly with no tackiness to the surface.

Although all health and safety precautions had been taken, an allergic skin reaction was experienced when using the Polyoptic range of resins so it had to be discarded, and an alternative choice was made for the remaining parts of the cast. The polyester clear casting resin had originally been

Fig. 7. Detail of the oral arm sculpted in wet clay.

Fig. 8. The oral arm moulded in pieces with silicone and Jesmonite.

Fig. 9. The completed jellyfish bell mould ready for heating prior to casting with Polyoptic resin.

discounted due the problems posed by styrene fumes in the workplace, but a lab space with an external extraction system was found in a remote part of the museum away from other office areas. Although it was also not crystal clear in colour, its use here was acceptable as jellyfish have natural variations in colour. The polyester was ordered and stored in an external unit away from staff and collections to eliminate risk. Once these measures were in place the clear cast polyester was used along with fibreglass tissue and coloured dyes to cast the oral arms (Fig 10). It proved to be an excellent material and was a far cheaper alternative to the polyurethane. The oral arms were cast in two parts then joined together and the process was

Fig. 11. The completed bell and oral arms painted with acrylic paints.

Fig. 10. Filling the two part silicone moulds of the oral arm with polyester resin.

repeated to produce all of the casts. The cured polyester components were stored for some time in the external unit until the smell of styrene had dissipated.

Building and finishing the model

The National Museum Cardiff building is located in the centre of town with very little in the way of outdoor spaces, so it was easier for the oral arms and lower sections of the jellyfish to be worked on outdoors at a private premises during the summer months. The seam lines were trimmed and the parts laminated together with strips of polyester and fibreglass matting. Once complete, the lower section was returned to the museum lab so the surface details could be added by hand painting and airbrushing with acrylic paints (Fig 11). All remaining parts were finally assembled and fixed with resin and fibreglass, and heavy duty monofilament wires were threaded through laminated hooks and loop holes ready for hanging.

Display

The finished model remained in storage until a slot became available for it to be hung in the gallery. During this time a safety assessment was carried out. The weight of the model was estimated, then sturdy lines of monofilament, crimps and hooks were attached (Fig 12). The fixings were tested by hanging the model from the ceiling hooks in the collection stores on long lines just above a cushioned surface.

The model was then moved up to the gallery, strapped to a plywood board and carefully moved up and into position on scissor lifts with the help of the gallery technicians (Fig 13). The hooks were attached to the ceiling fixings and finally the scissor lifts were lowered leaving the jellyfish model hanging in place (Fig 14).

Discussion

On reopening the 'Life in the Sea' the new *Rhizostoma pulmo* model made an immediate impression

Fig. 12. Attaching monofilament lines, and fixings to the model.

Fig. 13. Installing the model in the gallery.

on visitors to the museum: a group of primary school children who were visiting seemed particularly fascinated by the display. They stopped for a long time to discuss the object with their teacher and to find out more information from the surrounding specimens and text panels. The model allowed them to experience the size and scale of the *Rhizostoma pulmo* jellyfish in relation to the other specimens in the gallery such as the leatherback turtle. This is something that could not have been conveyed successfully to the same extent through the use of other media, such as video and photography.

It is important to use models to illustrate collections that cannot easily be displayed or which are altered in colour and shape from their original life-like state when preserved. At AC-NMW the combination of models and real specimens has been used effectively in the galleries to illustrate scientific stories and research that would otherwise be difficult to communicate. Models can also be seen as works of art in their own right. Visitors are captivated by the craftsmanship in historic models such as the Blaschkas, and large models such as *Rhizostomza pulmo* create a huge impact in a gallery space. The display of these models can attract new non specialist audiences to scientific displays. At this stage only qualitative data from personnel communications with visiting groups and comments recorded by visitors via the web or the comments book is available to support this. However more quantitative evaluation is being plan for the natural science galleries as a whole as AC-NMW begins to plan for

Fig. 14. The completed model hanging up in the 'Life in the Sea' gallery at National Museum Cardiff.

the future redevelopment of the Natural History part of the museum.

The making of the large jellyfish model has highlighted the importance of networking and keeping up to date with the latest techniques and materials. When good relationships are built with suppliers and peers, advice can be sought and solutions to problems can be found. This process has also shown the significance of sharing knowledge on the use and adaptation of materials, to create novel solutions with others in the field, so that our successes can be built upon.

Acknowledgments
Esben Horn at 10TONS for specialist advice on model making techniques and materials. Website http://10tons.dk/). Vicky Purewal AC-NMW and Jorge Garcia AC-NMW volunteer for practical assistance in making the model. Louise Mumford AC-NMW for kindly sharing lab spaces where the model was constructed. Ben Evans BGS and the AC-NMW technical team for assisting with the hanging and installation of the model. Thank you also to the reviewers for their comments on this paper.

Suppliers and materials
Industrial plasters, 63 Nether St, Bromham, Chippenham, Wiltshire SN15 2DP
Tel: 01380 850616
Modelling clay 1150:
http://www.industrialplasters.com/prod/clay/modelling-clay-1150
Clear casting polyester resin:
http://www.industrialplasters.com/prod/resin/clear-casting-resin

Resoltech Advanced Technology Resins, 35, Impasse Emeri, ZI Les Jalassières, 13510 EGUILLES, FRANCE. Tel: +33 (0)4 42 95 01 95, Fax: +33 (0)4 42 95 01 98
WWA clear epoxy casting system:
http://www.resoltech.com/markets.php?id_mot=152

Mouldlife Ltd, Miro House Western Way, West, Bury St Edmunds, Suffolk IP33 3SP
Tel: +44(0) 1638 750679
Poly optic 14 series polyurethane casting resin:
http://www.mouldlife.net/polyurethane-clear-casting-systems-32-c.asp
TinSil 70 Series RTV Silicone Rubber:
http://www.mouldlife.net/tinsil-7025-1129-p.asp

References
Carter, J.D. 2003. The effects of preservation and conservation treatments on the DNA of museum invertebrate fluid preserved collections. *M.Phil - Thesis*.

Carter, J.D. 2012. Investigating the effects on tissue preservation of DMDM-hydantoin using FTIR microscopy. Collection Forum 26(1-2): pp.130-135.

van Dam, A.J. 2003. DMDM-hydantoin: The promising result of a search for an alternative in fluid preservation of biological specimens. *Collection Forum* 18(1-2): pp.104-115

Birch, T. 1756-1757. *The history of the Royal Society of London for Improving of Natural Knowledge, from its first rise; in which the most considerable of those papers communicated to the Society, which have hitherto not been published, are inserted in their proper order, as a supplement to the Philosophical Transactions*. Vols 1-4.

Pearse, A.G.E. 1980. *Histochemistry: Preparative and Optical Technology, 4th Ed*. Churchill Livingstone; Edinburgh.

Reid, G. 1994. The preparation and preservation of collections. In *Manual of Natural History Curatorship*, (Eds. G.Stanfield, J.Mathias, and G.Reid), pp.28-69. HMSO.

Simmons, J.E. 2014. Fluid Preservation: A comprehend sive reference. Rowman & Littlefield.

Steedman, H.F. 1976. *Zooplankton Fixation and Preservation*. The Unesco Press; Paris.

Identifying and managing asbestiform minerals in geological collections

Jana Horak[1*], John Faithfull[2], Monica Price[3] & Peter Davidson[4]

[1] National Museum of Wales, Cardiff, CF10 3NP

[2] The Hunterian, University of Glasgow, Glasgow G12 8QQ

[3] Oxford University Museum of Natural History, Oxford OX1 3PW

[4] National Museum Scotland, Edinburgh, EH1 1JF

*Corresponding author: jana.horak@museumwales.ac.uk

Received: 13th Nov 2015
Accepted: 8th Jan 2016

Abstract

Asbestos is widely recognised as a serious hazard, and its industrial use is now banned within the UK, and EU, and strict regulations govern the use of older manufactured materials which may contain asbestos. However, asbestos is also a natural geological material, and may occur in museum collections as minerals or constituents of rock specimens. In the UK the Control of Asbestos Regulations 2012 (CAR 2012) provides the legal framework for the safe identification, use and disposal of asbestos. However, these regulations, and other EU regulations, provide no specific guidance on dealing with potentially asbestos-containing natural materials. CAR 2012 specifies just six asbestos minerals although a number of other minerals in museum collections are known to have asbestiform structures and be hazardous, including other amphiboles, and the zeolite erionite. Despite the lack of specific guidance, museums must comply with CAR 2012, and this paper outlines the professional advice, training and procedures which may be needed for this. It provides guidance on identification of potential asbestos-bearing specimens and on procedures to document them and store them for future use, or to prepare them for professional disposal. It also makes suggestions how visitors, employees and others in a museum can be protected from asbestos as incoming donations and enquiries, managed in the event of an emergency, and safely included in displays.

Key words: Asbestos minerals; Hazardous fibrous minerals; Asbestos management; The Control of Asbestos Regulations, 2012; Health & safety

Introduction

Asbestos is a hazardous substance, and most countries now have legislation restricting and controlling the use and management of asbestos in the workplace (e.g. WHO, 2014). Asbestos is now widely understood as an issue in museum collections, and well-tested procedures to ensure legal compliance have been devised for asbestos present in social and industrial collections, where it may be a component added in the manufacture of an object or artefact. However, all forms of asbestos also occur in nature, and this is barely considered by any current legislative or regulatory frameworks.

Many geological collections will include natural specimens which meet legal definitions of asbestos, or which present similar risks, and accordingly, in the UK at least, there is a legal requirement to manage this risk. However, there is currently little formal guidance as to how this should be done, as all current UK legislation and EU directives have been drafted to deal only with the risk from asbestos in industrial use, and manufactured items and materials.

Horak, J., *et al.* 2016. Identifying and managing asbestiform minerals in geological collections. *Journal of Natural Science Collections.* **3.** pp.51-61.

As with the management of radioactive mineral specimens or objects, any institution which holds asbestos will need to obtain professional advice at some stage in the process of legal compliance. However, natural asbestos in collections poses a far greater challenge than radioactivity. There is no simple means of measuring or quantifying the hazard instrumentally, as can be done with radioactivity, and in the UK at least, the asbestos regulatory framework is much more specific about management and mitigation approaches.

This paper, the second in the series dealing with hazardous geological materials in museum collections, examines some issues relating to natural asbestos, and provides practical advice to ensure legal compliance, and the safe custodianship of asbestos-bearing geological specimens. The relevant UK legislation is *The Control of Asbestos Regulations* 2012 (CAR, 2012; HSE, 2012a), which provides the legal framework for working with and managing asbestos to minimise release of fibres. It is enforced by the Health and Safety Executive and local authorities. As this legislation is derived from EU directive 2009/148/EC, measures suggested in this paper should, in general, be appropriate for collections housed in other parts of the EU, subject to differences in control limits for asbestos fibres (currently in the UK 0.1 fibres/cm^3 of air measured over a continuous 4 hours).

Asbestos: what is it?

Asbestos is not a single substance but a term used to refer to commercially extracted forms of the serpentine and amphibole groups of minerals which have particular chemical compositions and textural properties. In current UK legislation (CAR 2012) 'asbestos' specifically means any of the following:

- asbestos actinolite
  CAS No 77536-66-4
- asbestos grunerite (amosite)
  CAS No 12172-73-5
- asbestos anthophyllite
  CAS No 77536-67-5
- Chrysotile
  CAS No 12001-29-5 or CAS No 132207-32-0
- crocidolite
  CAS No 12001-28-4
- asbestos tremolite
  CAS No 77536-68-6

(The codes after the mineral names refer to CAS Registry Numbers assigned to chemicals by the Chemical Abstracts Service, a division of the American Chemical Society. Although these are included in UK legal definitions, they provide no useful information of either a geological or practical nature.)

In UK law the term 'asbestos' is also used for any material containing any one of the listed minerals or mixtures of these minerals in 'more than trace amounts'. A trace amount is defined by CAR 2012 as 1 or 2 fibres being identified in a sample using a stereo microscope or scanning electron microscope after examination for ten minutes (HSE, 2005). Whilst this definition works well for the purpose of identifying industrial asbestos in a wide range of commercial products and construction materials, it is of very limited use when applied to natural rocks and minerals.

One major problem is that the UK Control of Asbestos Regulations 2012 provides no definition of 'fibrous'. The term is used by mineralogists in a wide range of subjective ways, most of which are certainly distinct from what they would regard as asbestiform (e.g. Clinkenbeard, 2002). Asbestos fibres are defined under US guidance (EPA/600/R-93-116, Appendix A) as showing all of the following criteria:

Length	A mean aspect ratio from 20:1 to 100:1 or higher for fibres longer than 5 µm
Width	Very thin fibrils (individual components of fibre bundles), usually less than 0.5 µm in width
Form	Two or more of the following criteria: Parallel fibres occurring in bundles; Fibre bundles displaying splayed ends; Matted masses of individual fibres and/or fibres showing curvature.

Clearly these criteria require use of microscopy. However they do not address the broader issue of initial risk assessment, and deciding on thresholds where such resource-intensive techniques may be required.

To comply with legislation and safeguard those in the vicinity of or working with collections, it is important to be able to establish which specimens present a risk. Paraphrased, Regulation 5 of CAR 2012 states that if there is any doubt as to whether asbestos is present there is an obligation to assume that it is. This either means being able to differentiate between asbestos and non-asbestiform varieties of the minerals listed in the legislation, or erring on the side of caution and including specimens which might not prove to be asbestiform.

An additional complexity is that although asbestos is always fibrous by definition, geological 'asbestos' specimens will often be texturally variable, and it may be hard or impossible to provide a definitive statement as to how much, if any, material in natural specimens meets legal definitions of asbestos.

Who can identify asbestos?
UK legislation specifies that only a United Kingdom Accredited Service (UKAS) accredited specialist laboratory can provide a legally sound opinion as to whether asbestos is present or not. Such laboratories follow strict protocols for the handling and analysis of the standard industrial asbestos materials as defined in UK law. However, there are no protocols for the assessment of asbestos in natural geological materials, and in any case the potential mineralogical diversity of natural materials means that the methods used in asbestos labs will not uniquely or reliably distinguish asbestos from non-asbestos minerals.

It is also important to note that, in the UK, most specialist mineralogists, academic or curatorial, would not be considered legally competent to identify materials as being asbestos or not, unless they have UKAS accreditation and follow the appropriate protocols, even though these have not been designed to work with natural materials. This obviously leaves something of a "Catch-22" situation for those wishing to accurately assess and manage risk associated with natural rocks and minerals.

Identifying asbestos in geological collections
Many asbestos specimens will be labelled or recorded as such in museum records, and examination of registers and catalogues should always be an early stage of risk assessment. By looking for the word 'asbestos', or a variety of other trigger terms (see Table 1) it is possible to remotely identify parts of a collection which are likely to present significant risk.

However, in addition to the asbestos minerals listed in the legislation (Figs 1-6) there will be specimens which present a risk, but may not be labelled as containing these minerals. Examples include nemalite, a highly fibrous form of brucite, which although not hazardous, is intimately associated with chrysotile (Berman, 1932); garnets from Valmalenco, Italy and Asbestos, Quebec, Canada which are commonly associated with chrysotile; and epidote from a number of Alpine localities which may occur with actinolite asbestos. Many other possible associations with asbestos minerals exist, and routine curatorial training should include ensuring awareness that asbestos present in rock and mineral specimens may not be recorded in associated documentation. Asbestos minerals usually occur in low to medium grade metamorphic rocks, and ultrabasic or basic rocks. This means rock names such as serpentinite and metagabbro should also be regarded as potential asbestos trigger terms.

There is also debate surrounding the status of elongate cleavage fragments of the tremolite-actinolite group of minerals, but which do not meet the criteria for asbestiform fibres as shown on page 52. This includes the variety byssolite. Bailey *et al*. (2003) provide a synopsis of published research to suggest that these should not be considered an asbestos hazard. This somewhat conflicts with the NIOS (US National Institute for Occupation Safety)

Table 1. The main synonyms and variety names for asbestos and other hazardous asbestiform minerals, and other trigger terms.

General:	asbestos, asbestus, amianthus, asbestiform
Actinolite:	attinoto, byssolite, ferro-tremolite, manganactinolite, silbölite, Strahlstein, stralite, zillerthite/zillertite
Anthophyllite:	antholite, antholith, anthogrammite, anthophylline, grey asbestos, kupfferite, magnesio-anthophyllite strelite, thalacerite
Chrysotile:	asbophite, bastite, bostonite, clinochrysotile, faserserpentine, karystiolite, kuphoite/ kupholite, lefkasbestos, marmolite, metaxite, orthochrysotile, parachrysotile, picrosmine/Pikrosmin, pyroidesine, retinalite, schweizerite, serpentine, serpentinite, thermophyllite, vorhauserite, white asbestos Other serpentine group minerals that are very commonly mixed with chrysotile are: alumoantigorite, antigorite, Blätterserpentin, ferrolizardite, lizardite, picrolite, porcellophite, zermattite
Erionite:	no known synonyms but was once thought (erroneously) to be identical to offretite so check entries under this mineral
Grunerite:	amosite, brown asbestos
Richterite:	astochite, astorite, isabellite, kalio-magnesio-katophorite, magnophorite, mangan-tremolite, marmairolite, natronrichterite, Natrongrammatit, richterite-asbestos riebeckrichterite, simpsonite, soda richterite, soda tremolite, Szechenyiit/Szechenyit, tremolite-glaucophane-richterite, waldheimite
Riebeckite:	abriachanite, blue asbestos, blue ironstone, cape blue, crocidolite, mangan-crocidolite, Mangan-krokidolith, orthoriebeckite, osannite
Tremolite:	abkhazite, calamite, grammatite, Grammatit-Strahlstein, hoepfnerite, kalamite, nordenskiöldite, peponite, raphilite, sebesiteraphilite, smaragditic, Strahlstein, Tonerdehaltiger
Winchite:	eckrite

This list has been compiled mainly from Clark (1993) and is not comprehensive. A few of the names have also been used for other mineral species.

Fig. 1. Asbestiform actinolite from Austria (OUMNH-Min9250, specimen c.90 x 80mm).

publication of 2011, which presents an agenda for research to provide more robust evidence supporting or disproving this claim.

The volume of asbestos specimens in mineral collections will obviously vary from one museum to another, but is likely to be small. For example the National Museum of Wales mineral collection (34,000 registered specimens) contains just 0.5% asbestos minerals, whereas the Oxford University Museum of Natural History, which has similar sized total holdings, includes a substantial asbestos mineral research collection so contains 1.7%.

Fig. 3. Single packaged specimen of anthophyllite (OUMNH-Min22006, specimen c.95 x 50mm). Scandinavia, particularly Finland, is the main producer of commercial anthophyllite.

Fig. 2. Single packaged specimen of grunerite from South Africa (OUMNH-Min21564, specimen c.150 x 135mm). This mineral is known commercially as brown asbestos or amosite (from the acronym for the 'Asbestos Mines of South Africa').

Outside the law: hazardous fibrous minerals not covered by legislation

Discussion so far has focused on the fibrous minerals covered by legislation. Bailey *et al.* (2003) suggest that there may be as many as 100 mineral species capable of being fibrous, although such habits are typically quite rare. Unlike the six minerals listed in CAR 2012, evidence of detrimental health effect for these other minerals is generally lacking, or the data equivocal. Bailey *et al.* (2003) suggest that there is no compelling evidence that the fibrous nature of these minerals alone makes them hazardous and that factors such as biodurabilities (retention of the fibres in the body), bioactivity, and bioavailability can influence how active, and therefore hazardous, they are. Of the minerals for which data from mortality studies or laboratory experiments exist, they concluded that, asbestiform richterite, asbestiform winchite, and the zeolite group mineral erionite present a hazard equal to that of industrial asbestos. Research suggests that erionite may present a greater hazard than gruner-

Fig. 4. Chrysotile vein (NMS G.1908.36.5). Chrysotile, also referred to as white asbestos, is the most commonly used asbestos mineral.

Fig. 5. Crocidolite, also known as blue asbestos, is a variety of the amphibole riebeckite. (top: OUMNH-Min16130, specimen c.60 x 32mm; bottom: OUMNH-Min26175 from Australia, 53mm high tube).

ite (commercially known as brown asbestos) (Wagner *et al.,* 1985) and this may be a product of voids in the crystal lattice in addition to its fibrous nature (Coffin & Ghio, 1991). At present these minerals are not included within legislation. Erionite was original identified as a hazard in altered volcanic rocks in the Cappadocia region of Turkey but has been identified by the US Geological Survey in twelve US States (Sheppard, 1996). Wollastonite, palygorskite (referred to as attapulgite in the text) and sepiolite are also mentioned in the literature (WHO, 1986), and implicated as potentially hazardous, but Bailey *et al*. (2003) suggest that this status is unfounded. Once again until established as safe, the best approach is to treat all fibrous minerals with care to prevent fibre release.

Managing asbestos specimens in collections

The Control of Asbestos Regulations 2012 (CAR 2012) provides the legal framework which dictates how asbestos is managed, and general guidance on compliance is provided by the HSE document *Managing and working with asbestos* 2013. Although they are not listed, we would recommend including erionite, finely fibrous winchite, and finely fibrous richterite, in any work carried out to comply with this legislation.

There are several steps in the process of ensuring that asbestos specimens in collections are well managed. These comprise:

- Training and background research
- A desk study to scope the occurrence or likelihood of asbestos minerals in the collection

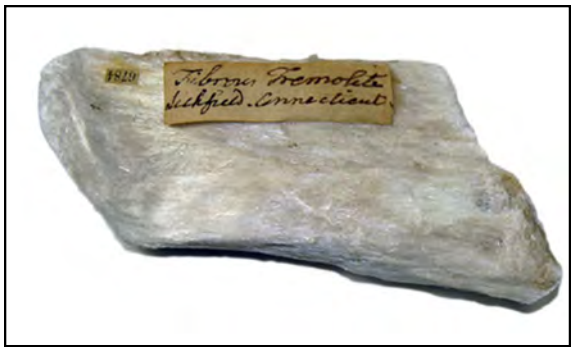


Fig. 6. Fibrous tremolite from the USA (OUMNH-Min6784, specimen c.93 x 40mm).

- Verifying the desk study through a specimen survey
- Establishing if areas where minerals have been stored or displayed are contaminated by asbestos fibres
- Decontamination of contaminated areas
- Controlling the release of fibres
  - Encapsulation of asbestos specimens OR
  - Disposal of asbestos specimens
  - Enclosing the specimen in airtight Perspex type boxes
- Establishing procedures for safe working with actual specimens

Training

Before any attempt is made to access specimens, or undertake any work related to the possible presence of asbestos specimens in collections, it is essential that staff receive appropriate training. It is a legal requirement (regulation 10, CAR, 2012) that employers provide adequate training for anyone who may be exposed to asbestos fibres, which includes asbestos-containing materials (ACMs) or asbestos-containing objects (ACOs), so they are aware of these substances and the risks they present. There are two UK levels of training that are relevant to those dealing with geological collections:

- *Asbestos awareness*
- *Non-licensable work with asbestos*

Asbestos awareness training covers the legal definition of asbestos, the health effects of exposure to asbestos, and key aspects of managing asbestos-bearing specimens (e.g. labelling and packaging). It also outlines the emergency procedures to follow should asbestos fibres be released accidentally, and how to avoid the risk from exposure to asbestos. An overview of the relevant legislation (CAR, 2012 and REACH, 2013 - see page 60) is included along with the different categories of asbestos work (e.g. licensed and non-licensed), and what level of training is required to undertake them. This training provides no specific mention of museum collections, but is essential for any museum staff, or vol-

unteers who may come across asbestos, natural or otherwise (see HSE, 2015a for further information).

Further training in *non-licensable work with asbestos* may be needed for specialist staff who carry out work on asbestos specimens where fibres could be released. These would typically be curatorial, conservation, or academic users of geological asbestos specimens. Again, this training may not currently include any specific mention of asbestos in natural or geological materials, but it does provide essential background to safe working. *Non-licensable work with asbestos* includes a more detailed understanding of the legislation, how to work safely with asbestos specimens (e.g. drafting plans of work and emergency procedures), the correct selection and use of personal protective equipment (PPE) and respiratory protective equipment (RPE), and dealing with asbestos waste. The training also covers completing risk assessments for work involving asbestos, writing plans of work to specify how this should be undertaken, and the writing of emergency procedures to deal with the accidental release of fibres. This training must cover the specific tasks that trainees will be undertaking, e.g. surveying mineral specimens during completion of a risk assessment, packaging asbestos specimens in a negative pressure air unit, and disposing of asbestos contaminated packaging. As with *asbestos awareness,* it must be refreshed yearly and the training customized to cover any new procedures or tasks included within the trainee's work.

Do we have a problem? Scoping the Risk

All organisations are required to hold and keep up to date an Asbestos Management Plan (AMP) for all known asbestos-containing materials/objects to help manage the risks. If exposure cannot be prevented, an Asbestos Management Policy should be implemented to indicate the safe working procedures that will be adopted and the documentation that must be kept up-to-date. Organisations should already have this in place for the fabric of the building so that any asbestos is documented, identified and managed (not necessarily removed). The AMP also applies to collections, and where social and industrial collections are also held by the museum, this may have already been initiated. For the sake of clarity it is preferable to have separate plans for collections and buildings.

The first stage in developing an AMP is to scope what specimens within the collections are are known or suspected to be either asbestos or asbestos-containing, and document these in an Asbestos Risk Register. The specimen registration or reference number, the storage location and the mineral or rock name should be listed in the register, so that the nature and location of all suspected material is recorded (an Excel spreadsheet is ideal). This is undertaken through a desk study using existing collection information. Care should be taken to include any unregistered specimens; minerals where asbestos is present but not the main constituent; and all relevant rock types and specimens from known asbestos localities. It is probably impossible to adequately complete this exercise without the involvement of a mineralogist or petrologist, so you may need to get outside help.

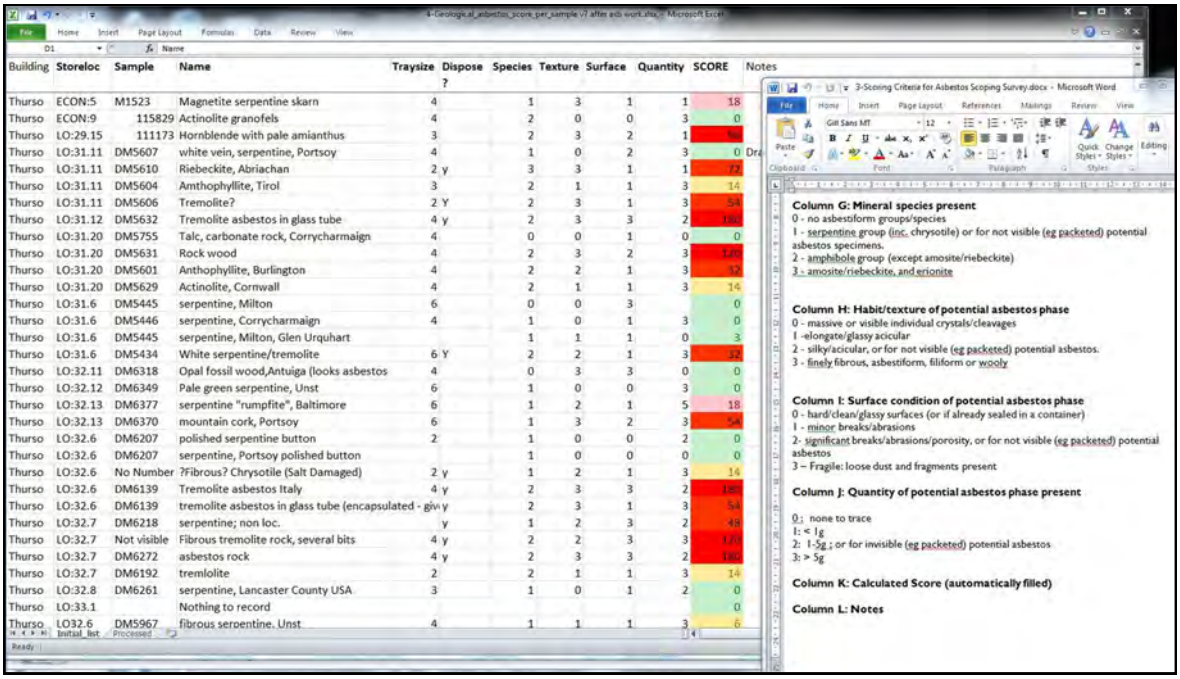
As mineral collections almost always contain historic specimens curated prior to standardisation of nomenclature, Table 1 provides a list of mineral names to check in addition to those listed in CAR 2012 and the three additional minerals mentioned above. This list is for guidance and is not exhaustive.

If no specimens are identified at the desk study stage as being asbestos or potentially asbestos, then no further action need be taken. However there should be continued vigilance and awareness of ACOs in case undocumented material is located subsequently, or specimens are presented as enquiries. Appropriate procedures should be developed for such situations (see page 60).

Identification/assessment of asbestos specimens

Once actual or potential asbestos specimens have been identified, you need to establish whether it is safe to work in the area containing these materials. If current building asbestos monitoring has not already shown that these areas are free of airborne and surface asbestos contamination, you must restrict access until a sampling program, carried out by an accredited asbestos laboratory, has demonstrated that the area is safe. Your organisation's health and safety officer will be able to advise on contractors to undertake sampling and analysis.

You should label any storage units with warning signs to indicate asbestos hazard and lock or secure them so that they cannot be opened accidentally (for details and examples see HSE, 2013, p110). These actions should be reported to the relevant managers and those with a specific responsibility for health and safety. Only those who have completed *non-licensable work with asbestos* training within the last 12 months, who are wearing appropriate PPE and PRE, and who follow the correct control measures may enter an area containing asbestos minerals, unless it has been certified as safe. In some instances air monitoring must be undertaken to enable a person's fibre exposure levels to be recorded, such records to be retained for a minimum of 40 years. An asbestos consultant will advise on this. The correct control measures include a risk assessment and plan of work (also known as a Method Statement). Personal protective equipment must be of the correct grade (specifications are covered in *non-licensable work with asbestos* training), including masks for which users have been face-fit tested and certified to use. Cabinets or storage units containing potential or actual asbestos specimens within an area identified as (or suspected of being) contaminated by asbes-



Building	Storeloc	Sample	Name	Traysize	Dispose ?	Species	Texture	Surface	Quantity	SCORE	Notes
Thurso	ECON:5	M1523	Magnetite serpentine skarn	4		1	3	1	1	18	
Thurso	ECON:9	115829	Actinolite granofels	4		2	0	0	3	0	
Thurso	LO:29.15	111173	Hornblende with pale amianthus	3		2	3	2	1	54	
Thurso	LO:31.11	DM5607	white vein, serpentine, Portsoy	4		1	0	2	3	0	Dra
Thurso	LO:31.11	DM5610	Riebeckite, Abriachan	2	y	3	3	1	1	72	
Thurso	LO:31.11	DM5604	Amthophyllite, Tirol	3		2	1	1	3	14	
Thurso	LO:31.11	DM5606	Tremolite?	2	Y	2	3	1	3	54	
Thurso	LO:31.12	DM5632	Tremolite asbestos in glass tube	4	y	2	3	3	2	108	
Thurso	LO:31.20	DM5755	Talc, carbonate rock, Corrycharmaign	4		0	0	1	0	0	
Thurso	LO:31.20	DM5631	Rock wood	4		2	3	2	3	108	
Thurso	LO:31.20	DM5601	Anthophyllite, Burlington	4		2	2	1	3	32	
Thurso	LO:31.20	DM5629	Actinolite, Cornwall	4		2	1	1	3	14	
Thurso	LO:31.6	DM5445	serpentine, Milton	6		0	0	3		0	
Thurso	LO:31.6	DM5446	serpentine, Corrycharmaign	4		1	0	1	3	0	
Thurso	LO:31.6	DM5445	serpentine, Milton, Glen Urquhart			1	1	1	0	3	
Thurso	LO:31.6	DM5434	White serpentine/tremolite	6	Y	2	2	1	3	32	
Thurso	LO:32.11	DM6318	Opal fossil wood,Antuiga (looks asbestos	4		0	3	3	0	0	
Thurso	LO:32.12	DM6349	Pale green serpentine, Unst	6		1	0	0	3	0	
Thurso	LO:32.13	DM6377	serpentine "rumpfite", Baltimore	6		1	2	1	5	18	
Thurso	LO:32.13	DM6370	mountain cork, Portsoy	6		1	3	2	3	54	
Thurso	LO:32.6	DM6207	polished serpentine button	2		1	0	0	2	0	
Thurso	LO:32.6	DM6207	serpentine, Portsoy polished button			1	0	0	0	0	
Thurso	LO:32.6	No Number	?Fibrous? Chrysotile (Salt Damaged)	2	y	1	2	1	3	14	
Thurso	LO:32.6	DM6139	Tremolite asbestos Italy	4	y	2	3	3	2	108	
Thurso	LO:32.6	DM6139	tremolite asbestos in glass tube (encapsulated - giv		y	2	3	1	3	54	
Thurso	LO:32.7	DM6218	serpentine; non loc.		y	1	2	3	2	48	
Thurso	LO:32.7	Not visible	Fibrous tremolite rock, several bits	4	y	2	2	3	3	108	
Thurso	LO:32.7	DM6272	asbestos rock	4	y	2	3	3	2	108	
Thurso	LO:32.7	DM6192	tremlolite	2		2	1	1	3	14	
Thurso	LO:32.8	DM6261	serpentine, Lancaster County USA	3		1	0	1	2	0	
Thurso	LO:33.1		Nothing to record							0	
Thurso	LO32.6	DM5967	fibrous serpentine. Unst	4		1	1	1	3	6	

Column G: Mineral species present
0 - no asbestiform groups/species
1 - serpentine group (inc. chrysotile) or for not visible (eg packeted) potential asbestos specimens.
2 - amphibole group (except amosite/riebeckite)
3 - amosite/riebeckite, and erionite

Column H: Habit/texture of potential asbestos phase
0 - massive or visible individual crystals/cleavages
1 -elongate/glassy acicular
2 - silky/acicular, or for not visible (eg packeted) potential asbestos.
3 - finely fibrous, asbestiform, filiform or wooly

Column I: Surface condition of potential asbestos phase
0 - hard/clean/glassy surfaces (or if already sealed in a container)
1 - minor breaks/abrasions
2- significant breaks/abrasions/porosity, or for not visible (eg packeted) potential asbestos
3 – Fragile: loose dust and fragments present

Column J: Quantity of potential asbestos phase present

0: none to trace
1: < 1g
2: 1-5g ; or for invisible (eg packeted) potential asbestos
3: > 5g

Column K: Calculated Score (automatically filled)

Column L: Notes

Fig. 7. The Hunterian geological asbestos Risk assessment.

tos can also only be opened by staff complying with these training and health and safety requirements.

Specimen Surveys

Anyone accessing specimens known to be, or suspected of being, asbestos must have completed *non-licensable work with asbestos* training and be wearing the correct personal protective clothing (PPE) and respiratory protective equipment (RPE) during survey work. Specimen and locations on the Asbestos Risk Register should be examined to establish their potential to release asbestos fibres. In the current absence of robust guidelines or protocols for assessing asbestos risk in natural materials, a simple visual risk assessment for asbestos minerals has been devised by the Hunterian Museum, and calibrated against results from an accredited asbestos lab. This scores the mineral species present, the mineral habit, the surface condition (representing the susceptibility to release fibres), and an estimate of the quantity of potential asbestos material (Fig 7). These data are then weighted to produce a risk assessment score used to decide how the specimen should be managed. Note that any assessment scheme such as this should be carried out by an experienced mineralogist/ petrologist.

Processing of specimens for storage or disposal

Once the scale and scope of the geological asbestos issue has been established, and confirmed, any hazards need to be addressed and mitigated. There are two basic approaches: encapsulation, where specimens are enclosed in a manner which will prevent exposure to respirable fibres; and disposal, where suspect specimens are treated as asbestos waste.

In general, it will usually be best to employ a specialist Licenced Asbestos Contractor to carry out either encapsulation or disposal work, as the logistics of implementing a safe, legally-compliant programme, and subsequent decontamination and disposal, are very onerous. However small scale work could be carried out in-house if the staff are trained in *non-licensable work with asbestos* and have access to a correctly filtered negative pressure unit. However, guidance will be required from an asbestos consultant to ensure the risk assessments and Plans of Work meet legal requirements. Specific details of how this work should be carried out are outside the scope of this paper. Where contractors are used, curatorial staff will need to be involved in the preparation of plans of work/method statements, to ensure that the security and safe handling of the collections are fully considered.

Space preparation and project planning

Any intensive asbestos handling must take place within an air-tight enclosure using negative pressure units to control air flow, typically a temporary polythene structure erected within the store or adjacent area (Fig 8). Such enclosures include a transparent viewing panel or have CCTV installed, so that curatorial staff can see, photograph and advise on specimens being processed within, and update the asbestos register to record encapsulation or disposal (Fig 9). The contractors will advise on the design and location of the work enclosure, and on

Fig. 8. Asbestos enclosure erected within storage area at National Museum Scotland.

the location and access route to their decontamination unit (Fig 10), which they will need for changing and disposing of contaminated personal protective equipment (PPE).

If licenced asbestos contractors are carrying out encapsulation, you will need to brief them on your documentation and specimen-handling protocols. It is very useful to go through the proposed workflow in advance with the individuals who will be carrying out the work, using dummy (i.e. non-asbestos) specimens.

It is important that no specimens should be removed from a drawer or container that houses samples requiring encapsulation or wrapping prior to disposal. The drawer or container with its entire contents should be sealed in air tight containers or asbestos waste bags before being taken into the enclosure for processing. By this method any fibres contaminating surrounding specimens and storage materials can be safely removed when the asbestos-bearing samples are encapsulated.

Decontamination and re-use of drawers may be possible, especially if samples were contained in card trays that restricted the spread of contamination. However, the trays, and any heavily contaminated drawers would usually need to be disposed of as asbestos waste. The contractor or trained staff member carrying out the work will carry out tests for contamination to ensure any remaining containers are safe for re-use.

Requirements for encapsulation

If specimens are to be encapsulated, the minimum standard for containment which will enable safe handling by staff without use of personal protective equipment, is to seal the material in two layers of transparent protective covering. The encapsulated specimens can then be stored as normal, in new, clean card trays, and managed within normal storage furniture. Double-bagging in sealable polyethylene bags is quick, cheap and effective for basic storage as long as food/conservation grade bags are used. Alternatively inner containers could be heat-sealed polyethylene tubing, or polystyrene tubes or jars. If the sample is already contained in

Fig. 9. View through large inspection window in enclosure (frame of window visible on right of photo) at the National Museum of Wales. There was inadequate space to fit the unit in the store area, so part of a corridor was used.

Fig. 10. Typical trailer-style decontamination unit used by asbestos contractors. This may be placed inside a storage area if space allows, although here it is show placed external to the building. National Museum of Wales decontamination work 2013.

this way it need not be removed. Enclosure in a polyethylene sealed bag will ensure that if the inner container should break, the contents will be contained. Glass containers are not recommended for repackaging. If specimens are already contained in this way it is better to retain the glass container and double-bag using and outer layer of a heavier gauge (e.g. 300µm) to provide protection in case the glass breaks.

Whatever containment is selected, contaminated labels which have been in contact with suspect specimens will also need to be encapsulated with the specimen. The container must to be marked with a standard asbestos hazard tag, and the specimen number will need to be visible, or marked on the outside of the container. Any drawers or boxes housing asbestos specimens, and any storage units containing them will also need to be marked with standard asbestos hazard stickers.

Requirements for disposal

Where asbestos specimens lack accompanying data or have no potential for use, it is recommended that they are disposed of. Because of the potential hazard that this material presents, the usual procedures for deaccessioning specimens as specified in the Museum's development (acquisition and disposal) policy will not be applicable unless specimens have particular scientific or cultural value. It is consequently important that managers are made aware of and approve the proposed work at planning stage so that all disposals can be fast-tracked.

Specimens for disposal must be treated according to Hazardous Waste Regulations 2005, along with any contaminated card trays, and other waste materials arising from the work. Such waste must be doubled bagged with a red inner bag and clear outer bag, and stored in a dedicated, lockable, labeled asbestos waste container until removed from site by a licensed waste carrier. If you employ a licensed contractor, they will normally include disposal in their work programme. It is essential that the waste consignment notes are filed for a minimum of three years to ensure the traceability of the material. Disposals should be properly recorded in specimen documentation according to SPECTRUM standards.

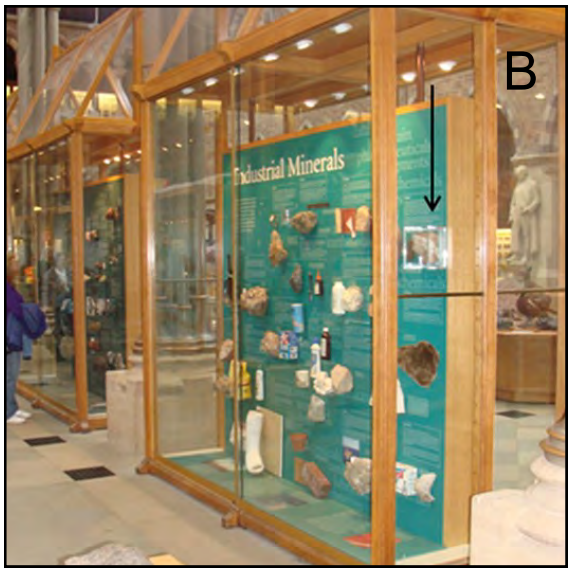


Fig. 11. An example of a hermetically sealed asbestos specimen on display at the Oxford University Museum of Natural History. 11b. The location of the specimen in the display case is indicated by the arrow.

Other things to consider

Emergency Procedures

Reference has been made in previous sections to Emergency Procedures to deal with the accidental release of asbestos fibres. Both *asbestos awareness* and *non-licensable work with asbestos* training emphasise the importance of procedures to deal with this, should it occur. The HSE document *EM1 - What to do if you uncover or damage materials that may contain asbestos* (HSE, 2012b) provides a useful checklist of actions to take. The Procedures must identify the person who will take control of any incident and document all actions that need to be undertaken following initial evacuation of the area suspected of being contaminated. This includes identification of those potentially exposed to asbestos and reporting this through RIDDOR (Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013). Those responsible for both health and safety and human resources in the organisation will be able to provide assistance with this task.

Loan and movement of asbestos specimens

The European Union regulation, *Registration, Evaluation, Authorisation & restriction of CHemicals*, more commonly referred to as REACH, controls the movement of, and prevents the sale of, 'articles to which asbestos fibres have been intentionally added' (for further details see HSE, 2015b). The Health and Safety Executive (HSE) has granted a class exemption to the museum sector solely to enable the loan or transfer of such asbestos-containing artefacts as WWII gas masks, for exhibition, subject to a number of conditions. However this exemption does not apply to geological specimens because of the technicality that the asbestos present is not an 'added' constituent.

Provided specimens are encapsulated they can be moved between sites within an organisation and also moved between organisations for the purposes of research or analysis, as this is allowed under REACH. The weight of material must not exceed 1 tonne - an ample amount for most research projects!

A grey area surrounds the movement of asbestos specimens for other purposes such as education or display, as this is technically not covered directly by REACH or the exemption. The safest approach to take is therefore to ensure that use or movement of any asbestos specimens complies with CAR 2012 (prevention of the release of fibres) and the Health and Safety at Work Act 1974. To underpin this a risk assessment and plan of work should be in place before any movement or preparation activity is undertaken, and all personal involved are aware of the Emergency Procedures, so they know what actions to take should fibres be released. Further advice as to the legitimacy of any movement of specimens should be sought from the airborne fibres team at the Health and Safety Executive.

Asbestos specimens on display

Legislation does not preclude asbestos specimens being included within displays, provided they are suitably contained to prevent any release of fibres. Specimens can be hermetically sealed into an acrylic Perspex container (or similar) provided an approved plan of work is followed and work carried out in a negative pressure unit by someone trained in n*on-licensable work with asbestos*. The encapsulated specimens can then be placed in the display case (Fig 11). This should still enable unimpeded observation of the specimens.

Specimens entering the museum through donations and public enquiries

Regardless of whether a museum's collection holds asbestos specimens, curatorial staff need to be aware that asbestos could enter the museum through donations and public enquiry services. It would be very unusual that either the public or museum staff would confuse a fossil with an asbestos-bearing geological specimen, so the main areas of concern are minerals, rocks, and collections of mixed geological material.

Possible hazards associated with these materials include radioactivity and toxicity as well as the presence of asbestos fibres, and the museum may also have concerns about the introduction of any pests or vermin with incoming material. On all fronts, it is essential to have robust procedures and well-trained front of house staff to interface with the public. They may receive *Asbestos Awareness* training, which can be undertaken in-house (see *Managing and working with asbestos* 2013).

It is important that public enquiries are never unwrapped by the enquirer or museum staff in a public area. Accidental shedding of fibres could mean the temporary closure of that area and incur the cost of decontamination. Museums can help by requesting that enquiry specimens should already be enclosed in clear seal polythene bags. If other wrappings are used, a supply of large grip-seal bags should be available to front of house staff, in which to place the fully wrapped enquiry material and then mark with the enquiry/entry number. The fact that the enquiry has been accepted unseen and uncounted should be stated on the enquiry form and enquirer's receipt.

All such enquiries should then be quarantined in a secure location away from both public and staff, and only unpacked by staff member who is trained for *non-licensable work with asbestos.* The sealed bag should be opened in the negative pressure unit so that the contents can be unwrapped and inspected by a suitably qualified person. If the museum does not have appropriate staff or facilities, then consideration should be given to refusing to carry out identifications of minerals and rocks.

Research and preparation activities: the Geological Asbestos Working Group (GAWG)

Rocks and minerals containing asbestos are retained in collections because they have value for use in research and education at a wide range of levels. If the encapsulation is opened and the specimen is sampled, sawn, ground, polished or undergoes any other geological preparation procedure, then new hazards will be introduced the nature and extent of which is currently poorly understood.

A working group was formed in 2015, to attempt to address this and some of the other hazards outlined in this paper associated with geological asbestos specimens. The group comprises university researchers, curators with responsibility for petrology and mineralogy research collections, those managing geological preparation laboratories, commercial asbestos consultants, and health and safety representatives from the university sector, the UK Health and Safety Executive and UK Health and Safety Laboratories. The main aim of the group is to develop a research programme to investigate the risks associated with the preparation of asbestos-bearing geological materials. The ultimate aim is to provide guidelines for best practice in this area. Further details of the activity of the Geological Asbestos Working Group (GAWG) will be reported through the NatSCA Journal and similar publications.

Acknowledgements

We would like to thank Laurie Davies (HSL, Buxton), Jon James (Principle Conservator Industry, AC-NMW), Dr Nick Elliott (Asbestos Manager, University of Glasgow) for sharing their knowledge and experience, and the two reviewers, Kevin Graham of Kadec Asbestos Management and Denis Morgan of Built Environment Services, for their comments and improvements to the text.

References

Back, M., 2014. Glossary of Mineral Species, 2014, 11th Edition. The Mineralogical Record, 434p.

Bailey, K.F., Kelse, J., Wylie, A.G., & Lee, R.J., 2003. The asbestiform and nonasbestiform mineral growth habit and their relationship to cancer studies. www.cdc.gov/niosh/docket/archive/pdfs/NIOSH-099A/0099A-030104- Pictorialpresentation.pdf.

Berman, H, 1932. Fibrous brucite from Quebec. American Mineralogist, 17, pp.313-316.

Clark, A.M., 1993. Stock Image *Hey's mineral index: mineral species, varieties and synonyms, third edition. Natural History Museum Publication/Chapman Hall, London.*

Clinkenbeard, J.P, Churchill, R.K, & Lee, K. Guidelines for geologic investigations of naturally occurring as bestos in California, California Geological Survey Special Publication No. 124.

Cofin, D.L. & Ghio, A.J., 1991. Relative Intrinsic Potency of Asbestos and Erionite Fibers: Proposed Mechanism of Action *In*: *Mechanisms in Fibre Carcinogenesis.* NATO ASI Series, Brown, R.C. & John son, N. F. (Eds), pp.71-80.

HSE, 2005. Asbestos: The analysts' guide for sampling, analysis and clearance procedures. HSE 248, IBSN 9780717628759 (downloadable free at: www.hse.gov.uk/pubns/books/hsg248.htm).

HSE, 2012a. Control of Asbestos regulations, 2012. http://www.legislation.gov.uk/uksi/2012/632/contents/made

HSE, 2012b. What to do if you uncover or damage materials that may contain asbestos. *Health and Safety Executive.* Available here: http://www.hse.gov.uk/pubns/guidance/em1.pdf

HSE, 2013. Managing and working with asbestos. HSE, ISBN: 9780717666188 (downloadable free at: www.hse.gov.uk/pubns/books/l143.htm).

HSE, 2015a. Asbestos information, instruction and training. Viewed 15th December 2015. www.hse.gov.uk/asbestos/training.htm

HSE, 2015b. Registration, Evaluation, Authorisation & restriction of CHemicals (REACH). Viewed on 1st November 2015. http://www.hse.gov.uk/reach/

NIOS, 2011. Current Intelligence Bulletin 62: Asbestos Fibers and Other Elongate Mineral Particles: State of the Science and Roadmap for Research, DHHS (NIOSH) Publication Number 2011-159, 174p.

Nuttall, T., 1821. Observations on the serpentine rocks of Hoboken in New Jersey, and on the minerals which they contain. Amer. tr. Sci.4, pp.16-23.

Perkins, R.L. & Harvey, B.W. 1993. Method for the determination of asbestos in bulk building material. US Environmental Protection Agency, Report EPA/600, R-93-116, p.61.

Sheppard, R.A. 1996. Occurrence of erionite in sedimentary rocks of the Western United States. Open-File Report 96-018, US Geological Survey, Denver, Colorado.

Wagner, J.C., Skidmore, J.W., Hill, R.J. & Griffiths, D.M., 1985. Erionite exposure and mesothiliomas in rats. *British Journal of Cancer*, 51, pp 727-730.

WHO, 1986. Asbestos and other natural mineral fibres. Environmental health criteria; 53. *World Health Organisation*. apps.who.int/iris/handle/10665/37190.

Japanese tissue paper and its uses in osteological conservation

Nigel R. Larkin

Cambridge University Museum of Zoology,
Downing St, Cambridge, CB2 3EJ, UK

email: nrlarkin@easynet.co.uk

Received: 18th Sept 2015
Accepted: 10th Oct 2015

Abstract

Various grades, weights and types of traditionally hand-made Japanese tissue have been used in the conservation of paper, manuscripts and books for hundreds of years and have also been used in the repair of ethnographic and taxidermy specimens in museums more recently. However, not much has been published about the use of this material in the conservation of osteological specimens even though it has several applications. For example when used in the repair of breaks in bone with an appropriate conservation adhesive it can help to add greater strength to the join than adhesive alone, especially where bone is thin. It can also be used as a gap-filling medium, for modelling-in areas of missing bone in a break and to provide long term support for fragile but important labels removed from specimens. Adhesives that have been used successfully with Japanese tissue paper in the conservation of natural history specimens include ParaloidB72, polyvinyl alcohol and neutral pH PVA adhesive, all of which are reversible.

Keywords: Japanese; Tissue; Paper; Osteology; Conservation; Repair; Gap-filler

Introduction

Japanese tissue is handmade with traditional techniques using natural fibres found in the bark of the gampi tree (*Diplomorpha sikokiana*), mitsumata shrub (*Edgeworthia chrysantha*, also known as the oriental paper bush) and the kozo plant (*Broussonetia kazinoki).* The latter is a type of mulberry tree and whilst other varieties of mulberry tree yield bark also suitable for making paper, this variety (*kazinoki*) is considered to produces the best results. The bark fibres of these three plants are exceptionally long and strong which gives the thin tissue its characteristic strength. Tissues of varying grades and weights can be made by choosing the appropriate plant fibres and slightly altering the manufacturing process. The handmade papers are very pure, are acid free, do not degrade easily and they reputedly have a strong resistance to insects (McBride, 2009). The history and process of their manufacture is well documented (e.g. Narita 1980; Fukuda 2015; Moore 2007) but there is now a complicating issue of inferior products being made elsewhere such as Thailand and Indonesia but still being sold as 'Japanese Tissue' (Moore, 2007).

The traditional process of turning the bark fibres into large sheets of tissue deliberately aims to make a strong, thin and flexible paper suitable for repairing tears and filling-in gaps when conserving paper, books, manuscripts and paper-based art objects but it is also suitable for aiding in the conservation of leather, parchment and cloth (Fukada, 2014). As such, Japanese tissue in its various grades, weights and types has been used for conserving objects for hundreds of years. As it is a very versatile material its use has spread to the conservation of ethnographic specimens in museums - principally for backing and facing materials and filling gaps (e.g. Kaminitz & Levinson 1989) - and also for the conservation of taxidermy specimens, giving support and filling gaps during the repair of fur, feather and skin and the repair of entomological collections (Moore, 2007).

Larkin, N. R. 2016. Japanese tissue paper and its use in osteological conservation.
Journal of Natural Science Collections. **3.** pp.62-67.

However, not much has been published about the use of Japanese tissue in the conservation of osteological specimens even though it has several applications. For example when used in the repair of breaks in bone with an appropriate conservation adhesive it can help to add greater strength to the join than adhesive alone. It can also be used as a gap-filling medium, for modelling-in small areas of missing bone and for backing fragile but important labels removed from specimens to provide long term support.

Traditional adhesives used with the tissue in Japan are derived from plants (such as wheat starch) and seaweeds and wheat starch is still used in paper conservation in the UK. However, the tissues can be used with many modern reversible conservation adhesives including neutral pH PVA adhesive, polyvinyl alcohol and ParaloidB72 (the latter at 10 to 50% in ethanol or acetone solutions). A strip of tissue of an appropriate size for the task in hand is taken from the main sheet by wetting the paper along the line to be torn and then tearing the strip away slowly. This is to ensure the edges are 'feathered' so that the tissue fibres will have a firmer hold on the specimen and will have an almost invisible edge when the adhesive dries.

Heavier weighted tissues make for stronger repairs but need to be well moistened with the adhesive. It is best to apply the adhesive to the tissue, then move the tissue to the specimen, especially when making a gap fill by folding the tissue in on to itself. It can also be pulped with an adhesive and applied with a small spatula. When dry it can be trimmed with a scalpel or lightly filed or sanded.

Example projects involving the use of Japanese tissue in the conservation of osteological material

Repairing a broken orangutan skull for the Grant Museum of Zoology, University College London

This orangutan skeleton (*Pongo pygmaeus* [Linnaeus, 1760], Grant Museum specimen number Z409) required some adjustments to its mount but the main issue was with the skull. The rear of the skull had been badly broken in the past (Figs 1 & 2) and although the bone fragments had been wired together, many pieces were still loose and moved against one another and one large piece was completely detached.

The thin wires used to hold pieces together protruded from the surface (Fig 2) and were unsightly as well as a health and safety issue (they could puncture skin if the skull was picked up incorrectly or poorly handled). A couple of these twisted wires had actually snapped, which is one reason why some of the pieces of bone moved against one another. Also, the skull was attached to the rest of skeleton simply by being placed on the end of the rod that ran though the vertebrae and inserted into the skull through the occipital foramen, from which the skull dangled precariously. This meant that the weight of the skull was taken by the broken pieces of the skull that were loosely wired together, inviting further damage.

The skull was repaired with Gampi Japanese tissue paper and neutral pH adhesive, applying it within the breaks where there had been some bone loss and also applying it to the inside of the skull across the joins in small sheets while the bone fragments were held in place. Gaps between pieces of skull where fragments were missing were filled with the Japanese tissue and adhesive and when this dried it did not need to be painted out as it was a similar colour to the bone (Fig 3). Significant gaps were filled in this way. This made the skull so robust that the unsightly twisted wires could be removed in the areas that had been repaired (Fig 3), reducing the health and safety issue. The right side of the mandible had also been damaged in the past and some of the old gap filler had disintegrated so where appropriate these gaps were filled with Japanese tissue paper soaked in adhesive, to strengthen the mandible.

Fig. 1. The skull of the orangutan from the UCL Grant Museum of Zoology (specimen no. Z409) before conservation commenced, showing the large hole and some sections of bone wired together.

Fig. 2. Close up of the same orangutan skull as in Figure 1 showing pieces of bone wired together in two places, with some gaps along the joins surrounded by old adhesive showing where fragments have been lost.

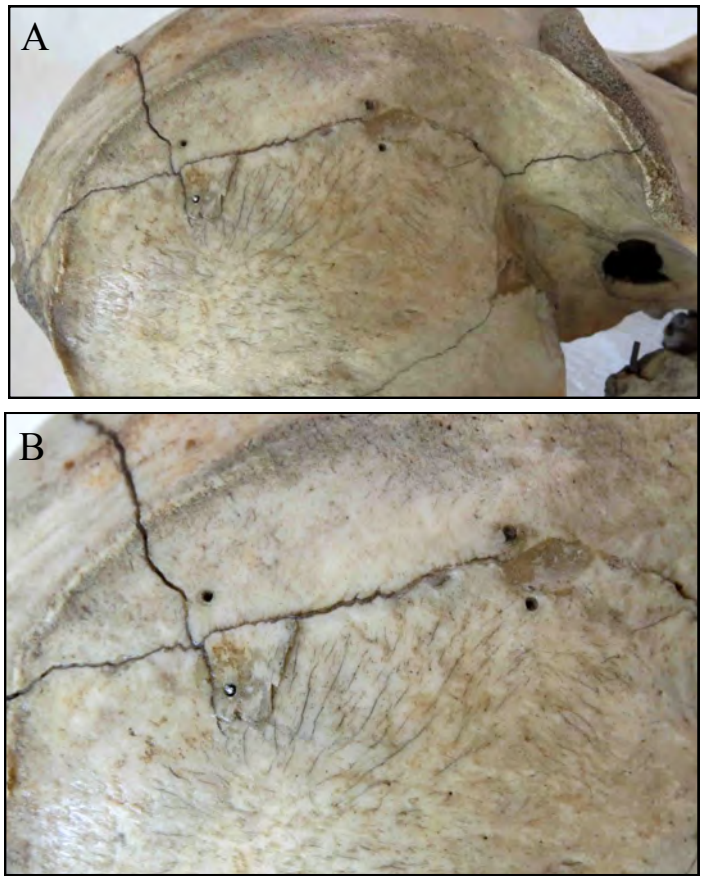


Fig. 3. A. The same area as shown in Figure 2 (from a slightly different angle) after the bone fragments have been realigned and glued with Gampi Japanese tissue and adhesive, the gaps filled with Gampi Japanese tissue and adhesive and the wires removed. There were several such areas glued and gap-filled around the skull; B. Detail.

Gap-filling and modelling to join two pieces of a skull of a heavy-footed moa for Leeds Museums and Galleries.

This moa skeleton (*Pachyornis elephantopus* [Owen, 1856], specimen number LEEDM.C.1868.6) required thorough cleaning, remounting and extensive conservation. Japanese tissue was only used in the conservation of the skull which was in two pieces (Fig 4A) without any clear join. After cleaning (with Synperonic A7) the two portions of the skull were attached together using Gampi Japanese tissue with neutral pH PVA and one small short wooden skewer embedded within the tissue for extra support. When the adhesive had set, the missing areas of bone were modelled-in using the same tissue and adhesive (Fig 4B) and a scalpel. When this had set, the tissue was painted with artists acrylic paints to blend in with the dark bones (Fig 4C). The mandible was partially broken at the symphysis and this was repaired with Paraloid B72 and gap-filled with a small amount of the same tissue and Paraloid B72 adhesive to ensure a good bond before the mandible was wired back on to the skull.

Repairing a tortoise carapace for the Grant Museum of Zoology, University College London

This tortoise specimen (Fig 5, Grant Museum specimen number X1369) required cleaning (including removing red nail varnish from its claws!), a permanent plinth made to reduce overhandling and whilst some pieces of the 'shell' of the carapace and plastron were missing some remaining pieces were loose and had to be glued down. More significantly, there was a large crack running right through the bone of the carapace on the front right along a suture, adjacent to where a large piece of the edge of the carapace had become detached (Fig 6). This crack needed to be closed and the edges adhered together so that the detached piece of bone could be re-joined.

Unfortunately the crack was quite old and the edges had moved quite far away from one another over the years (maybe responding to changes in RH). Some pressure was applied to the pieces of the carapace to get the gap between them to close, but a long thin gap was still left between the two edges within which an adhesive on its own would do almost nothing. Similarly, any gap filler placed between the two edges would almost certainly have simply fallen out once dry. The best way to repair this crack and to re-adhere the detached piece of bone (which now would not fit back perfectly either) was to glue Japanese tissue paper to the rear

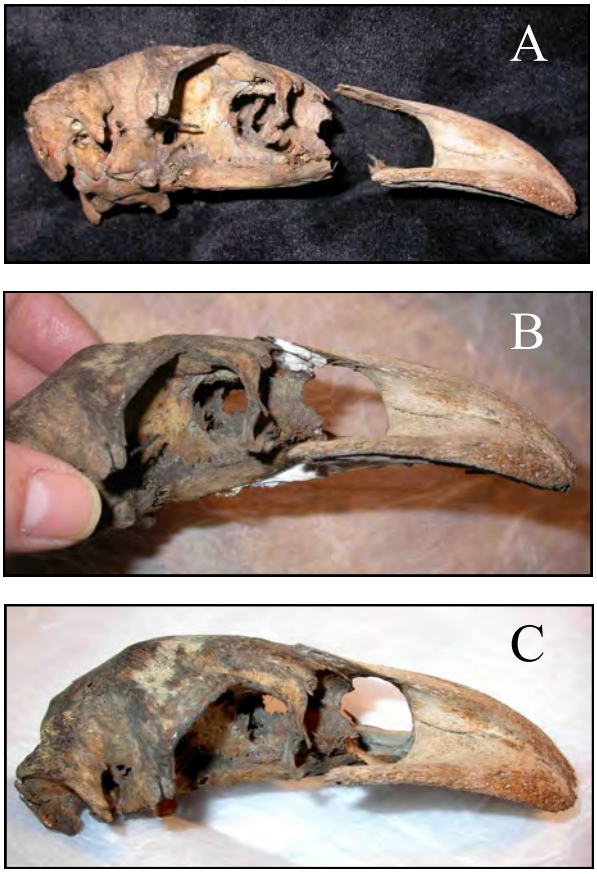


Fig. 4. The skull of the heavy-footed moa from Leeds Galleries and Museums (specimen number LEEDM. C.1868.6):
A. the two portions of the skull before re-joining;
B. after joining the pieces of the skull with Gampi Japanese tissue paper and neutral pH adhesive (the tissue is the white material underneath and on top of the skull, in the middle);
C. after the Japanese tissue had been painted out.

(internal) sides of the bones across the joins so that it bridged the gaps and stuck to the bone on either side, holding the bones in place. To do this several small sheets of Gampi tissue were applied across each of the joins with neutral pH adhesive. By having a much larger surface area of bone (i.e. either side of the gaps) employed in keeping the bones in place with adhesive and tissue rather than just adhesive within the cracks, this made for a much more robust repair of this specimen. This is important as the specimen is in a University museum collection and is used for teaching so it moved and handled regularly. Whilst a gap can still be seen between the pieces of bone (Fig 7), the sheets of tissue are transparent and almost invisible, even on the inside (Fig 8).

Rebuilding a large broken Aepyornis egg

This large ancient *Aepyornis* egg, consisting of over 120 fragments from more than one original shell, had undergone collapse and many pieces were separated (Fig 9). It was previously held together with photocopy paper and old brown parcel paper glued to the inside of the shell. These materials were removed and the egg fragments were cleaned (using conservation erasers) and the specimen completely rebuilt (Fig 10). The pieces were backed internally with Gampi Japanese tissue and neutral pH PVA adhesive, adhering the small sheets across the joins. The pieces needed to be stuck back together with reversible conservation materials and techniques not just because this is best practice but because this would enable the egg to be dismantled and put back together again, or at least adjusted, during the painstaking rebuilding process as corrections were required to the three dimensional shape in the later stages. Japanese tissue and neutral pH PVA adhesive can be reversed by softening it with a small amount of warm water. To keep the shape and provide additional structural support thin wooden skewers were glued into position across the width of the shell with the Gampi tissue and adhesive. Some small gaps were filled with the tissue and adhesive but larger gaps were backed using tissue and then filled with plas-

Fig. 5. The Grant Museum of Zoology tortoise (no. X1369) after cleaning and conservation, on its new plinth.

Fig. 6. The area of the tortoise carapace (no. X1369) requiring repair: The detached piece held roughly in place, with the crack in the carapace just visible in the bottom left, below the thumb.

Fig. 7. The joins in the tortoise carapace repaired with Gampi Japanese tissue paper: external view with gaps still evident.

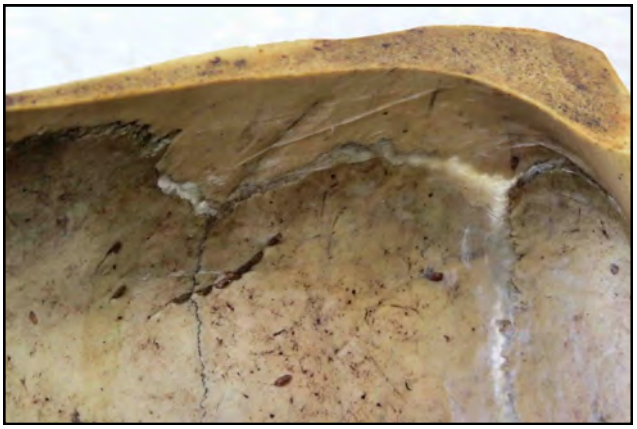


Fig. 8. The joins in the tortoise carapace repaired with Gampi Japanese tissue paper: internal view with gaps still evident and the tissue shown adhering to the bone either side of the gaps but quite transparent and almost invisible.

ter of paris. In retrospect, and now with more experience with the tissue, the author should have used the tissue and adhesive for all the gap-filling for a much stronger join and to keep the variety of materials used to a minimum to avoid long-term problems.

Repairing and conserving old labels

Repairs to old labels can be made using Japanese Kozo tissue (Carter & Walker, 1999) although the author has also used Gampi tissue with Paraloid B72. The tissue can be used as a permanent strengthening backing for fragile old labels, including those removed from the top surfaces of specimens prior to display after a photographic record has been made of the label in situ.

Discussion

The projects described above show how versatile Japanese tissue can be. By applying the tissue within small gaps in a break or across the 'back' of a join either side of a break it can make a strong repair where adhesive alone would not have provided an effective enough solution (e.g. if the specimen itself is quite thin, so there is a not a large surface area for the adhesive to act on, or when bones do not fully meet). Also, the tissue can be applied as a useful gap filler – even used for modelling-in missing bone - resulting in a surface similar in texture and colour to bone, so that little finishing-off is required to disguise it (if that is desired). Many different 'gap filler' materials have been used over the years in museums but different fillers are suited to different tasks. In regards to the conservation of natural history specimens, some comparative studies have been undertaken for use in conserving geological material and subfossil bone (Howie, 1984; Larkin & Makridou,1999; Andrew, 2009) but not much has been published that is directly relevant to the repair of modern and historical bone.

Fig. 9. The broken *Aepyornis* egg showing how it is partly held together with brown parcel paper on the inside and cellotape on the outside.

Fig. 10. The same *Aepyornis* egg as in Figure 5 after being cleaned, repaired and rebuilt using Gampi Japanese tissue paper and neutral pH adhesive with a few wooden skewers providing additional internal structural support. With the author for scale.

Therefore gaps filled with Japanese tissue paper and adhesive should not be relied upon to take a great deal of weight until specific strength or weight -bearing tests have been undertaken. However, anecdotal evidence and the author's own experience suggests that Japanese tissue impregnated with suitable conservation adhesive and then pulped for use as a gap fill or used in sheet form to structurally support gaps including where there is limited or no contact between joins, or indeed both techniques combined, can make a very strong repair in bone.

Conclusions

Japanese tissue paper is a very versatile medium and has been used in a variety of ways with a range of adhesives in paper conservation for hundreds of years. Its use in the conservation of other materials in museums is increasingly diverse and it is now used regularly in the repair of taxidermy specimens and elsewhere in the conservation of natural history specimens. As long as the adhesives it is used with are reliable, well-known, and reversible conservation products there is no reason not to experiment with it and employ it on suitable specimens.

Acknowledgements

The conservation of the orangutan and tortoise was part of University College London Grant Museum of Zoology's 'Bone Idols' Project (funded by NatSCA, Arts Council England's Museum Development Fund and various members of the public); the conservation of the moa skeleton was for Leeds Museums & Galleries (partly funded by the Leeds Philosophical and Literary Society and the Yorkshire Museums Hub); and the Aepyornis egg belonged to an individual who had inherited it.

References

Andrew, K. 2009. Gap fills for geological specimens – or making gap fills with Paraloid, *NatSCA News,* issue 16, March 2009.

Carter, D. J. & Walker, A. K. 1999. Papers, inks and label conservation. In: Carter, D. & Walker, A. (eds). (1999). Appendix II: *Care and Conservation of Natural History Collections*. Oxford: Butterworth Heinemann, pp. 198 - 203.

Fukuda, S. 2014. Japanese papers revisited, *ICON News The Magazine of the Institute of Conservation*, March 2014, issue 51: p.20.

Fukuda, S. 2015. Visiting Japanese paper making facilities, *ICON News The Magazine of the Institute of Conservation*, March 2015, issue 57: pp.18-21.

Howie, F.M.P. 1984. Materials used for conserving fossil specimens since 1930: a review. In: *Adhesives and consolidants: contributions to the 1984 IIC Congress*, Paris (1984): pp.92-97

Kaminitz, M. & Levinson, J. 1989. The conservation of ethnographic skin objects at the American Museum of Natural History, *Leather Conservation News* ,1: pp.1-7.

Larkin, N.R. & Makridou, E. 1999. Comparing gap-fillers used in conserving sub-fossil material, *The Geological Curator,* 7 (2): pp.81-90.

McBride, C. 2009. *A Pigment Particle & Fiber Atlas for Paper Conservators*, eCommons@Cornell. Retrieved September 11th, 2015, from the website: www.library.cornell.edu/presser vation/ paper/5FibAtlasEastern1.pdf

Moore, S. J. 2007. Japanese Tissues: uses in repairing natural science specimens, *Collection Forum,* 21 (1): pp.126-132.

Narita, K. 1980. *Life of Ts'ai Lung and Japanese Paper Making*. Tokyo: The Paper Museum: p.p.15-70.

NatSCA AGM Minutes
16:30, Thursday 21st May 2015

M Shed, Princes Wharf, Bristol Museums, Galleries and Archives

Attendees:
Paolo Viscardi(PV), Holly Morgenroth(HM), Jan Freedman(JF), Clare Brown(CB), Donna Young (DY), Roberto Portela Miguez(RPM), Vicky Purewal(VP), Maggie Reilly(MR), Paul Brown(PB), David Gelsthorpe(DG), and Jack Ashby(JA)

Apologies for absence:
Miranda Lowe(ML) and Emma Bernard(EB)

Minutes of AGM Thursday 26th June, 2014.
Held at the Victor Slavi Suite, Wales Millennium Centre, Cardiff Bay as published in *Journal of Natural Science Collections* 2: 61-67.
There were no issues raised by members at the meeting. These were signed as a correct record of that meeting by the chair.
Proposed: Dona Young
Seconded: Anthony Roach

Chairman's report:
Paolo Viscardi
PV apologized to membership for the lack of information provided about the process for electing new committee members. This issue will be discussed by committee in coming meetings and guidelines will be made available through the NatSCA website. In the meantime PV encouraged those who want to take an active role for the society to contact committee to discuss volunteering options.

End of HLF Skills for the Future project. PV reported that funding for this area has come to an end. It has been a great success with 80% of trainees finding jobs afterwards. PV confirmed committee will be reassessing applying for this funding again as it has been acknowledge as a great training model.

Emerging Professionals Group. The emerging professionals group has met up and discuss various options to move forward with the agreement between societies. A document produced by the Group has been forwarded to all committees for assessment.

Strategic Plan. PV reported that committee has been working on a document that outlines NatSCA's strategy and it will be posted in the Society's website in coming weeks.

Secretary's Report:
Roberto Portela Miguez
RPM explained that the secretary's report has adopted the template provided by the Charities Commission to report the Society's activities.

Trustees' Annual Report for the period

From	Period start date	To	Period end date
	31 1 2014		31 1 2015

Section A Reference and administration details

Charity name Natural Sciences Collections Association

Other names charity is known by

Registered charity number (if any) 1098156

Charity's principal address

Natural History Museum
Cromwell Road
London
Postcode *SW7 5BD*

Names of the charity trustees who manage the charity

	Trustee name	Office (if any)	Dates acted if not for whole year	Name of person (or body) entitled to appoint trustee (if any)
1	Jack Ashby	Communications & Marketing	2014-2015	
2	Clare Brown	Training Co-ordinator	2014-2015	
3	Paul Brown	Archivist	2014-2015	
4	Jan Freedman	Journal Editor	2014-2015	
5	David Gelsthorpe	Bursary Co-ordinator	2014-2015	
6	Miranda Lowe	Collections at Risk	2014-2015	
7	Holly Morgen-roth	Treasurer	2014-2015	
8	Roberto Portela Miguez	Secretary	2014-2015	
9	Vicky Purewal	Conservation	2014-2015	
10	Maggie Reilly	Membership	2014-2015	
11	Emma Bernard	Social Media & GCG Rep.	2014-2015	
12	Paolo Viscardi	Chair	2014-2015	
13	Donna Young	Training Co-ordinator	2014-2015	

Name of chief executive or names of senior staff members (Optional information)	Paolo Viscardi, Holly Morgenroth, Roberto Portela Miguez, Maggie Reilly and David Gelsthorpe

10 Section B Structure, governance and management

Description of the charity's trusts

Type of governing document (eg. trust deed, constitution)	The Constitution was adopted on 7th April 2003
How the charity is constituted (eg. trust, association, company)	Association
Trustee selection methods (eg. appointed by, elected by)	Trustees are selected from membership

Additional governance issues (Optional information)

You **may choose** to include additional information, where relevant, about: · relationship with any related parties	A Memorandum of Understanding was signed between the Natural Sciences Collection Association, the Geological Curators Group and the Society for the Preservation of Natural History Collections on the 26th of June 2014.

Section C Objectives and activities

Summary of the objects of the charity set out in its governing document	Our mission is to promote and support natural science collections, the institutions that house them and the people that work with them, in order to improve collections care, understanding, accessibility and enjoyment for all.
Summary of the main activities undertaken for the public benefit in relation to these objects (include within this section the statutory declaration that trustees have had regard to the guidance issued by the Charity Commission on public benefit)	Objectives: (1) to advance the education of the public in the care and use of natural sciences collections and specimens (2) to promote for the benefit of the public the highest standards in the preparation, care, conservation, management, interpretation and research of natural sciences collections and specimens (3) for the benefit of the public to promote the science of natural sciences collections conservation and curation **Our Focus:** ● Community - developing an open, friendly and accessible network for sharing information, experience and skills. ● Support – facilitating the professional development of stakeholders in natural science collections. ● Standards – identifying and promoting good quality practice in the care and use of natural science collections. ● Promoting collections - increasing awareness of the scientific and cultural value of natural science collections. ● Advocacy – challenging neglect of collections and lobbying for the appropriate resourcing of collections for their care and sustainable use.

Section D Achievements and performance

Summary of the main achievements of the charity during the year

It was another busy year for NatSCA, as Natural Science collections continue to face a variety of threats in the UK.

The biggest problems facing collections continue to be posed by reductions in funding. The financial support for museums of all sizes has been decreasing every year, with jobs being lost and stored collections often bearing the brunt of cuts. NatSCA has been to trying to keep track of threats to collections and offer our support in an effort to make the vital role of collections, and the people with the skills to care for them, more clearly recognised by management.

As the funding situation continues to tighten its grip on many museums and their staff, NatSCA continued to work to highlight the value of Natural Sciences collections and the specialist staff who care for and maintain those collections.

In our role as the UK Subject Specialist Network (SSN) for natural science collections we have met with representatives of ACE and the UK Natural Science Consortium to discuss the future of natural science collections at a strategic level, with a view to understanding and combating the threats to collections. The UK Collection Consortium comprises 22 major Museums, Galleries and Archives. Many NatSCA committee members have been involved, taking on specific roles to support and provide input on various working groups for this consortium.

In the interest of reaching wider audiences NatSCA welcomed evolutionary biologist and BBC presenter Ben Garrod as new patron. Ben joins Professor Alice Roberts and Professor Iain Stewart who in their role as patrons have helped to raise the profile of natural science collections whilst showing tremendous support for the Association and its work. http://www.natsca.org/patrons

NatSCA has also created another avenue to publish and discuss natural science collections issues. NatSCA Notes & Comments are electronic-only publications that are not peer-reviewed and do not necessarily represent the views of NatSCA. These papers provide an opportunity for sharing opinions and information that may be of relevance to the society's membership, natural historians and the wider museums sector.

The first issue of our new online publication NatSCA Notes & Comments provides a case study of decline from the Midlands, written by Geoffrey Hall. Although the picture painted is bleak, there have been some small wins, as Ludlow has since acknowledged the importance of maintaining a geologist to manage their globally important geology collection.

For peer-reviewed articles NatSCA continues to publish the Journal of Natural Science Collections and for short articles the NatSCA blog.

As in previous years we ran several very successful and well attended workshops and training events. The topics covered range from Hazards in Museum Geological Collections, Identification of Osseous and Keratinous Material, Caring for Botanical Collections, Understanding Museum Taxidermy: Construction, Care and Commissioning among others. We will continue to run more over the course of the year, so for updates on the events programme consult the relevant section in the NatSCA website. http://www.natsca.org/events-and-workshops

Our membership fees have been increased to the rates copied below and members can now make payment via PayPal.

Personal members £20

Unwaged members £15

Institutional members £40

http://www.natsca.org/membership

As in previous years, we have kept supporting our membership through bursaries for workshops and conferences.

In the ever constantly changing legal world, it is sometimes difficult to keep abreast of all new legal requirements, but it is possibly now more important than ever for institutions to ensure compliance and transparency. NatSCA has strived to provide advice to our membership on this arena and when necessary raised issues on behalf of the museum sector and engage in discussion with the appropriate governmental offices.

NatSCA corresponded with the Department of Environment and Rural Affairs (DEFRA) on the issue of the possession of egg collections and the legal requirements. As a consequence DEFRA has acknowledged that changes to the law were not fully consulted on and are now seeking to rectify this by holding a public consultation. This new consultation should hopefully take into consideration museum collections and their idiosyncrasies.

NatSCA has also been working on resolving the problem of museum drugs licensing for a couple of years now. We are currently working with the National Museum Directors Council and the Home Office on reducing the costs of the current drugs licence for museums. It is proposed that accredited museums will qualify for a licence that would span 5 years and cost less than the annual renewal and twice yearly spot checks of the current provision. Museums currently without licences would still have to pay for the initial expense of setting up the licence. NatSCA is also working on producing guidelines for museums who cannot afford a licence.

The SPNHC, GCG, and NatSCA emerging professionals group had their first meeting at the Natural History Museum and have produced a document that outlines some ideas and projects for the societies to work together on.

UK oganisations like NatSCA, that have an interest in maintaining natural science collections in Britain and Ireland, also have need for a database of collections to facilitate advocacy work. In order to address this need NatSCA and various partners (including the Linnean Society and the NHM) are undertaking a sector-wide project to develop an information system for natural science collections in the UK and Ireland, under the working title #NatureData. Over the past year we've been involved in development of a resource to collect and share collections level data for the natural sciences in the UK and Ireland.

On addition, NatSCA has also met with the National Forum for Biological Recoding and discussed societies overlapping interests.

Graham Walley from NFBR presented a summary of their remit which covers everything to do with Biological Recording in the UK.

Their main current objective is to identify how the future needs of all sectors of the biological recording community, the various users of biodiversity information and the support infrastructures on which they depend may best be addressed.

Therefore NFBR is also interested in what is happening on our field.

This was the last year of the Heritage Lottery Fund (HLF) funded “Skills for the Future” programme. This programme has provided paid training for up-and-coming natural science curators, and has been very successful and useful for both the trainees and the institutions that hosted them.

NatSCA’s public profile continues to grow and the society got a mention in Nature in an important feature article on the decline of natural science collections.

Web: http://www.nature.com/news/museums-the-endangered-dead-1.16942 .

NatSCA has also been developing a strategy document which will serve as a guide to the society’s activities and projects, providing greater transparency to members on the committee’s decision making process.

Through the combined efforts of the committee and members, we keep active on all fronts and look forward to developing our partnerships and working more closely with both the Society for the Preservation of Natural History Collections (SPNHC) and Geological Curators’ Group (GCG) over the next year.

Section E Financial review

Brief statement of the charity’s policy on reserves	The charity has no policy on reserves
Details of any funds materially in deficit	The charity has no funds in deficit

Treasurer's Report:
Holly Morgenroth

Accounts Summary 01.02.2014—31.01.2015

Income		2014-15	2013-14
Institutional Subscriptions			
Previous Years	30		30
Current Year	1,535		1,380
Future Years	39		135
		1,604	1,545
Personal Subscriptions			
Previous Years			105
Current Year	2,875		2,406
Future Years	386		177
		3,261	2,687
Workshop Income			
Herbarium II 2012			120
Law 2013			940
Entomology 2013			306
Taxidermy	1,068		
Hazards	599		
Entomology 2013	238		
Osseous	123		
		2,028	1,366
Conference Income			
2012			182
2013	325		6,630
SPNHC 2014	1,500		
		1,825	6,812
Grant Income			
Audience survey			10,000
NIP	6,000		7,500
		6,000	17,500
Other			
Paypal	0		
Bank interest	7		9
		7	9
TOTAL INCOME		**14,725**	29,919

Expenditure		2014-15	2013-14
Running costs			
Committee Expenses	1,610		1,959
Insurance			865
Postage	7		41
Bank Charges	12		14
Data Protection	35		35
		1,664	2,914
Events			
Conference 2013			6,181
SPNHC	500		
Workshops	934		935
		1,434	7,116
Publications & Information Provision			
Journal print & postage			1,834
Icon Leaflets			300
Website			300
		-	2,434
Projects			
Audience Survey			11,970
NIP	9,822		3,842
Bill Pettit Fund	784		1,838
		10,606	17,650
Other			
Recruitment Expenses	52		95
Bursaries	498		
NBN Trust Sub			30
HLF trainee	1,500		
		2,050	125
TOTAL EXPENDITURE		**15,754**	30,239

Cash Flow Statement				
01.02.2014	Current a/c	4,182.17		
	Deposit a/c	16,376.43		
	Paypal a/c	-		
			20,558.60	
31.01.2015	Current a/c	6,653.89		
	Deposit a/c	12,383.54		
	Paypal a/c	492.00		
			19,529.43	
Net Outflow				1,029.17

Proposed: Erica McAlister **Seconded:** David Gelsthorpe

Membership secretary's Report:
Maggie Reilly
2014 ended with 267 paid up members breaking down as 54 institutional members and 213 personal. There are 10 FOC mailings plus 3 patrons in addition to the paying membership. The membership remains largely UK based with 15% overseas members, largely continental Europe, North America and a few Australia and New Zealand. 57 new or returning former members joined up last year. A last minute last reminder went out in December to the remaining non payers (40 members) which realised a few subs. As usual there were a few resignations due to retiral or leaving the profession. Our total membership in years prior to 2013 has hovered around the 220 mark so the 2014 figure of 267 represents a ca. 20% increase in membership which I think is significant in these straightened times of job losses and cuts. Well done all for encouraging membership and the new systems for facilitating management of the membership –Justine Aw, Sam Barnett and Russell Dornan in particular deserve special thanks here. This is evidence also of the impact of increased profile, activity and revamped social media.

Subs have been received via PayPal, BACS, cheque, cash, bank transfer and standing orders. As expected Paypal has been a convenient addition to our means to pay, with 87 members choosing this method last year. Please note that unless you pay by standing order, you must take action each year to renew your sub. Existing members who use Paypal will be sent their 'unique renewal link' on request – this is to avoid duplicating their entry in the database.

With DG and Justine Aw's help, a google Mail group for emailing to the entire membership has been set up and after a few teething problems all seems to be working satisfactorily now. We encourage all members to sign up to JISCMAIL and follow NatSCA Twitter and Facebook but as this is voluntary and possibly may not suit institutional subs well, we also need a mechanism to get essential information to the whole membership. Please keep us up to date with any changes in your email addresses (or other details) by emailing membership@natsca.org.

For 2015:
We agreed at the 2014 AGM to raise the subs to £15 unwaged, £20 personal and £40 institutional Just under 70% of the existing membership have paid up so far (mid May 2015). We thank the membership for their continuing support and payment of the new subs.

As expected with the change in sub fees around 33 personal subs by standing order have been paid at the old rate so members will be contacted to ask them to pay the extra £5. PayPal or electronic bank transfers continue to be popular ways to pay.

Archivist Report:
Paul Brown
PB described how he and Kate Andrew had sorted the NSCG papers (committee minutes, letters and reports) for archiving and that Kate had deposited them at the Lapworth geological Museum at Birmingham, Edgbaston University. PB has approached the Natural History Museum, London's archivist and they are willing to take the NSCG archive as well as that of the BCG and NatSCA. PB will fetch the NSCG archive from the Lapworth and will locate the BCG archive material held at the NHM and will sort these before handing them over the NHM archive.

PB asked the membership to pass on any paperwork or photographs that could be added to the archive. It has been proposed that there will be an archive section to the NatSCA website and those papers of interest that do not have 'in committee confidence only' status could be placed here. PB will also make up a who's who of all BCG, NSCG and NatSCA committee members and their lengths of tenure.

Editor's Report:
Jan Freedman
Volume 2 of the new journal is out. It has lots of interesting articles covering natural history displays, conservation, museum databases and an article assessing the DNA damage to specimens. Two articles were rejected for this Volume. The peer reviewing process has significantly improved the quality of submissions. Reject articles are discussed with the authors and can be turned in to posts for the blog.

All articles from Volume 1 is now freely available online, so you can enjoy the articles when you are on the move or in a coffee shop! All the articles from all the old issues of NatSCA News are freely available too – so don't forget to have a search.

We are developing some clearer guidelines for submissions (including, font, referencing, images, etc). This will reduce formatting time and ensure all articles are submitted to the same standard.

JF would like to thank David Notton who continues to provide invaluable support as a volunteer.

We have a few articles for the next Volume. The deadline is July 15th. So please do get in touch if you are interested in submitting an article. If anyone wants to see a specific topic covered in the Journal, please contact JF and he will try and get it in. The Journal is for you, the members!

Dr David Waterhouse from Norfolk Museum Service reported that he did not receive the last issue. JF/MR to post latest issue to Dr Waterhouse.

DY reported that due to the nature of the conference some speakers will not be making contributions to the journal as it is more suited for the web or blog.

Electon of ordinary members of NatSCA committee:
Paolo Viscardi

Below are the nominees for NatSCA committee posts to serve from 2015 to 2017 which have reached the secretary.

The membership secretary has checked to see that those proposed, those proposing and those seconding are all present members of NatSCA.

OM 2015-2017 **Jack Ashby Grant Museums, UCL**
Proposed: Erica McAlister
Seconded: David Waterhouse

OM 2015-2017 **Miranda Lowe, NHM, London**
Proposed: Holly Morgenroth
Seconded: Jo Hatton

OM Conservation 2015-2017 Vicki Purewal, Pure Conservation
Proposed: Donna Young
Seconded: Vicky Singleton

OM 2015-2017 **David Gelsthorpe Manchester Museum**
Proposed: Dmitri Logunov
Seconded: Rachel Webster

OM GCG Rep 2015-2017 **Emma Bernard, NHM, London**
Proposed: Roberto Portela
Seconded: Sam Barnett

OM 2015-2017 **Isla Gladstone, Bristol City Museum**
Proposed: Ray Barnett
Seconded: Donna Young

If there are no objections to the candidates, can we accept and elect the listed people *en-block* onto committee to serve for two years.

Proposed by: Anthony Roach **Seconded by:** Hannah Allum

Already in post

1.	**Chair 2014-2017**	**Paolo Viscardi**	**Horniman Museum and Gardens**
2.	**Secretary 2014-2017**	**Roberto Portela Miguez**	**NHM, London**
3.	**Editor 2014-2016**	**Jan Freedman**	**Plymouth Museum**
4.	**Membership 2014-2016**	**Maggie Reilly**	**Hunterian Museum, Glasgow**
5.	**OM 2014-2016**	**Donna Young**	**World Museum, Liverpool**
6.	**OM 2014-2016**	**Clare Brown**	**Leeds Museum**
7.	**OM 2014-2016**	**Paul A, Brown**	**NHM London**
8.	**Treasurer 2013-16**	**Holly Morgenroth**	**Exeter Museum**

Any Other Business:
No other business

Vote of thanks:
PV thanked Justine Aw, Sam Barnett, Isla Gladstone & Bristol Team, Rachel Jennings, Emma-Louise Nichols, David Notton, Glenn Roadley, Donna Young, and Holly Morgenroth

Next committee meeting:
Natural History Museum, London. 3rd July 2015. 11am – 15.30

Close at 17:00 21st May 2015