Journal of Natural Science Collections

ISSN 2053-1133 Volume 12 | 2024

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 elected 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.

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

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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:

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Journal of Natural Science Collections

Aims and scope

The *Journal of Natural Science Collections* is a place for those working with these collections to share projects and ways of working that will benefit the museum community. The Journal represents all areas of work with natural science collections, and includes articles about best practice and latest research across disciplines, including conservation, curatorial methods, learning, exhibitions, and outreach. Articles in the Journal should be relevant and accessible to all of our diverse membership. Submissions are peer reviewed, resulting in high quality articles.

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Editorial Board

Front cover image: *Photograph of the holotype specimen of* Puma pardoides *(Owen, 1846), a molar from the Red Crag of Newbourne, Suffolk (IPSMG:R.1951.28.21.2) in the Ipswich Museums' collections. ©Colchester and Ipswich Museums. Photograph by Douglas Atfield.*

Editorial

Jan Freedman

Welcome to Volume 12 of the *Journal of Natural Science Collections*, and my final Volume as the Editor for NatSCA. After working on the Journal since 2008 (goodness, 16 years, with a small hiatus), I'm very proud of what the Journal has become. Those early years as the Editor for *NatSCA News* introduced me to so many colleagues all across the museum sector, and how natural history is so important across so many departments - and crucially, interlinked with so many departments. I have been extremely lucky to work with, and meet, so many amazingly talented people, from those that submit their hard work to the Journal, to those who spend their time expertly reviewing the articles.

Volume 12 is a very full Volume, with several articles from expert colleagues across the world. As always, the Volume can be split into sections. The first section focuses on **decolonisation** within natural history collections. **Versluis** has developed a new methodology to uncover the collecting motives of collectors, focusing on a geological collection at the Delft University of Technology. In the next article, **Armstrong and Oromeng** engages with empirical, theoretical, and practical considerations of anti-colonial approaches when working with mineralogical collections.

The article by **Pardoe *et al*.** nicely dovetails decolonisation and **engagement** highlighting the outcomes of their workshops engaging local community groups of Asian heritage with relevant biocultural specimens to raise awareness of the collections, to reach a wider audience. **Wednesday** follows with an article highlighting several different engagement projects at the Tullie House Museum and Art Gallery that have highlighted the climate emergency to a variety of new and different audiences.

The next section, focusing on **collections** begins with **Winters** examining object biographies, and how these are so important to increasing our knowledge of the specimens in our collections. **Jackson** provides a very useful paper on how important collaborations are for submitting a Designation application, and experts from many areas can really strengthen the application. A different type of environment presents different types of challenges for developing natural history collections, as discussed by **Freedman *et al.*** And in the final article in this section, **Crane** introduces the hidden life of the travels of an octopus, all the way from New Zealand to Dublin.

The final section of Volume 12 focuses on **conservation**, which begins with a new and more efficient method for collections surveys detailed by **Royce**. And in our final paper, **Castelain** outlines the detailed work that was undertaken to conserve severely damaged taxidermy specimens in a historical diorama.

The articles and the variety of expertise in this Volume shows how much expert talent there is in our sector, and they are all articles that we can learn from for our daily work. Thank you to the wonderful Editorial Board for all their support with developing this Volume: Paolo Viscardi, Verity Burke, Emilie Pearson, and Lisa Winters. They are patient, fantastic and dedicated, and without them this Volume would not be what it is. As always, a huge thank you to all the reviewers for the papers in this Volume, their feedback and suggestions have made these articles the highest of professional quality.

It has been an real honour to serve for so many years as the Editor for NatSCA. Developing the Journal for our members from *NatSCA News* into the *Journal of Natural Science Collections* has been just one of the many highlights. I will truly miss it. I know that the new Editor will be taking on something already wonderful, and they will make it their own. I have to thank the NatSCA committee for their never-ending support, expertise, and encouragement over the many years. Committee appears like an unapproachable word, but this committee is the kindest, most supportive group of people I have met, and those past and present members, will remain life-long friends. A final thank you, to *you*, the membership: for reading the Journal over the years, for submitting articles, for always being so engaging and enthusiastic about the work you do. Being a part of this dedicated, proactive, passionate community is something to be really proud of. It can feel alone working as a natural history curator, particularly in smaller museums, but NatSCA has shown that it isn't - there is a deeply passionate community. A community of the best minds who work in museums.

This is quite an emotional farewell as Editor. An emotional, but proud farewell. A little like seeing a child going off to University.

View from the Chair

Jennifer Gallichan and Isla Gladstone

This is the first view from the NatSCA co-chairs as 2023 marked a change in the Chair role, with the position being divided into two with the aim to increase capacity and better support the role. It has been an interesting year of transition and learning. NatSCA has worked hard to re-grow and adapt our activity and we are mindful of the difficult situations colleagues are facing globally and locally. With this in mind, we have aimed to have a continued positive focus on community, support and advocacy.

A key component of this was our first in person NatSCA-led conference since 2019, held in April at The Potteries Museum & Art Gallery in Stoke on Trent. It was fantastic to welcome over 100 attendees including many familiar as well as new faces. The subject was *'So how do we actually do all this? Hopeful futures and turning theory into practice for big issues in natural history collections'*. We experimented with new formats of lightning talks as well as a very well received round table discussion with Oliver Crimmen (Natural History Museum, London), Nigel Monaghan (National Museum of Ireland) and Maggie Reilly (Hunterian Museum, Glasgow) with their observations from a full career in the sector. There were many comments on how warm, welcoming and reviving the conference was for all.

We were also happy to see a return to training events, successfully delivering one in person and one online training event, both of which were sold out. The in person workshop was held in July and organised in partnership with the Natural History Museum London's DiSSCo UK team. This was followed by an online workshop in November with 96 attendees, covering some of the legislation that custodians of natural science collections need to be aware of. This is a complex area and one which we get many requests for training in. A heartfelt thanks to everyone who has helped deliver the sessions and shared their expertise.

We are continuing to grow our online presence through the NatSCA blog, consistently engaging over 1.7K – 2K views a month. This is testament to the fantastic contributions we have from the natural history community who continue to submit articles on a wide range of subjects including best practice when it comes to preserving collections, alongside large collection move projects, decolonisation work and articles revealing the intricate histories of objects in our collections. Interestingly, the top most viewed blogs cover a range of both new and old articles, showing that they have longevity and remain relevant to readers for a long period after they are posted. Our website is regularly updated with new resources including event materials, as well as job listings and event links.

NatSCA has continued to participate in pilot work to scope a national digital research infrastructure for natural science collections called DiSSCo UK (Distributed System of Scientific Collections UK). We are excited to see this opportunity develop, and will continue to work to support involvement of small to large collections across the UK.

We had a successful committee away day on 17-18th October at Amgueddfa Cymru - Museum Wales in Cardiff. These concentrated sessions are so important for us to pull together as a group and spend time working on our 2024-2027 strategy and action plan for the year. We had good discussions on our ways of working across the committee to identify where we need more capacity and how we can better deliver for our members. We also focused on key areas for future training as well as discussing how we can increase the amount of funds available to members for core work and training, such as bursaries and the Bill Petitt award during these tough times.

We would like to express our deep gratitude to the whole of the NatSCA committee and the excellent volunteers who help us in our mission. This includes the Editorial Board (Paolo Viscardi, Verity Burke, Emilie Pearson, and Lisa Winters, the Digital Digest Team (Glenn Roadley, Olivia Beaver, Milo Phillips), and Justine Aw for her continued technical operational support helping us deliver events, projects, the conference and the website.

We would like to end with a special thanks to Jan Freedman for his many long years of service as committee member and crucially as Editor of the Journal. The Journal is one of the key benefits of being a NatSCA member and takes a monumental amount of time and commitment to deliver. We recognise and appreciate your unwavering commitment to delivering a high quality publication for all, and give thanks for your contributions as a long-standing member of the committee. We wish you all the best for your future endeavours.

Applying a novel methodology to decipher colonial collection practices: Uncovering the collecting motives of the TU Delft Geological Suriname Collection

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Received: 28th Jul 2023

Accepted: 4th Feb 2024

Citation: Versluis, F. C. 2024. Applying a novel methodology to decipher colonial collection practices: Uncovering the collecting motives of the TU Deft Geological Suriname Collection. *Journal of Natural Science Collections.* **12.** pp. 3-18.

Abstract

During the first half of the twentieth century, a colonial natural history collection of nearly 4000 geological specimens from Suriname, accumulated at the Delft University of Technology. This collection is the focus of this study and was previously used at the university for both research and education on the geology and ores of the Dutch colony. A novel methodology was developed and tested to uncover the collecting motives of the collectors, with the aim to understand the processes behind the formation of the geological Suriname collection. This study has extensively examined the collection through archival, literature and collection research, using the obtained knowledge to create collecting motive categories. These categories were used to classify different parts of the collection, using literature sources that reveal the circumstances under which the objects were collected. The findings predominantly show the presence of economic collecting motives, highlighting the economic drive in colonial practices. This paper also critically assesses the used methodology. It has been found that the results are influenced by the information available and the researcher's interpretation of that information. On the other hand, the use of collecting motive categories allows for an analysis of drivers that played a key role in the colonial collecting processes. If interpreted with care, the results show the evolution of our understanding of the colonial context of natural history collections, supporting decolonizing practices and commence dialogues.

Keywords: colonial natural history collection; methodology; Suriname; collecting motives; TU Delft; Naturalis; decolonization

Introduction

In October 2022, the Netherlands received the first repatriation request for a natural history collection (NHC). The petition was submitted by Indonesia and involved the renowned Dubois collection (Van Nuland, 2022). This collection is most famous for the 'Java Man' fossils, which were, at the time of discovery, the oldest remains found of the *Homo erectus* (Dubois, 1893). Dubois first travelled to Indonesia in search of these fossils as a doctor enrolled with the Dutch East Indies army (Leakey and Slikkerveer, 1993). There is a great deal of controversy surrounding this history of the collection because during his search Dubois *"received a team which was completed by a group of fifty forced labourers*" (Leakey and Slikkerveer, 1993). This repatriation request gathered extensive media attention and triggered strong responses among Dutch citizens. An example of this are some of the reactions to a social media post by the Naturalis museum, housing the Dubois

collection. For instance, one of the responses stated: "*Give those items back to Indonesia, you bunch of thieves"*. This example illustrates the growing public awareness and sensitivity towards colonial heritage among the Dutch population.

Three months earlier, in July 2022, the Dutch government implemented policy following an advisory report titled '*Colonial collections and recognition of injustice'* (RVC, 2020). The policy primarily considers the unconditional return of looted colonial collections upon request, acknowledgement of injustice and the rectification of this injustice done (Uslu, 2022). While the government's decisions contribute to the recent developments in Dutch colonial collections, it is noteworthy that research output on this subject in the Netherlands has concurrently seen a substantial increase. One of the latest Dutch publications on the subject is from The Cultural Heritage Agency of The Netherlands. The agency wrote a guide that helps to locate collection objects in collection databases that are related to the Dutch history of slavery and colonies. A list with search terms is provided that can be used to search for such objects, including words such as 'servant', 'Dutch-Indies', Curiosities' or 'gold'. (RCE, 2021). Another recent Dutch report is titled '*Pilot project Provenance Research on Objects of the Colonial Era*' (Mooren, Stutje and Van Vree, 2022), which describes an extensive method that includes prioritisation, source criticism, finding sources, object research, approaching experts and reporting.

Apart from the ongoing developments in provenance studies, the research landscape for colonial NHCs is rapidly developing its own distinct methodological approaches (for example, Bewell, 2004; Das and Lowe, 2018; Green, 2019; Park *et al*., 2021; Weber, 2019; Ashby 2021), That shows a broad variety of examples how one can approach a colonial NHC collection. In the Manchester Museum, for instance, the influence of the British empire in the mineral collection was quantitatively assessed, highlighting a significant fraction of the objects originating from territories once under rule of the British empire or other colonial European empires (Gelsthorpe, 2021). Hearth and Robbins (2022) analyse the evolution of mineral displays, from Renaissance curiosity cabinets to contemporary museum exhibitions. Their research underscores how these presentations, while often focusing on scientific and aesthetic values, have historically overlooked the minerals' connections to human histories, particularly those related to colonialism. Ashby and Machin (2021) advise to target objects from specific individual collectors or locations as a starting point for colonial research. In their paper a gorilla and a springhare specimen are used to showcase examples of how military violence and colonial exploitation contributed to the formation of western natural history collections.

Building upon the existing literature and methodologies, this research introduces a novel approach to study colonial natural history collections. The methodology was developed during extensive research on the background of the geological collection from Suriname, South America (called the Suriname Collection) of the Delft University of Technology (TU Delft), which took place in the winter of 2021-2022. The collection is a subset of a larger collection of the TU Delft containing ~125.000 ores, rocks and minerals.

Established in 1864 by Professor Hermann Vogelsang (1838-1874), the collection initially served an educational purpose for mining engineering students at TU Delft (Mijnbouwkundige Vereeniging, 1992). Beyond its educational use, it was a research resource for the university. In 1911, the mining faculty and its vast collection moved to a new building, where the collection was exhibited on three different floors. In post-independence of the Dutch colonies, the collection of colonial ores lost its relevance to the university, leading to the discontinuation of its permanent exhibition. In 2001, it was relocated to the national natural history museum, Naturalis. During this transfer, the collection changed ownership and is currently part of the national collection owned by the Dutch government. The initiative for the investigation of the geological Suriname collection came from the TU Delft Science Centre which wanted to learn why this collection accumulated and which historic individuals from the university were involved. An extensive report was written (Versluis, 2022), and the method outlined in this paper was formulated during the report's development.

While existing literature provides valuable insights into methodologies for provenance research and colonial NHCs, there remains a gap in approaches specifically aimed at identifying trends in the collection process, which is a key focus of this study. This research proposes a novel approach to uncover the collecting motives behind the accumulation of colonial NHCs. The addition of this technique to the existing field of study can further broaden the spectrum of perspectives on colonial collections.

The method presented in this paper illustrates how to recognise the different processes behind

the formation of colonial collections. In order to accomplish that, this research has used literature sources to deduce the motives that drove the collectors, so that the intentions of the collection acquisition during the colonial-era becomes clearer. Having knowledge on the motives of collecting could:

1) influence collection management decisions,
2) assist with the assessment of restitution requests,
3) improve public education about colonial collecting practices
4) add academic value to the collection by augmenting its historical context and
5) improve or initiate the dialogue with the countries of origin by sharing information.

In this paper, the process and outcome of applying the newly developed methodology to discern colonial collecting motives is shared. Different insights that have been obtained during this process are presented and followed by a discussion. This paper follows from an extensive report that has been written on the investigated geological Suriname collection of the TU Delft (Versluis, 2022) and could serve as an example for exploring both the processes that shaped today's colonial NHCs and how our understanding of such processes evolves.

Methods

A novel methodology was applied to research the colonial geological Suriname collection of the TU Delft. The presented method aims to understand the collecting motives of the collectors. This can only be done by gathering as much information on the circumstances of the collecting process as possible and thoroughly studying the collection itself. The first step of the method involved an indepth analysis of archival materials, the collection itself, and literary sources. Following this, a collection hierarchy was created based on the acquisition circumstances of the collection items. This allowed for formulating collecting motive categories that could be matched to each part of the collection (Figure 1). The following section outlines the details of each step of this methodology.

1. Literature, archival and collection research

At the start of this research, all that was known regarding the content of the TU Delft geological Suriname collection was derived from the index page of the corresponding accession book. The first step of this research aimed to further expand

Figure 1. Flowchart of the methodology for recognition of collecting motives.

the knowledge of the collection history via literature and archival research. Various archives, including those of the Royal Dutch Geographical Society, TU Delft and Naturalis, were consulted for this research. Simultaneously, the accession books of the collection itself were researched. Notes on locations, names and dates found in the accession books were used to deduce the collection history. These leads were extensively studied using Delpher, an open access digital archive that contains Dutch books, magazines and newspapers that reach back to the 15th century.

Every box in the museum store room containing objects of the TU Delft geological Suriname collection was assessed, and each specimen and label visually checked for collector name and date (Figure 2). If original reports were available, the specimen information of the report was compared to the information on the label and the object itself. Due to its substantial size and suspected homogeneity, boxes labelled as the Lawa gold project were investigated for 33% via systematic sampling.

2. Collection hierarchy

With the obtained knowledge on the collection's context, a collection hierarchy was created, dividing the collection in subcollections and collection components that contain objects that were collected under the same circumstances. The division between different collecting circumstances was as detailed as possible and is limited by the knowledge derived from literature sources. This hierarchy is visualised in Table 1.

The collection encompasses 3868 rock specimens. The specimens were collected between 1853 and 1965, although the collection date is uncertain for some objects. With the exception of 88 specimens, every object could be connected to a collector, expedition, institute, mining company or project. The majority of the objects ended up at TU Delft due to its laboratory facilities available for geology and mining research, as well as through alumni. Such laboratory facilities were not available in Suriname during the collecting period, prompting the transportation of rock specimens from Suriname to Delft for analysis.

Table 1. The collection hierarchy of the geological Suriname collection from the TU Delft, reflecting the different collection circumstances. Components marked with an '' represent unexpected collection objects, as they were not listed in the Suriname accession book index. Abbreviations used: GMD (Geological- and Mining service of Suriname), TU Delft (Delft University of Technology), KNAG (Royal Dutch Geographical Society).*

Subcollection	*Collection Component*	*Amount objects*	*Year*	*Location*
Individuals	C.L.Van Nes	1	1905?	Gros placer, Suriname
	E. Essed	74	1924 - 1925	Coppename river, Suriname
	H. Roodenhuis*	17	1946?	Suriname river, Suriname
	A.H.Van Lessen	32	?	Saramacca river, Suriname
	B.P.F. Romer	12	?	Placer von Hemert, Suriname
	J.B. Harrison*	1	?	Marowijne river, Suriname
GMD	K*	29	1947?	Suriname
	F. d'Audretsch*	35	1949, 1951?	Suriname
	B*	32	1951?	Suriname
	H. Schols*	227	1953 - 1954?	Suriname
	Calcutta boring*	2	1965	Calcutta, Suriname
	V. De Munck*	4	?	Suriname, British Guiana
	AS*	2	?	Brokopondodam, Suriname
	J*	32	?	Jong Noord, Suriname
	KW*	2	?	Sabanpassi, Suriname
	L*	17	?	Suriname
	RM*	5	?	KM 62.5, Suriname
	Si*	19	?	Kabalebo, Suriname
	WK*	21	?	Suriname
Museums	K. Martin	60	1884 - 1885	Suriname river, Suriname
TU Delft	M.H. Caron*	2	?	Moengo, Suriname
	J.F. Holtrop*	162	1959 - 1961	Suriname, French Guiana, Brazilie, British Guiana

Table 1. (cont)

Subcollection	*Collection Component*	*Amount objects*	*Year*	*Location*
Expeditions	**Nickerie expeditions**	**206**	**1897 - 1900**	**Nickerie river, Suriname**
	KNAG - Coppename expedition	11	1901	Coppename river, Suriname
	KNAG - Saramacca expedition	99	1902 - 1903	Saramacca river, Suriname
	KNAG - Tapanahoni expedition	78	1904	Tapanahoni river, Suriname
	KNAG - Gonini expedition	78	1903 - 1904	Gonini river, Suriname
	KNAG - Toemoekhoemak expedition	21	1907 - 1908	Toemoekhoemak mountains., Suriname
	KNAG - Suriname expedition	67	1908	Suriname river, Suriname
	KNAG - Corantijn expedition	50	1910 - 1911	Corantijn river, Suriname
	Hendriktop expedition*	1	1922	Hendriktop, Suriname
	Border expedition*	37	1937	Suriname
	New York Botanical Garden Expedition*	24	1944	Tafelberg, Suriname
	Military expedition Coppename river*	23	1945	Coppename river, Suriname
	Coppename rubber expedition*	59	1943 - 1944	Coppename river, Suriname
	Emma range expedition*	61	1959	Emma range, Suriname
Mining business	Maatschappij Suriname - G.C. Dubois	281	1898 - 1899	Suriname
	Merkuur - G. Duyfjes	69	1915	Chinaqui, Nijbroek, Suriname
	Merkuur - G.E.J. Wiessing	25	1916 - 1917	Rosebel, Placer Toeval, Suriname
	NENIEM - J.A. Grutterink	114	1918 - 1919	Suriname
	NENIEM - E.A. Douglas	584	1918 - 1919	Suriname
	Sarakreek goudvelden N.V. - W. de Haan*	5	1953	Boschland, Suriname
	SBM	6	?	Moengo, Suriname
	Jannapau Mining Syndicate*	18	?	Jannapau, Suriname
Dutch government	German committee*	1	1853 - 1855	Nooit gedacht, Suriname
	Lawa	1074	1904 - 1907	Suriname
Unknown	Unknown	88	?	Suriname

In the subcollection 'Individuals', objects collected by individuals independently of any organization are found. Another subcollection has been identified as belonging to the Geological and Mining service of Suriname (GMD). These specimen bear specific markings related to this organization, and collectors are identified by either their full name or initials. Karl Martin (1851-1942) gathered as the director of the National Museum of Geology and Mineralogy. His collection is part of the subcollection 'Museums'. Two collectors, identified as researchers of the TU Delft, have collected specimens linked to their research. Additionally, a substantial part of the collection was amassed during various expeditions. The 'Mining business' subcollection contains objects collected by mining engineers, often TU Delft alumni. The collection also includes specimens from the German committee, which explored possibilities for German farmers to settle in

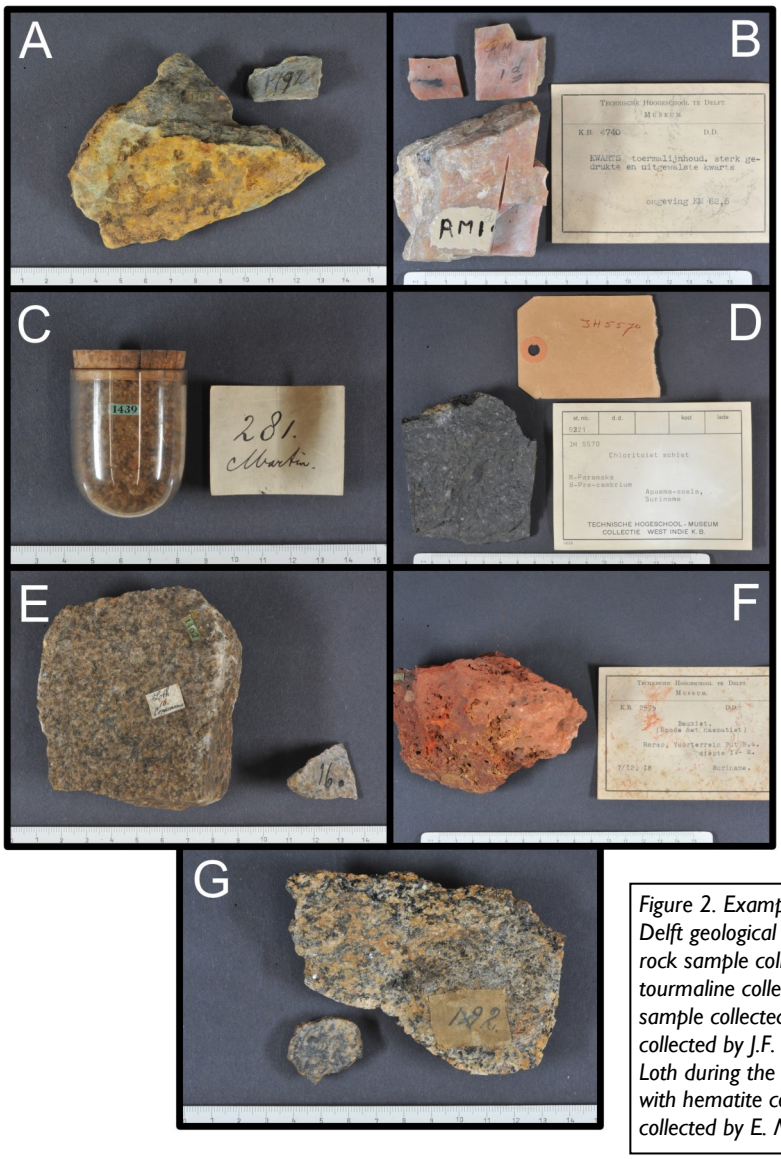

Figure 2. Examples of objects encountered in the TU Delft geological Suriname collection. A: unidentified rock sample collected by B.P.F. Romer; B: quartz with tourmaline collected by R.M.; C: unidentified sediment sample collected by K. Martin; D: chloritoid schist collected by J.F. Holtrop; E: granite collected by W.L. Loth during the Coppename expedition; F: bauxite with hematite collected by E.A. Douglas; G: granite collected by E. Middelberg for the Lawa gold project.

Suriname. Lastly, a significant number of samples relate to the Lawa gold project, a research initiative established to investigate the potential extraction of gold from the Lawa region in south Suriname. The research conducted by the German committee and the exploration of the Lawa region were both commissioned by the Dutch government.

3. Search collecting motives

Using the gathered sources, the next step focused on deducing collecting motives, which involved a thorough review of these sources for each component of the collection. The texts were scanned for phrases that stated as precisely as possible the aim or goal of the collecting process. In this way, all citations found that refer to the aim or goal of collecting the objects were noted and referenced for every collection component.

4. Create collecting motive categories

The most crucial step in this method concerns the appointment of collection objects to collecting motive categories. These categories were designed by reviewing all the citations found while attempting to identify trends. For every studied text the author tried to answer the question *'Why was this component of the collection collected?'* Often the answer to this question was: *'these objects were collected for science'* and so it was decided to create a scientific collecting motive category. These categories are entirely based on the information found in text sources. In this fashion, four distinct collecting motive categories were identified: 'scientific', 'economic', 'pure collecting' and 'intrinsic'. Definitions were then formulated for each of these categories:

The scientific motive

Objects collected with a scientific motive are collected with the aim to improve knowledge of the natural world. Specimens could be considered as collected with a scientific motive if the rocks, for instance, were collected for geological study. Indicators suggesting that objects were collected for science include instances where the collector published a scientific paper or geological map related to the object shortly after the collecting process. The collector often collects on behalf of a scientific institute or organization with the goal of addressing a specific research question.

The economic motive

An object is considered to have been collected with an economic motive if the collector's intentions were primarily focused on financial gain. An example could be a set of ore samples collected by an employee of a mining company. Ore, a natural rock containing valuable minerals, can be sold for profit. Hence, if the collected object is ore, there is a chance that it has been collected with an economic motive. Mineral samples can be sold for profit as well if the collected specimen has, for instance, an aesthetic value or even spiritual value. In many cases, a company is involved in the collecting process. Another indicator of an economic motive is evidence of the sale of the collected specimen shortly after the collecting date.

The pure collecting motive

An object is collected with a pure collecting motive when it was gathered with the goal of creating or expanding a professional collection. This may be the case when objects are collected on the instructions of a museum with the aim of adding them to the museum's collection. The affiliation of the collector with an institute that hosts collections could be an indicator that the object is collected for the collection of the same institute. Often, the goal of the specimen is to further complete a natural history collection, thereby improving the reputation of the institute hosting the collection.

The intrinsic motive

In contrast to the categories described above, objects collected with an intrinsic motive are gathered by a collector driven to collect for enjoyment or satisfaction rather than for a separable consequence. In other words, the collector was intrinsically motivated and moved to act for the fun or challenge entailed rather than because of external products, pressures or rewards. The collected object often ends up being a part of a personal collection instead of a professional collection, as is the case with a pure collecting motive. The collector is often an amateur, although professional collectors are not excluded from this category. An indicator of collecting with intrinsic motivation could be that the collector is on personal leave while collecting.

5. Categorization

The last step is to match the found citations on the purpose of collecting with the motive categories that are described above. For every match made, an argument is depicted to show why the researcher made the match. Of course, cases quickly become more complicated when multiple motives are thought to have played a role in the collecting process. In such cases an attempt was made to make a distinction between the main motive of collecting and the additional motive of collecting. It is assumed that without the main motive of collecting the collecting process would not have taken place at all (Table 2 for examples). Cases were encountered where it was impossible to match the collection component to a collecting motive category. Such collection components were assigned to the category 'Unknown'. In the result section, the arguments of every match made per motive category is presented together with the found context of the collection components. For the sake of this paper the original citations are translated into English. However, as translations can influence the interpretation of the text it is of utmost importance to use the original language of the citations during the application of this method.

6. Plot results

Finally, to obtain an overview of the different collecting motives that drove collectors, a graph is created by plotting the number of objects per (mixed) collecting motive category. Distinctions can be made between the different subcollections or collection components.

Results

During this research the newly developed method described above was applied to the TU Delft geological Suriname collection. The analysis followed a comprehensive review of archival records, literature sources and an examination of the collection itself. Different parts of the collection were assigned to various motive categories on the smallest scale possible, constrained by the available information. The section below details the trends uncovered in the collecting processes that shaped the studied colonial NHC. After presenting the obtained overview of recognised collecting motives, the

Table 2. Examples of mixed motives recognised in TU Delft's geological Suriname collection, applying the methodology for recognition of collecting motives.

	Example 1	*Example 2*
Subcollection	Expeditions	Dutch government
Component	Emma Range expedition	German committee
Collecting motive	Main: Scientific Additional: Economic	Main: Economic Additional: Scientific
Argument(s)	**Scientific:** The Emma Range expedition was a botanical expedition that aimed to travel to the Emma Range. The funding of the expedition came from the WOSUNA foundation (short for 'Scientific research in Suriname and the Dutch Antilles'), which finances scientific research in Suriname. The main goal during this expedition was to understand the processes that shaped the Emma range (Ijmuider Courant, 1959) **Economic:** During the expedition eyes were kept open for possible new sources of bauxite. (Ijmuider Courant, 1959)	**Economic**: Geologist Friedrich Voltz was sent to Suriname by the Dutch Government as a member of the 'German committee' to investigate the suitability of the soil for agriculture. (IJzerman, 1931; Kroonenberg, 2020). Furthermore the Dutch government included a geologist in the committee to learn more about the ores present in Suriname (Kroonenberg, 2020) **Scientific:** During his stay in Suriname Voltz had contact on a regular basis with Dutch geologist Winand Staring about his findings. At that time, Staring was the secretary of the head committee of Geological research of The Netherlands. Furthermore, Voltz sent his collected geological and botanical specimens to The Netherlands for research. (Kroonenberg, 2020)
Citation(s)	**Economic/Scientific:** "The soil expert and geomorphologist J.J. Wensink will collect soil samples, rocks and water samples and expose the geomorphology of the Emma Range to extensive research. Points of focus will be the tectonics, stratigraphy and character of the plateaus and terraces, and the measurement of the altitude of several peaks. Moreover, it will become clear whether the Emma Range hosts bauxite and whether the Roraima formation is present there." (Ijmuider Courant, 1959)	**Economic:** "He (Voltz) didn't make those journeys as an individual explorer. He was part of a committee that was send by the Dutch government to investigate the suitability of Suriname as settlement for German farmers. His travels were therefore limited and he had to apply with the instructions to investigate the coastal area and inland for the suitability of colonisation for Germans" (Kroonenberg, 2020) "The colonial government did, of course, select a geologist for the committee with a purpose. In the end it would be nice if valuable ores could be located" (Kroonenberg, 2020) **Scientific:** "During the planning stage, some members of the commission contacted the Dutch government, which arranged a contact between them and … Dr. W.C.H. Staring. It was arranged that Voltz would inform Staring by letter on the results of the German commission's work … Staring studied Voltz' letters of which he published excerpts" (Wong *et al.*, 1998) **Economic and Scientific**: "Voltz's work is characterized by purposeful and accurate research; he takes an interest in economical possibilities as well as in the advancement of science" (IJzerman, 1931)

used sources and arguments that led to the overview will be introduced per collecting motive category.

Recognised collecting motives

The studied colonial collection is described using subcollections which in its turn are divided into collection components, i.e. the most detailed division possible to group objects that were collected under the same circumstances or context. The developed method uses literature sources that describe the circumstances of collecting for every collection component to assign collecting motive categories. With the obtained data a visualisation was made of the relationship between the collecting motives and the

subcollections present in the collection: Individuals, Geological- and Mining Service of Suriname (GMD), Museums, TU Delft, Expeditions, Mining companies, Dutch Government and Unknown (Figure 3). As can be seen in Figure 3, the two primary collecting motives identified in the studied collection were the 'scientific' and the 'economic' motive (see the method section for category descriptions). In many cases, a mix of motives was identified, and efforts were made to distinguish between the primary and secondary motives. In this research the cases of mixed categories are denoted as follows: main motive/second motive/ third motive. The analysis depicted in Figure 3 reveals that the 'economic' motive emerges as the most prominent collecting motive in the NHC. More than half of the TU Delft geological Suriname collection was interpreted as being collected for economic purposes. The majority of collection objects that belong to this category are part of the 'Dutch government' subcollection (27.8%)

and the 'Mining business' subcollection (28.5%). This suggests that economic factors played a significant role in the collecting processes that took place in the early 20th century. Another 27.1% of the collection was understood to have been collected with a mixed scientific/economic motive. Specimens linked to this mixed motive were mainly gathered during expeditions, indicating that collecting during these voyages was not only done with the goal to gain (natural historical) knowledge but also for the purpose of, for instance, seeking exploitation possibilities. Examples of the 'pure collecting' and 'intrinsic' motives were also recognised, although these appeared far less frequently. Using the designed method it was possible to attribute 94.5% of the entire TU Delft geological Suriname collection to a collecting motive category. This left only 5.5%, or 213 objects, in the category 'Unknown'. From these objects, a total of 88 lacked any information about the collection year, location, or collector.

The economic motive

Within the TU Delft geological Suriname collection, literature sources indicate that more than half of the collected objects was collected with an economic motive. A total of 1102 objects linked to this motive were collected for the mining business, primarily by mining engineers, the majority of whom graduated from the mining faculty of the TU Delft. The engineers collected on behalf of the companies they worked for. Table 3 illustrates how the economic motive is deduced for three

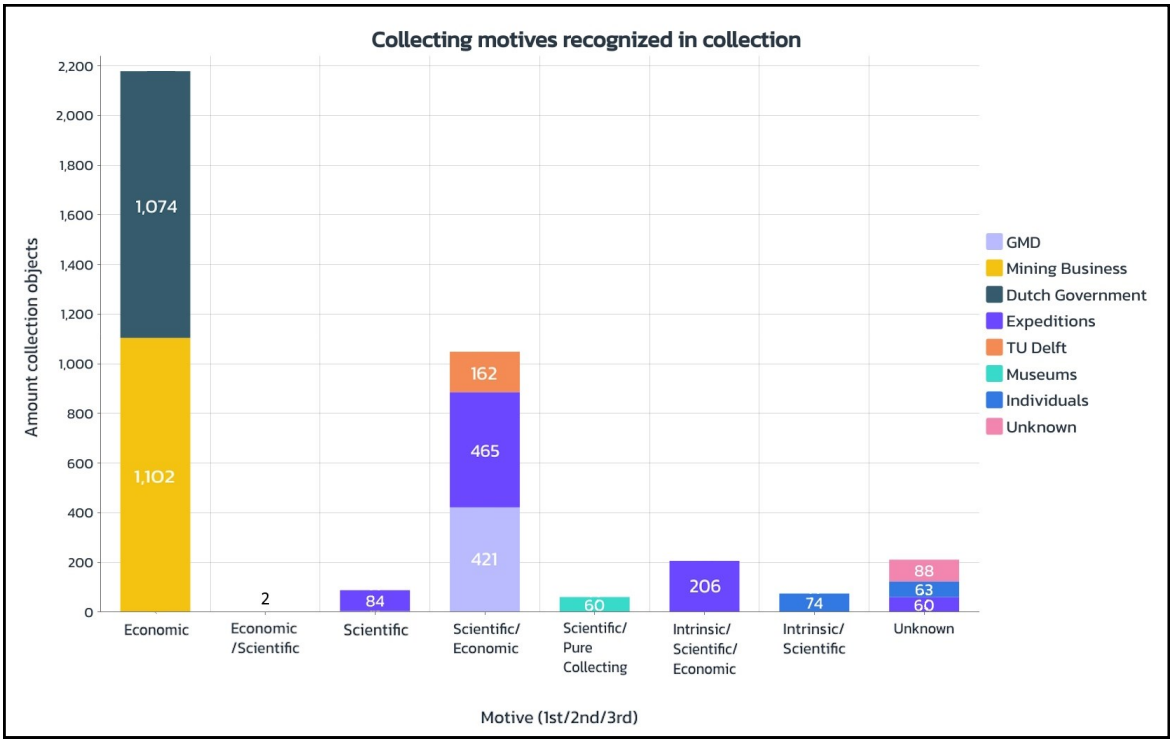

Figure 3. This graph shows how different collecting motives are interpreted in relation to the different subcollections of the TU Delft geological Suriname collection. The entire collection encompasses 3868 objects. A distinction has been made between a primary (1st) and secondary (2nd), or even third (3rd), motive when multiple collecting motives were thought to apply to a collection component.

Table 3. Three examples of collection components which have been collected by a mining engineer for a mining business, showing an economic collecting motive.

Collection component	Argument economic collecting motive	Citation(s)
Maatschappij Suriname – G.C. Du Bois	Du Bois was commissioned by the company 'Maatschappij Suriname' to investigate the plausibility of mining gold.	"A German geologist, G.C. Du Bois, visited Suriname in 1898-1899 as a gold prospector for the 'Maatschappij Suriname" (Wong *et al.,* 1998)
Merkuur – G. Duyfjes	Duyfjes was sent to investigate mercury deposits in Suriname by the Bonidoro exploration syndicate and Maatschappij Merkuur. (Duyfjes, 1915)	"We have succeeded in tracing the original location of the Chin A Qui terrain where cinnabar was found. This site cannot be considered for exploitation." (Duyfjes, 1915)
NENIEM – E.A. Douglas	Douglas was sent in 1918 to investigate the bauxite quality on the Rorac concession and the Nassau mountains on behalf of the NENIEM (Wong *et al.*, 1998)	"Interest in the mining of mineral resources in Suriname awakened in the meantime also in Europe. NENIEM (Nederlandsche Mijnexploitatie en Exploratie Maatschappij) was formed in 1917 … In 1918 E.A. Douglas … arrived in Paramaribo to investigate the NENIEM bauxite deposits" (Wong *et al.*, 1998)

collection components following the method for recognition of collecting motives.

The collection also contains over 1000 objects from the government-led Lawa gold project. The gold fields of the Lawa region were discovered in 1885. However, the fields were situated between two tributaries of the Marowijne River, which was considered the boundary between Suriname and French Guiana. A border dispute followed that concluded in favour of the Dutch. On what happened after, found citations in sources state the following:

> "*Towards the end of last century petitions were addressed to the Government for a systematic investigation by Mining experts. The petitioners pointed to the deficient geological knowledge, and maintained that a systematic investigation would open up new goldfields. They also set forth that traces of other minerals furnished support to their belief that Surinam would have a future as a Mining country, if the interior were opened and explored… The exploration of the Lawa basin was taken up by the Government"* (IJzerman, 1931)

> *"By order of the Minister of Colonies of 23 December 1902... the reporter was instructed to go... to Suriname and to make himself available there to the Governor of that Colony in preparation for an investigation into mineral-bearing sites in the Lawa area and the way in which they can be extracted"* (Van Loon, 1904)

On behalf of the Dutch minister of Colonies, Eduard Middelberg (1873-1948) and Carel Jan van Loon (1859-1915) (both TU Delft graduates) investigated the gold field area on the feasibility of gold exploitation. The results were unsatisfactory as large quantities of gold had been previously extracted or looted from the area, making the mining of the remaining ore unprofitable. (Van Loon, 1904; Middelberg, 1908; Duyfjes, 1910;

Wong *et al.*, 1998). In this case, collector Middelberg accumulated the rock specimens on behalf of the Dutch government. The citation indicates a purely economic motive due to the focus on exploring new goldfields. According to this text the exploration was a response to the petitions addressed to the government and implies a primary incentive to uncover and exploit valuable mineral resources for economic gain.

The economic/scientific motive

In a couple of particular fractions of the collection, sources regarding the collecting process were found that gave the impression that aside from an economic drive also a scientific motive played a

role. Hence, in these cases objects were assigned a primary economic motive with a secondary scientific motive. The case of geologist Friedrich Voltz (1828-1855), who collected samples as a member of the German committee, is shown in Table 2 in the method section. In a similar way, mixed motives were assigned to kaolin samples that have been linked to TU Delft professor Martinus Hendrik Caron (1883-1958). On the circumstances of his research the following has been written:

> "*However, the samples and the equipment available here did not allow us to assess the Surinamese kaolins for their usability. Hence, there was sufficient reason to conduct a more extensive investigation ... In addition to the investigation for usability as a ceramic material, the samples were also examined for their mineralogical composition ... it appears that the Surinamese kaolins are of a very varied character, both in terms of usability and raw material for the ceramic industry and in terms of the geological origin*" (Schols, 1949)

Whether Caron was the actual collector of the samples is not known, but he investigated the samples for the GMD both to assess the commercial feasibility for the ceramic industry and to understand the geological formation process. As the citation above explicitly mentions the need to assess the usability of the kaolin samples, this citation infers that the geological research regarding the kaolin formation would not have been conducted if kaolin had no value for the ceramic industry.

The scientific motive

Compared to the economic motive, there is a modest portion of the collection understood to have been collected solely for scientific purposes. Most of the objects associated with a scientific motive were collected to improve the knowledge of the geology of Suriname. But that was not always the case. A notable yet small component of the studied collection comprises three Pre-Columbian stone axes collected by Victor de Munck (1920-1957). These axes are ethnographic objects that have always been part of this NHC collection, and were described as rocks. Hence, prior to this research it was not known that these axes were present in the collection. De Munck worked for the GMD and therefore the axes are linked to a paper published by GMD geologist Salomon Kroonenberg in 1976 (Boomert and Kroonenberg, 1976). Their goal was stated as:

> *"We will try to reconstruct and describe one of the Amerindian trade networks, existing in the Guinanas during Pre-Colombian times and discuss its geographical limits, centre, radiation and dating…. In addition we will discuss the evidence for the trade of stone artifacts during Post-Columbian times in the Guianas"* (Boomert and Kroonenberg, 1976)

The mineralogy of the collected stone axes was investigated with the aim of uncovering Indigenous trade routes by tracing the origin of the stone axes (Boomert and Kroonenberg, 1976). The axes collected by De Munck bear the marks of mineralogical research and hence are most likely connected to the paper of Kroonenberg. To collect stone axes for the purpose of retracing Indigenous trade routes is an unusual example of collecting. In this research, the axes are matched to the scientific motive, although the cultural-historical dimension of the axes does not fit neatly in this category. The case is further elaborated in the discussion section.

The scientific/economic motive

The mixed scientific/economic collecting motive represents the second largest fraction in the TU Delft geological Suriname collection. A total of 1048 collection objects are understood to have been collected for scientific advancement, with distinct economic goals also playing a role. The line between this mixed motive category and the economic/scientific category is very fine. Nonetheless, an attempt was made to make the distinction between the two. An useful example concerns the majority of the GMD subcollection. Despite the fact that mining activity in Suriname was already present in 1875, it took decades before a geological survey was set up:

> *"The need for a systematic geological survey of the interior had already been recognized during the period of intensive gold mining but only in 1943, the Mining Section was established …the section was transferred into the Geological and Mining Service (GMD) in 1949… The tasks given to the GMD were: to survey and prepare a geological map of Suriname, to compile an inventory of mineral resources, to advise the Minister on mining legislation, exploration licenses and concessions,.. to render consulting services to government and private organizations. …The GMD activities at the time (1943) covered both mineral investigations (including water) and systematic reconnaissance mapping of the northeastern part of the country … These great efforts eventually led to the publication in 1977 of the .. geological map of Suriname …*

> *After having reached this milestone … the main activities shifted towards exploration"* (Wong *et al.*, 1998)

Although tasks of the GMD were linked to the mining sector, the first main goal of the organisation was to systematically map the country. Since the objects in the collection were gathered before 1977, the primary objective for collecting the rock specimens was to acquire knowledge to publish a geological map. Therefore, in this research this part of the collection has been appointed to the scientific motive with an additional economic motive. However, one could argue that the geological map was mainly produced for mining purposes. This demonstrates how applying the method can open up dialogues concerning colonial collecting circumstances.

Another significant subcollection assigned to the scientific/economic category includes rock specimens gathered during expeditions by the Royal Dutch Geographical Society. Similar to the GMD, these expeditions aimed at mapping the interior of Suriname, although there was plenty of room to conduct natural-historical research as well. Geological research during these journeys was especially mentioned as essential, not for science but for the possibility of uncovering economic deposits such as gold:

> "*The Society for Suriname considered in the course of 1897 the desirability of systematic scientific investigations of the lesser known parts of the 'Colony Suriname'. Favourable advice from a group of influential gentlemen, in 1897, was followed by a discussion of the proposal .... Positive reactions were received by April 1899, with the suggestion to commence with the Coppename/Saramacca river areas. The primary activity should be a topograpical survey with ample room for natural-historical investigations, and, in particular for the collection of rock samples and floral and faunal specimens.*" (Wong *et al.*, 1998)

> "*Furthermore, in this report great importance was attached to geological research with a view to finding rich mineral resources*" (Van Stockum, 1902)

The scientific/pure collecting motive

Collecting often results in the formation or enlargement of a collection, but the objects in the TU Delft Geological Suriname collection were not primarily gathered with the intention of being part of the university's collection. The only case of the pure collecting motive recognised in the collection are the 60 rock specimens of Karl Martin (1851-1942). As the director of the National museum of geology and mineralogy during his travels to Suriname, Martin's main purpose to collect was to gain more geological knowledge:

> "*The geological investigation was the actual purpose of my trip"* (Martin, 1887)

Indeed, a geological map resulted from Martin's journey (Martin, 1887), but a book published fifty years later to celebrate Martin's achievements, implied that the museum benefitted from his journey, suggesting the collected specimen were added to the museum collection:

> *"Martin undertook three important trips abroad to gain knowledge about the geology of the Dutch Colonies and to advance the geology of those colonies. The trips benefited the Leiden museum*" (Leidse geologische mededelingen, 1931)

While no proof has been found yet to support this, it is known that around 200 zoological objects collected during the same journey were donated to the museum by his fellow traveller Mr. Neervoort van de Poll (1862-1924):

> *"Mr. Neervoort van de Poll in Amsterdam collected all the animals on his trip to the West Indies ... gave them as a gift to the Museum"* (Gijzen, 1938).

This knowledge strengthens the theory that Martin's collection might have been obtained for a scientific purpose but with an additional pure collecting goal for the museum.

The intrinsic/scientific/economic motive

The 206 rock specimens collected during the Nickerie expeditions of 1897 and 1900 represent the most complex mix of motive categories identified during this study. From the expedition report it has been assumed that these two expeditions would not have taken place without the personal desire of the expedition leaders to experience an adventure and to explore. The first expedition, initiated by lieutenant Corstiaan Van Drimmelen (1860-1935) during his personal leave, was driven by a desire to explore uncharted territories:

> *"Wanting to follow the example of one of his [Van Drimmelen] predecessors... to travel some distance into the inland never before entered by a European, this diligent civil servant did not wish to return*

> *without some knowledge of mineral and geography, in order to bring together a collection of earth and stone types useful for research and to add notes that could reveal the general features of the geological condition of the area travelled through."* (Van Capelle, 1903)

From this citation it becomes evident that it was Van Drimmelen's wish to return to the Netherlands with knowledge relevant for geology. Hence, this research has appointed a scientific motive as a secondary motive of collecting. Afterwards, Van Drimmelen met Herman van Capelle (1857-1932) at the institute for agriculture in Wageningen. Sharing his expedition experience, Van Drimmelen ignited a childhood dream of Van Capelle, who wished to explore the tropics. This led to the organisation of a second expedition:

> "*During the meetings that I [Van Cappele] held with Van Drimmelen … the great desire for a research trip in the tropics, the dream of my youth, awoke again in me. This desire grew, when I had to consult ... the important writing of my former teacher. … not least the questions that the geological results of Van Drimmelens' journey had given rise to, aroused my desire more and more to go on an exploratory tour through the West of the colony of Suriname*" (Van Capelle, 1903)

Van Cappele found various investors, some of whom requested to include gold prospecting alongside the scientific objectives:

> "*a number of private individuals and companies had also selflessly promised me equal support ... I received a proposal from capitalists that, in addition to scientific research, I would also be responsible for research into exploitable minerals, more specifically gold. and to accept a significant amount of money for this purpose.*" (Van Capelle, 1903)

Hence, the economic motive was assigned to this part of the collection as a third reason for collecting.

The intrinsic/scientific motive

A minor amount of the TU Delft geological Suriname collection has been assigned an intrinsic/ scientific motive. E. Essed's collection of 74 rock specimens serves as an interesting example of intrinsic collecting intertwined with scientific motives. His story considers the scientific heritage of Friedrich Voltz. Voltz, previously mentioned as a collector who collected for the German committee, was also viewed upon as the first geologist to conduct geological research in Suriname. His collection of almost 900 rock specimens ended up in the collection of the National museum of geology and mineralogy. But information on the locations was minimal as Voltz' map was lost, together with a significant amount of specimen labels (Kroonenberg, 2020). In order to try and regain some of the lost knowledge, researchers tried to resample the same sites along the Coppename River that Voltz must have sampled, but the research led to more questions than answers (Bergt, 1901; Kroonenberg, 2020). Unsatisfied with this outcome, Essed embarked on a personal mission to the Coppename River to retrace Voltz's work himself:

> *"In the following pages I shall try to conclusively prove that Martin and Bergt were wrong in basing such a strong opinion on the results of the microscopic examination of only 16 rockspecimens … and to place this opinion against that of Voltz…"* (Essed, 1926)

Though the application of the collecting was scientific, Essed's reasoning has been emotional in his paper:

> *"It will give me great pleasure if this sketch … will lead to the restoration of Voltz into the place he really deserves amongst the men, who, bravely facing all the troubles and obstacles laid in their way by men and nature, assiduously worked, even laid down their lives as Voltz had done, apparently with no other aim in view than delivering, to the best of their ability, their fair share in the furtherance of human knowledge and scientific research."* (Essed, 1926)

This sentiment was also recognised by the scientific community at that time (Martin, 1926/1927). Thus, the objects in the collection are understood to not have been solely collected for geological knowledge since Essed might have had a personal concern for Voltz's heritage. Most likely Essed experienced satisfaction while trying to safeguard Voltz's heritage.

Discussion

In this research, a novel method was developed and tested to uncover the reasons for collecting the geological Suriname collection of the TU Delft. Since the method is designed to investigate cultural sensitive collections it is necessary to critically evaluate the process.

Creating collecting motive categories

A key point of discussion regards the process of creating collecting motive categories. It is evident

that the results that followed from the tested method are entirely dependent on the categories created, their definition, and the researcher's point of view. Of course, it is only possible to create relevant categories to the best of our knowledge and when information is limited, it will influence the quality of the results. The outcomes of this method should be interpreted as a visual representation of the current understanding of the examined collection.

As the stories behind every collection are unique, so should be the created collecting motive categories. The categories used in this research are based on the cases encountered in the studied TU Delft geological Suriname collection. Investigating another collection could reveal entirely different collecting motives. One can imagine that NHC objects might be collected with political or military motives. Or perhaps with religious or cultural drivers. The exploration of collecting motives is an ongoing process. The same is true for the description of the categories. Another study might wish to search for economic motives in their collection history as well, but with another understanding of what that encompasses. This poses no problem, provided the researcher explicitly outlines their definition of the category and offers justifications for its applicability to specific parts of the collection.

Applying collecting motive categories

During this study, it has often been challenging to distinguish between the scientific and economic motive. The challenge is inherent to the difference between collecting for geological research and for mining. Mining engineers practise applied science when collecting, while geologists practise basic, or natural science. At the same time, the geological research conducted in Suriname often supported mining operations. Recognising intrinsic collecting, defined here as collecting for personal joy or satisfaction, presents its own challenges. In the entire studied collection, no case was encountered that could be solely linked to intrinsic collecting. The category was primarily created to address the objects collected during the Nickerie expeditions. This part of the collection was assigned a partial intrinsic collecting motive, even though it is likely that the objects not find a place in a personal collection. Lieutenant Van Drimmelen can be seen as an amateur, given that his entire career path was not connected to science, geology or mining. Van Capelle, on the other hand, was teaching geology at the Wageningen institute were he met Van Drimmelen, and together they organized a second Nickerie expedition. Nonetheless, this research argues that the objects would not have been collected if both Van Drimmelen and Van Capelle did not have the desire to embark on an adventure.

These nuances highlight the difficulty of applying the tested method. The effectiveness of the method depends on transparently justifying each categorisation decision. In this way, the context of the collection is depicted to the best of our ability and the results may open up dialogues. If a dialogue follows that changes the categorisation decisions, the opportunity arises to replot the results. In this way it is possible to track the development of the understanding of the collection's context by replotting Figure 3 and observing the changes. Unfortunately, this study lacked cooperation with a Surinamese community. Otherwise, the changed perspective on the collections context after a dialogue with such a community could have been presented in this paper.

Use of literature sources

As evident from the result section, the method used in this research entirely relies upon the Available information. The usage of words gives us hints that allow us to form an opinion about the circumstances under which the objects were collected. For this paper, many of the quotes were translated into English. However, the matches with collecting motives were made using the original languages of the texts. Translations always involve an interpretation of the text from the translator's point of view and could hence influence the results of the method. Furthermore, while studying literature sources, it is important to practice source criticism: prior to using a source one must evaluate the reliability of that source and avoid presentism. This means that we must not use a present-day interpretation of texts that have been written in the past.

Repeatability

Whether the method is suited for other collections entirely depends on the used collecting motive categories. In this case the categories were especially designed for NHC objects. This has become evident from an encounter with Pre-Columbian stone axes in the studied geology collection. This research has tried to include these objects in the collection analysis, which has proven to be difficult. The axes cannot be linked to a motive category that is designed to study NHC objects, as they were gathered for their cultural-historical value. It is for this reason that this research intended to show this case, as it is an example of challenges encountered in colonial NHCs.

The abundance of background information enabled this research to match 94.5% of the collection to specific collecting motives. In this way the study showed that economic drivers played a major role in the collecting process. However, the absence of information could lead to misguided conclusions. Hence, the effectiveness of the method presented here relies on the accuracy and quantity of available information on the studied collection. It is hard to predict the effectiveness of the method when applied to another collection as it is difficult to determine a threshold on the amount of necessary information. Matching collection objects to a collecting motive requires information such as a year, affiliated collector or institute, and the context of collecting. Without such information at hand, the application of this method will prove to be ineffective.

Future research

As stated earlier, the method could be used to track changes in the perspective on the collection's historical context over time. This could be done for instance at the start and end of a study or after a dialogue with a relevant community where the first results of the applied method could be discussed. Perhaps the method could be used to gauge the opinion of the museum public on colonial collections as well. In an exhibition featuring a colonial collection, the public can be engaged at each display by offering a choice of collecting motive categories and providing space for their own interpretations, thereby gathering diverse perspectives on the context of the collection. Furthermore, it would be interesting to test the method on different types of colonial NHCs, such as a vertebrate or botanical collection. This could reveal varied motivations in colonial collection practices. It may be that the method can be applied to ethnographic colonial collections as well, when entirely different motive categories are developed.

Conclusion

This paper results from investigating the provenance and collecting motives of the geological Suriname collection of the Delft University of Technology. The investigation aimed to understand the processes behind the formation of the collection. After extensive archival, literature and collection research, an overview of different recognised collecting motives was made. The most significant motive identified in the collection was the economic motive, accounting for 56.3% of the collection. The collectors connected to this part of the collection were often TU Delft alumni and either employed by a mining company or by the Dutch government. Many objects collecting during expeditions were found to have dual motives, not only scientific but also economic. Hence, this research illustrates the significant role that economic factors played during the formation of the studied NHC. These findings align with Gelsthorpe's research on Manchester's museum mineral collection, reflecting the economic activities of colonial powers in their respective regions (Gelsthorpe, 2021).

When applied with clear definitions of the used categories and transparently presenting the arguments for every categorization choice, this method becomes a tool that visualises the processes that drove colonial collecting. A single application of the method provides results that could initiate dialogues about colonial collecting motives. A second application of the method, following dialogues that consider the initial results, might show how our understanding of colonial collecting processes evolves. Therefore, this research could assist decolonization efforts by making complex colonial collecting histories comprehensible and by encouraging dialogue and collaboration between the Netherlands and Suriname on colonial collections.

Acknowledgments

I would like to extend my gratitude to the employees of the Naturalis collection department, who always made themselves available to answer my questions. I am particularly grateful to the former collection manager Arike Gill, who helped me find my way in the collection during this research, and archivist Karien Lahaise who helped me find the way in the archive. I also want to thank Salomon Kroonenberg for his valuable help in understanding the GMD collection and providing me with literature and knowledge on the history of mining and geology in Suriname. I would like to thank both Theo Wong and Natasja den Ouden, who provided useful feedback on this paper. I am especially thankful to Abel Streefland, for his critical view and extensive supervision during the writing process. Lastly, I am grateful to Science Centre director Michael van der Meer who inspired me to view the collection as a valuable heritage.

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Labours of Excavation: Reflections on "Unearthing the Collection"

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Received: 30th July 2023

Accepted: 24th Nov 2024

Citation: Armstrong, E. S., and Oromeng, K. V. 2024. Labours of Excavation: Reflections on "Unearthing the Collection." *Journal of Natural Science Collections.* **12.** pp.19-36.

Abstract

This article explores how theoretical framings of *heritage as process* can be employed to contextualise natural science collections as complex, dynamic and contested assemblages of objects, places, practices and people. This research is a result of reflections on a workshop the authors organized, "*Unearthing the Collection*", with the aims of exploring and engaging with empirical, theoretical, and practical considerations of anti-colonial approaches when working with mineralogical collections. Using mineralogical collections as a model, the article draws on scholarships of critical heritage studies, science communication, and decolonial curatorial interventions to interrogate natural science collections' past, present, and future lives. Leveraging insights from the workshop, this article expands on labour as a key theme and a critically neglected social dimension of natural science collections. We build on this and frame labour as a tactic and tool for strategic intervention through museum activism or curatorial approaches. We define three different labour-centric perspectives that serve as lenses for constructing spatiotemporal life-histories of collections and specimens (from points of extraction to acquisition and maintenance) and for implementing anti-colonial praxis. This article concludes with a reflection on the limitations of labour as a lens and other tactics that can be explored to unearth collections.

Keywords: Heritagisation; labour; mineralogical collections; Anthropocene; science communication; education; anti-colonial; extraction; anti-racist

Introduction

In response to calls in natural history and science museums to develop real, truthful historical contextualization of science collections, this paper takes on the challenge by reflecting on a workshop the authors ran, "*Unearthing the Collection*" (UtC), that used anti-racist and anti-colonial scholarship as a critical lens to examine mineral collections. The workshop brought together advanced undergraduate and graduate students from the University of Delaware to explore the ways in which science communication, anti-racist and anti-colonial practices can be employed to contextualize mineralogical collections. UtC was funded by the University of Delaware Anti-Racist Initiative (UDARI) to develop community engagement with anti-racist practice in public institutions. A key observation by the authors from the workshop was how highlighting labour acted as a powerful device for unveiling hidden histories of collections and as a tool for strategic curatorial interventions. By closely examining different types of labour linked to mineralogical

collections such as the work of mineral specimen extraction, the logistics and histories of the mobility required for specimen trade or to get into exhibitions, and the attentive care and maintenance of collections, we unlock productive pathways for anti-colonial and anti-racist interventions. In practice this might involve proactively including in public displays the traces of the historical forms of labour that contributed to the establishment of a collection, and the acknowledgement of processes of erasure, concealment and under-documentation of distant or marginalized actors.

We present our framing questions for the data and discussion of this paper: What does it mean to be contextualising science within the mineralogical museum? What has our workshop's specifically anti -colonial orientation allowed us to highlight ? Finally: how are these approaches understood or engaged within the workshop? We draw on Liboiron's (2021a) formulation of *anti*-colonial (emphasis ours) in this text, rejecting colonial and settler practices, instead drawing on lineages that span Indigenous, queer, feminist, and Afro-futurist, decolonial and postcolonial approaches and lenses. Then we utilise two theoretical frameworks:

i.) heritage as a dynamic process that ongoingly assembles objects, places, bodies, histories, and practises
ii.) the strategic use of activist tactics as guiding principles and prompts for anti-colonial interventions within mineral collections.

We explore how these theoretical framings illuminated three different types of labours at work: the labour of extraction, the labour associated with mobility, and the labour of maintenance. In conclusion, we offer a reflection on our focus on labour, and gesture towards other themes that may also give those working in public-facing mineralogical collections further avenues to explore their own tactics in museum activism praxis.

This paper contributes to the scholarship by continuing discussions in the *Journal of Natural Science Collections* on capital-colonialism in natural science collections (including Das and Lowe, 2018; Gelsthorpe, 2021; Hearth and Robbins, 2022), by documenting an intervention at the university-level to stimulate engagement with these questions beyond the scholarly archive and into public practice with collections, and finally by suggesting ways that these theoretical insights may be picked up in praxis elsewhere. Our workshop approach also aligns this work with innovations in teaching and learning in the natural sciences that employ situated and embodied inquiry-led learning, particularly introducing elements of verticality such as atmospheres (e.g., Engelmann, 2023) and the subterranean (e.g., Truyts, 2018) to the classroom.

Heritagisation and the Mineralogical Museum

The relevance of heritage is always a question of the present, rather than the past - shaped by contemporary needs and demands (Tunbridge and Ashworth, 1996). This perspective is particularly well theorised in literature that grapples with "heritage as process", a framework that conceptualises "heritagisation" as a dynamic process involving the continuous creation and maintenance of heritage. Such a perspective opens a space for discussions about the processes that have shaped our institutions, and the possibilities for them going forwards. Rather than heritage (objects, places, practices) as static, fixed, and unchanging in meaning and relevance over time; this theoretical lens helps us see how heritage is (re)made over time. In *Heritage: Critical Approaches,* Harrison (2012) posits that:

> *Heritage is not a passive process of simply preserving things from the past that remain, but an active process of assembling a series of objects, places and practices that we choose to hold up as a mirror to the present, associated with a particular set of values that we wish to take with us into the future.* (p. 4)

While Harrison formulates this in relation to *cultural* heritage, we argue that this is equally applicable to *scientific* heritage. Science (and its collections) somewhat resists heritagisation (as Harrison coins) as the idea of 'objectivity' (Daston and Galison, 2021) permits scientific heritage to be formulated as not socially specific or historically contingent. The literature on science centres as a space for demonstrating 'laws' and 'theories' rather than 'facts' lends credence to the idea that science heritage is not (re)made but, rather, simply *is*. In the context of mineralogical collections - typified in display by cases of rocks and minerals which are often wooden, often arranged spatially such that one can look down on the collections, frequently unchanged over many years - the impression of the space is to make the objectivity, and thus *realness,* of science tacit to the visitor. The mineralogical collections are framed as part of a system that delivers value-neutral, scientific knowledge about the world, obscuring the intentional creation of these spaces, preparing visitors for particular views about the position of science in society, the security of scientific futures, and the idea that science is 'outside' social systems.

Attending to processes of making this scientific heritage, through a focus on embodied and interactive mechanisms, can help researchers and curators articulate the tensions of the collection to visitors as we demonstrate in the discussion below.

This changing understanding of science museums by scholars and practitioners has been conceptualised through frameworks such as the fourth-generation science museums, those seeking to promote active citizenship and social responsibility through a dialogical and participatory model (Pedretti and Iannini, 2020). This work builds on previous scholarship that has examined the development of museums through a 3-tier successive generations model, where first-generation science museums were defined by conservation, collection, research and training which was marked by their strong affiliations to academic institutions and a strong adherence to the 'look-but-don't-touch' principle (Amodio, 2013). These were succeeded by second -generation science museums which shifted their attention from experts and scholars towards using their collections for public science education (Friedman, 2010; McManus, 1992). By the early 1960s third-generation museums emerged distinguished by the development of science-technology centers that have little to no permanent collections, and the inclusion of contemporary science concepts and interactive hands-on science exhibits (Figure 1). Pedretti and Iannini (2020) conceptualise the fourth and new generation of science museums which tackle contemporary socioscientific phenomena such as climate change, sustainability and COVID-19. They employ dialogical and participatory models and techniques such as blogs, newsletters, forums and public lectures in addition to exhibits. A critical examination of their own colonial, imperialist and racist historical ties may serve as a key marker of evolving towards the realization of fourth-generation science museums.

Perhaps most visible in socio-cultural museums, the values embedded in such orientations are increasingly visible in discourses of scientific heritage. Employing Harrison's call to understand that 'our futures are imagined and made possible through the pasts which are produced through heritage in our present' (Harrison, 2013: 7), we

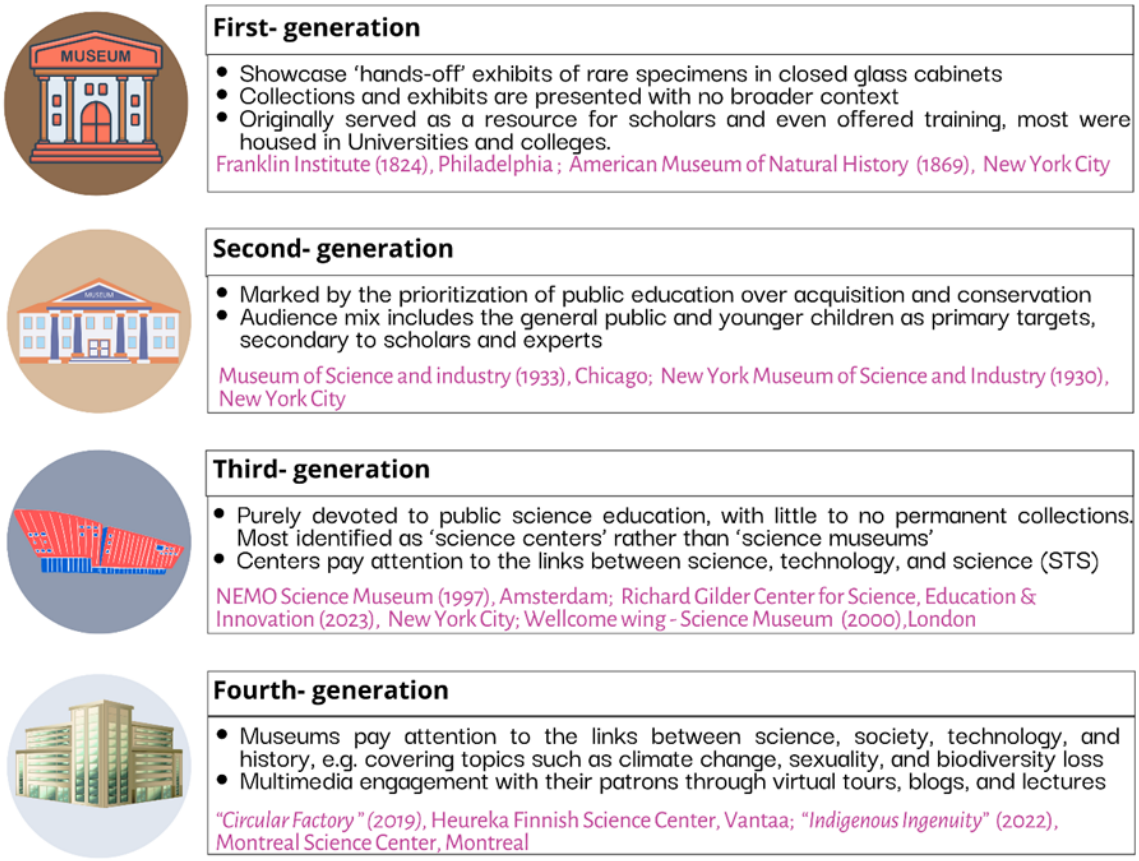

Figure 1: Illustrates the various successive generations of science museums, including Pedretti and Iannini's proposed 'fourth-generation museum'. Distinct characteristics for each generation and relevant examples of museums or key exhibits are also provided for contextual and illustrative purposes.

find a process of (re)developing our narratives of the past in relation to science integral to bringing these futures into being. Particularly relevant to our questions of international networks of accumulation (e.g. trade), Harrison (2012) especially draws attention to the recent heritagisation of "globalised and globalising processes of broad international concern." We argue that our focus on mineralogical museums comes in tandem with other similar pushes across heritage sectors to embed global systems - by which we mean systems such as colonialism, capitalism, extraction - within local collections. A focus on these global systems in heritage can take many forms. For instance, Harrison and Sterling (2020, p.22) argue that centring heritage in the planet-wide Anthropocene is not "a nostalgic longing for how things were, but [is] a means of expanding our collective imagination," giving a way for visitors in one heritage to site to see both the site and themselves as part of a global system.

Our workshop's call to "unearth," or expose, some of the tensions inherent in mineralogical collections adhered to an anti-colonial approach that is specific and intentional about the promotion of an ethics of "good relations" between humans and nonhumans (Liboiron, 2021a), and challenges to dominant knowledge systems, by treating 'Indigenous knowledge as expertise, rather than culture' (Liboiron, 2021b). Our anti-colonial orientation drew attention particularly to the way museums appeal to "objective science" - a notion that claims scientific knowledge as impartial, neutral, and presents science museums as apolitical and ahistorical institutions. The anti-colonial perspective challenges this notion by highlighting how museums are *necessarily* entangled with larger systems of power and prompts us to critically examine the values that underpin the scientific practices that result in scientific collections.

Many natural science museums are undertaking reflective exercises to address their colonial histories. One example is Leeds Museum and Galleries which are acknowledging and addressing the institution's colonial ties through restructuring their collections database to flag controversial or offensive objects and engaging with local African diaspora communities to undertake provenance research. Expanding a decolonial approach, which calls for the 'repatriation of Indigenous land and life' (Tuck and Yang, 2012, p.21), an anti-colonial approach urges us to additionally acknowledge, critique and address the historical ties between science museum collections and colonialism.

Using the metaphor of 'unearthing', our work mobilises an anti-colonial approach that places emphasis on values over objects. We depart from a longstanding focus on the histories of museum and heritage objects (such as the rocks and minerals themselves). Instead of dwelling on their entangled histories, our work is oriented towards the possibility of action in communicating to visitors. We look not at further documentation of the objects, but rather how to make this knowledge more widely available. In *What comes after entanglement* Giraud (2019, p.7) argues that while the focus on entanglement - which Giraud uses as a term to describe complex histories of phenomena - captures the complexity of world-making relationships, 'there is still a tendency to celebrate entanglement - or treat it as good in itself - with questions about intervention hinted at but ultimately left underdeveloped'. Guided by Giraud's use of the term tactics to describe the possibilities of such interventions (2019, p.18), we also offer *tactics* in this paper where 'tactics are a useful concept in maintaining a focus on how praxis is framed by power'. These tactics for activism and change which can be undertaken by anyone in the institution reveal where and how power operates. Thus, the tactics are processes of resistance in themselves. Giraud (2019) differentiates *tactics* from *strategies*, where the latter seek to impose their own way of doing things as instructions. We, like Giraud's theorising, aim to highlight in this paper that there are a multiplicity of *tactics* that can be used by interested parties. In doing so, we draw attention to how such tactics are context-specific, plural, and can open the possibilities for the future in different places and at different times. We resist the idea that this paper can offer a series of universal *strategies* for museum folk to implement. Instead, *tactics* direct the reader to their specific context and it's possibilities. One deliberate tactic we used in the set up of *UtC*, for example, is celebrating multiple existing projects as a group to demonstrate the values we hope to see in mineralogical contexts, rather than seeing these individual projects as templates, or strategies, to be directly replicated elsewhere.

Contextualizing Mineralogical Museums

Alongside a rise in industrialised mining, which underpinned the extractivist capitalist-colonialism of the late 1700s and early 1800s, was an expansion of rock and mineralogical collections. Collectors were nearly exclusively Western aristocrats who had the time and resources to leisurely amass mineral collections to use as symbols of class and wealth (Hearth and Robbins, 2022). The impetus to identify, categorise, and collect materials that could be extracted from the ground based on their physical properties, morphology, chemistry,

and chemical purity increased from the 16th century onwards, as a motivation to maximise capital accumulation from a mine. For example, as Claire Sabel (2021) notes, the early Royal Society of London was extensively invested in the composition of the Earth and the sources and origins of metals and precious stones; frequently with a view to their industrial and capital potential. Elsewhere Stafford (1984) shows how geological surveys by the British were linked with intelligence gathering both on minerals and on local politics. Advances in chemically categorising materials and separating out inorganic materials removed objects such as fossils from mineralogical collections. Even the remaining collections were subject to repeated re-classififcation impulses of scholars and amateur enthusiasts alike, visible through both the changing names and the changing organisational structures of the collections in archives. These begin to demonstrate how the collections are constituted and shaped by power-knowledge acts by those responsible for them (Foucault, 1981).

From the late 1700s onwards public museums and institutions in western nations (and their colonial outposts - see, e.g., Stafford, 1984) began facilitating the large-scale collecting of geological materials beyond wealthy individuals, during what Knell (1996) describes as the 'heroic age' of geology. A formalising of the field through the coalescing of specialist societies, professionalisation of the practice (including unified museum display styles), and prolific popularisation had taken place by around 1850 (Wyse Jackson, 1999); and by the late 1800s natural history became not only a professional pursuit but an amateur hobby of great popularity. Private and public geology collections were part of a growing fascination with understanding the history of the Earth - and the tension of natural history's epistemic position with that of Christian religious doctrine - as well as placing 'civilisations' in geological time (Allen, 2008). Geology collections were primarily employed in service of a geological education for school children in public museums and in higher education at university collections until the mid-1900s, when the geology field shifted to laboratory and fieldwork studies, leading to a decline in the use of university collections as teaching objects.

These collections had multiple purposes. Utilised as a demonstration of wealth and prestige, to a documentation of imperial expansion, to a resource for scientific practice; mineralogical collections were located in multiple places including the houses of miners, wealthy patrons' private showcases, in the shops of dealers, exhibitions in museums, displays at world fairs.

An example of collecting for imperial expansion to exhibition can be seen in the Sedgwick Museum's John Watson Building Stones Collection. Collected by John Watson (1842 - 1928) with over 1100 samples of building materials throughout the then-British Empire in the late 19th and early 20th centuries (Merrill, 1911). This collection and a descriptive catalogue published in 1911 were donated to the Museum of Economic Geology (later incorporated into the Sedgwick Museum) and continues to expand, now housing over 2500 samples.

Contrastingly, Sendino and Porter (2020) demonstrate how, for example, Louisa Finch, Countess of Aylesford (1760 - 1832) had a mineral collection that was primarily sourced through dealers and at auction between 1810-1832, a collection that was auctioned off itself after her death to various institutions across the United Kingdom and United States of America including the Natural History Museum and Yale Center for British Arts.

Geological and mineralogical collections are now largely housed as i.) stand-alone institutions, ii.) as part of larger natural history - or indeed science or social - museums, or iii.) as part of higher education collections (Hearth and Robbins, 2022). Consequently, mineralogical museums and collections are part of both formal and informal geological education, as well as being part of the other functions of contemporary science museums in lifestyle and leisure choices of publics (e.g. see Figure 1). Current collections are diverse in terms of how they are affiliated with institutions, the style of ownership of the collections, the size and composition of the collection, the number of staff who work with the collections, and the way that collections are being used. Some mineralogical museums (and/or geological museums) have been removed from their physical display locations, while others were disposed of altogether by institutions. Wyse Jackson (1999, p.425) makes the argument that although legacy collections may be of use to historians of geology to move beyond paper records and into a material turn to focus on the rocks as artefacts, this use is dependent on their retained documentation: 'an undocumented and unidentified piece of granite is simply that: perhaps attractive but worthless in terms of scientific history; regardless of where it is kept'.

Worldwide, displays of mineral collections share a visual and physical vernacular in looks and structures: often glass-topped wooden display cases with draws of materials populated with samples; labels that declared their name, type, and location of origin; all sorted according to

standardised classificatory schemes (see for example Figure 2). A number of these rooms at prominent national institutions remain remained unchanged over decades, invoking an affective experience in contemporary audience members that is often characterised by nostalgia and awe in the space, as our workshop speaker Florence Okoye demonstrated in her presentation on members of the public's experiences of the Minerals Gallery of the Natural History Museum, London. The original intention of such cases being for education in stratigraphy and natural history, many visitors to museums around the world in the twenty-first century experience these spaces as part of a growning experience economy of museums (Harrison, 2012) and "edutainment" (Buckingham and Scanlon, 2001): the museum visitor interest is often in taking photographs of the collections - especially large visually spectacular gemstones such as giant purple amethysts from Uruguay, a 9-foot geode displayed at the American Museum of Natural History.

Despite this longevity of these display styles (the Swedish Museum of Natural History, for example, retains some of the older display cases as a museum of mineralogical museology in their more recently refurbished gallery), some mineralogical collections have been part of a turn towards contextualising science in public institutions. Some of this is led internally in the institutions. The 2021 opening of the Allison and Roberto Mignone Halls of Gems and Minerals at the American Museum of Natural History (New York, USA) sees displays that highlight the people who worked in building the collections (e.g., George F Kunz, a New York based gem dealer for Tiffany & Co; or students Elijah Hamlin and Ezekiel Holmes in the finding Tourmalines - see Figure 3). This builds on other contextualising elsewhere in the museum around, for example, the theft of the Ahnighito Meteorite (also known as the Cape York Meteorite). Elsewhere, the work to contextualise artefacts comes from grassroot movements outside the institution. Beyond Extraction (2022), a community group, led counter tours titled 'Mining the Museum' at the Royal Ontario Museum's Teck Suite of Galleries that critiques both the histories of colonial extraction as well as the continued benefit to the extractive industry in the mineral-intensive transition to renewable energy in Canada and around the world. These changing dynamics take place against a larger shift in public pressure against the mining and extractive industries that originated many of these collections worldwide. For instance, rejection of oil sponsorship in museums is happening apace - in the UK the Natural History Museum London has stopped accepting oil sponsorship (2021), and protest by grassroots organisations such as Liberate Tate, BP or Not BP, and Culture Unstained, as well as specific actions against institutions that continue to take their funding, work to reshape the relation between extraction and processes of heritage.

Alongside scholarship on the Anthropocene and in environmental humanities, a rising interest in the entanglement of geoscience collections and larger systems of power is visible, demonstrating shifting values both in museums and in society at large (see e.g., Roy, 2018). While, '[p]ublic memory, it would seem, can be just as selective as the individual sort,' as Hooper (2017, p.9) asks, 'can such guilty landscapes ever truly be forgotten?' A rich strand of art and design engages with mining and extractivism constantly resurfacing the impacts of

Figure 2: Author photograph of the mineral collection at the Vienna Natural History Museum. (Photo Eleanor Armstrong, 11th October 2023)

Figure 3: Museum exhibition board detailing the discovery of tourmaline gemstones by two college students at Mount Mica, Maine in 1820. Photograph taken at the American Museum of Natural History's Allison and Roberto Mignone Halls of Gems and Minerals. (Photo Eleanor Armstrong, 10th November 2021)

of industrialisation (see, for example, Berlo, 2009; Lippard, 2013; Premiyak 2020). Engaging questions of human-inflicted changes of the landscape through the extraction of materials from the subsurface, these acts of socio-cultural contextualisation are yet another way to help return us as scholars and scientists to the impacts extractive industries have on human lives, global and local environments, and social and cultural practices.

Through foregrounding this existing work that grapples with pulling these changes into view for audience members, UtC worked within a heritage framework that centres on reparative history (Hall, 2018, p.6). The process of heritagisation makes clear that there is always 'contestation over memory – what was to be remembered and how?' (Hall, 2018, p.6). Rather than disavowal or evasion of the past as is the current regime, we use this idea of remaking our heritage 'in ways that enable thinking about responsibility in the present' (Hall, 2018, p.6) and orient us towards the possibilities for action and transformation of futures. Reparative history in heritage work, as part of a large frame of transformative justice (Sharpe, 2016), sees a reprisal of interest in setting contemporary systems in the contexts of larger historic and global networks. We pick up this movement here in its emphasis not just within academic scholarship, but also within public history and public pedagogy spaces such as mineralogical museums. We equally heed the call of Joseph-Salisbury and Connelly (2021) to think about how we as scholar-activists within the institution could leverage the resources of the university to support communities of resistance and social justices in scientific heritage spaces.

Unearthing the Collection: The Workshop

The workshop was hosted as three half-day workshops aimed at advanced undergraduates and graduate students at the University of Delaware (UD) to initiate thinking on practical, public-facing tactics for anti-racist and anti-colonial practice and public scholarship in/on museums through mineralogical collections. Our project was financed by the University of Delaware Anti-Racist Initiative (UDARI) through their anti-racist programming sub-committee. Three invited speakers-facilitators - Chitra Ramalingam, Selby Hearth, and Florence Okoye - with expertise ranging from mineralogy, natural history collections, and museum user experience unpacked the ways systemic and institutional racism are manifested by and can be subverted in museums.

After active engagement with speakers in their ninety-minute sessions and an initial framing session, participants undertook a speculative design-informed project (Dunne and Raby, 2013) to produce anti-racist and anti-colonial programming ideas for a mineralogical museum context and beyond with rock collections outside of museums. Many of the participant's reflections and ideas have been collated into a legacy workbook zine that will be made available to non-attendees. The workshop legacy includes a digital resource repository for contributors holding an annotated bibliography, relevant readings, and mineral biographies. In the workshop we had three key aims: to raise awareness of existing anti-colonial practice in science museums and science communication; to have a practical element that allowed participants to develop their own ideas; and to develop a legacy that allows future UD learners - particularly those in museum studies - to be engaged in anti-colonial practice in science museums, which has been a lacuna of the museum studies scholarship at large. Our evaluation included questionnaires for participants and for the developers and discursive analysis by ourselves of the anti-colonial content in the projects proposed in the workshop.

Workshop participants came from humanities to geoscience departments and indicated a strong interest in pursuing future careers in museums or archival studies and a shared enthusiasm for science and museums. Some participants already had work experience in museums, and almost all of them expressed enthusiasm for learning more about anti-colonial practices in museum spaces. The cohort for this workshop thus represented both museum visitors and future museum workers. As part of the grant, we offered honoraria to students to defray the costs of participation outside of their usual studies. Future workshops and research will benefit from a consideration of the labour of engagement (and its compensation) from museum visitors and patrons when engaging with critical questions in ethical, non-extractive engagement, which we took steps to in this project.

Possibilising new narratives and values through a focus on labour

Drawing on our framework of developing tactics (Giraud, 2019) to think through (re)heritagisation in mineralogical museums, it became apparent to us during the workshop that one tactic that is being utilised in research and public communication is to trace, track, and talk about the entangled nature of labour in these collections. As is well documented in other scholarship on mineralogical museums, a focus on labour complicates the histories and futures of heritage-making by highlighting the people, processes, and knowledge systems that underpin the extraction, scientific identification, cataloguing, acquisition, and care of specimens in their journeys from the Earth to within the museum. We argue that a focus on labour reframes what purposes and values the mineralogical museum might have in learning contexts. It makes the possibilities of (re)heritagisation for the public in these collections visible to researchers and practitioners.

Using labour as an analytical device within the context of mineralogical museums, particularly whilst reaching into the past, serves as an anti-colonial strategy. This approach highlights the obscured intersections between histories of empire-expansion, colonial wealth accumulation, and the symbolic significance large assemblages of mineral specimens played in aristocratic social landscapes. Moreover, it demonstrates how science knowledge production is subsumed in these complex histories, sometimes positioned as the result of the collection and at other times serving as a justification for its existance. We echo other researchers' call to reflect on and see the 'role of science…in both colonialism and militarism and in resistance' (Pollock and Subramaniam, 2016). We argue science and natural history museums provide a microcosm of exploring this relationship, and a testing field for possible points of intervention and advocacy. By virtue of being meaning-making spaces for the public, science and natural history museums are especially well-positioned to address colonialist and imperialist logics through critical engagement with topics of labour or accumulation in and in relation to knowledge production (Pedretti and Iannini, 2020). For instance, while mineralogical museum

catalogue and display labels often reflect mineral provenance, there is room to address place-specific histories of labours of extraction and attend to the sociocultural landscapes that led to mineral extraction. This could offer visitors a chance to engage with the material in a more meaningful way and explore its histories beyond the museum.

In the following sections, we trace and discuss three broad categories of labour identified from the workshop: labour of extraction of mineral objects; labour of mobility that put objects in motion and congregate them in mineral collections; as well as the labour of maintaining museum spaces. Using data from the workshop content, participant reflections, and project proposals we highlight corresponding themes of labour and then show how this framing demonstrates their potential as tools and tactics for anti-colonial interventions in public spaces.

i. Labours of extraction

Workshop discussions and presentations indicated an array of interest in obscured histories and legacies of labours of extraction in various ways. Chitra Ramalingam's workshop contribution, "*Out of Place: A British Mineralogy*", engaged with the intersecting histories of mineral collections from India's Deccan Traps formation and the imperialist occupation of India by Britain. Ramalingam's presentation also highlighted the successes of collaborative efforts with Indian artist Garima Gupta, where photographs, maps, and mineral imagery were employed to unpick the layered histories of mineral specimens from a natural history collection for public visitors. This demonstrated how innovative and collaborative interventions could serve as a tactic for (re) heritagisation of mineral collections, as well as documenting the labours of interdisciplinary collaborations. Ramalingam's work highlighted how different forms of labours could be productively assembled to bring specimen-specific or subject-specific histories within museum collections to the fore. A contemporary focus on the ongoing relationship between mineral extraction and digital technology was made visible in Florence Okoye's workshop talk "*Mobiles, minerals and missing links.*" Today, while mineralogical museums might hold and practice rigorous ethical sourcing codes, exploitative labours of extraction persist in gems and mineral industries that supply the global smartphone market from the same sites, offering an opportunity to utilise collections to highlight ongoing global issues and to showcase networked supply chains.

During the speculative design component of the workshop, participants built on existing interventions similar to the "*Mobiles, minerals and missing links*" to develop ideas for projects, exhibitions and alternative forms of intervention. We successfully employed a critical speculative design format to allow participants to reimagine museum practices for the public. Participants were encouraged to develop ambitious interventions that used science communication, anti-racist and anti-colonial takeaways from the session to generate new narratives and improve accessibility. A key advantage of employing speculative design in this workshop were that anxieties about project feasibility are removed as potential limiting factors to creativity and innovation. As a result, participants developed projects for interventions that explored the use of digital platforms to improve public participation and access, and considered the potential for stories and narratives unconfined by borders as demonstrated by discussions of some of the proposed interventions that follows.

One group of participants formulated and prototyped a museum exhibition that memorialise the thousands of Black miners who died in and near the *Kimberley* mine - apartheid South Africa's largest diamond mining operation. This intervention resonates with inquiries within the dark tourism field (Lennon, 2017; Scarlett and Riede, 2019) that question what kinds of commemorations are deemed (un)acceptable. In the case of Kimberley mine, the 'Big Hole' attracts thousands of visitors mostly on account of its status as the largest hole excavated by hand in the world. The intervention responded to the Kimberley Mine Museum, where a sanitised narrative about the lives of Black labourers in the hand-dug mine (Hatcher, 2016) is presented; and associated local monuments such as the Diggers' Memorial, a fountain statue in the Oppenheimer Gardens of Kimberley that was commissioned from Herman Wald (1906 - 1970) in 1960 to honour the men "who pioneered the diamond industry." The narrative of pioneers and "hero-workers" that both portray are countered by a memorial stone that was installed in 2009 to the Bafokeng Regiments who died while working as labourers at the mine. The epitaph reads: "They toiled here to earn money for their people so that the land which had been forcibly taken from Bafokeng could be bought back". This acknowledgement of the Bafokeng's labour and sacrifice highlights the pressures of apartheid-induced displacement that pushed their men into the mines. The participants envisioned a project that built on this by incorporating the untold stories of migrant labourers.

This interest our participants worked on in showcasing the labour that was required to excavate at the mine was in fact considered at the time of a recent re-development of the museum in South Africa. In their masters thesis, Brown (2006, p.52) interviewed contributors who undertook this re-development in the early 2000s, who themselves described the choice to leave out the "social history and the life of the diggers" motivated by how it was "not appropriate in the Big Hole Project," because it was "negative history" that would be on display in a space where those developing the display hoped that visitors were to be entertained: "They want to have fun – not be depressed" (Brown, 2006, p.54). In reviewing the documentation of the mine in local museums, Morris (2021) argues that both the Mine Museum and other local socio-cultural museums (such as the McGregor Museum, the Rudd House) are places where labours of extractivism and labours that facilitated the lives of mine-owners are being ongoingly made visible. The speculative project at UtC that imagined a display that moved around local communities, echoes the tactics for engaging in the entanglement of labours of extraction and mines that have taken place at Sol Plaatje University on the 'Big Hole Counter Narrative Project' that sought to subvert the "reigning imperial and colonial fantasy imbued in the particular place of Kimberley" (Truyts, 2018, p.55) through questions of value, worth and waste; past, present and future; and about which narratives are told in these contexts.

Post-workshop feedback from participants also recognised the missing discussions of "families of those affected, the communities that are experiencing residual effects of mining and/or empire" in narratives about extraction that we discussed in the workshop. While we advocate for re-heritagisation to foreground these labours in relation to mineralogical collections, we are astute to the critiques of ethical practice in displaying images or stories, discussing narratives, and encouraging the consumption of what are often exploitative and extractive events. Photographs of workers in mines or gravesites generate issues about how they were captured and their display. As Hooper argues, the practices of 'late modernity, where everything is available for sale and consumption, including images and narratives associated with death' (Hooper, 2017, p.4) are not unambiguously good and require caring and careful engagement in public history contexts.

We argue that employed as a tool for anti-colonial work in mineralogical collections, including the labour - past and present - that has been and is key to mineral extraction in processes of re-heritagisation can be used to bring to attention the narratives of colonial-capitalism that have been smoothed from scientific spaces. This separation creates the idea that such contexts and labours are perhaps not of concern to science - they are somehow non-scientific (although, is it not science, technology and engineering that supports the development and maintenance of these extractive sites through labour?), and allows publics to not have to engage in the discomfort of reparative histories (as acknowledged in the case of the Kimberley Mine Museum). We see this process of re-heritagisation around labours of extraction as part of a value shift that engages with labour-relations, centres the conditions of miners and near-mine communities, and acknowledges the power dynamics governing labour contracts. These are not struggles relegated to the annals of history: the contemporary global mineral extraction systems remain critical to the flows of materials and capital but largely invisible especially in museum collections. A focus on labours of extraction is a tactic that pulls mineralogical specimens metaphorically out of the display case and back into entanglements with the geology from which they came.

ii. Labours of mobility

Having explored labours of mineral extraction, we also noted a theme of the labour involved in the movement of mineralogical specimens. What are the processes, trade routes, territories, and forms of relations that connected mineral collectors and gem traders with distant mining sites? Once lifted out of their geological beds, how did these specimens come to be in the collections; described, named, and valued? We see some of these in the narratives of the mineralogical museum already - the human-centred stories that are present often feature the individuals who were or are central to the acquisition of objects. For instance, the Carnegie Museum of Natural History, established in 1896, boasts a mineralogical collection of over 30,000 specimens. The museum's largest mineral acquisition was in 1904 when Andrew Carnegie (1835 - 1919) purchased a $20,000 collection from William W. Jefferis (1820 - 1906). The movement of these purchased minerals from Philadelphia to Pittsburg required two railroad cars. Though this anecdote is often shared in stories about the collection, the logistical efforts and labour involved in such a transfer remain underexplored and only two central figures are emphasized. In this section, we document what anti-colonial approaches to these labours of mobility and acquisition might bring to light in the mineralogical collection.

During the workshop, one of the speakers, Selby Hearth, the curator of Bryn Mawr College's mineral collection, highlighted and illustrated the complex hidden historical ties of wealth accumulation, industrial oligarchs, and labour that can be drawn from a mineral collection. For instance, consider the foundations of the College's mineral collection which was established by Florence Bascom (1862 - 1945), who was also the founder of the Geology Department at Bryn Mawr. The beginnings of the mineralogical museum were a consolidation of donations including contributions from Theodore D. Rand (1836 - 1903), and George Vaux Jr. (1906 - 1927), both prominent industrial oligarchs. The Vaux family's vast wealth was generated by a range of ventures - through licit and illicit trade with China and India; inherited capital from plantation exploitation; and colonial land theft through the Walking Purchase of 1737 (Newman, 2012). By the late 1800s, the money financed the family's interest in mineral collection. Their sponsorship of work in the field led to not only a collection of specimens that now comprise part of multiple university collections with George Vaux Jr bequeathing his to Bryn Mawr College and William Samsom Vaux's (1811 - 1882) going to Drexel University's Academy of Natural Sciences, but also a range of rocks named after them as exemplified by the likes of "vauxite", "paravauxite", and "metavauxite".

While it is, in this instance, the donors and affluent collectors whose stories are carried through the names of their collections, these minerals were rarely excavated by them. Instead, mineral specimens moved through networks of international mineral dealers such as George Letchworth English (1864 - 1944). English's influence also extends to neighbouring institutions like the University of Delaware's Du Pont mineral collection. The circulation of minerals occurred through World's Fairs, trade within the mineral community, and at times even through theft from miners. These networks connect not only specimens within any single collection like a latticework of threads that show the interrelation of capital, purchase, and trades; but also connect one collection to another - showing the vast web that contributed to the development of mineralogical knowledge. More than being mere curiosities, mineral collections serve as a means of illustrating the contingencies of consolidating scientific power and authority through capital.

Tracing these mobilities was also something we aimed to make visible in the resources we created for participants on the project to help inform the design of their final interventions during the speculative design session of the workshop. These object biographies, were developed from the available and accessible material on the mineralogical collection of the University of Delaware and using platforms such as ARTSTOR a digital image library that hosts records of images from museums, archives and scholars. Biographies comprised of sections describing the different uses and significance, extraction and mining techniques, origins of the specimens, and where possible names of specific mines that specimens came from. The development of mineral biographies drew on wider critical science history scholarship that has, through the influence of anthropological work, proposed object-centred biographies within museums of science, technology and medicine as a way of illustrating the objects' trajectories and entanglements with people, institutions and places (Alberti, 2005).

Inspired by Alberti's (2005) direction on process, and the question-based calls to action in Gelsthorpe's (2021) work on mineralogical displays at Manchester Museum, we also presented a series of prompt questions at the beginning of the mineral biographies for the course, some of which are reproduced verbatim here, that offer mineral-collection-specific departures into anti-colonial possibility in public displays:

- Where, when and how was the mineral named? Notice the differences in the resolution of the place of origin, some minerals have specific mine names and others only have district and province names e.g. Rhodochrosite (South Africa) and Azurite (Namibia) specimens were sourced from named mines while the Cassiterite (Afghanistan) and Mesolite (India) place of origin does not go beyond district and sub-district levels.
- Origins of mineral names - connections to specific languages and people? e.g. Sillimanite is named after Yale Chemistry Professor Ben Silliman.
- Why is it scientifically interesting? What sorts of geologic occurrences and environments is it normally found in? Does it have any cultural significance?
- What is it used for? Industrial etc, can it be substituted for something else or serve as an affordable alternative for another type of good?
- How is it mined? Purified or converted to other goods? What kinds of infrastructure (skills included, artisanal and technical) does it require?
- What funding structures support it? In the collection, in extraction? In transportation?

As Hearth and Robbins (2022, p.14) observe, while the questions in displays might be about *which* minerals are used in everyday items such as your toothpaste (a tactic which sits largely in line with projects about connecting people's everyday lives to scientific displays), it is rarely if ever "*how* do these get into your toothpaste?". Working through these questions, a workshop participant reflected in the after-survey that "being more transparent about the violent histories of mineral acquisition" stood out for them as a strategy for undertaking anti-colonial work in physical science museums.

One of the interventions developed a public-facing project about mineral resources in high-end commodities, tackling the *how* question more explicitly. The project took inspiration from the Center for Plants & Culture (2022), which works to educate on "the many ways our politics, economics, and culture are shaped by plants… encourag[ing] critical thinking and self-reflection", by using plants as a mechanism to discuss history, labour and economics, and arts and culture. The Center's Instagram account, @plants.and.culture, runs a series of posts that document the circulation of individual plants in global systems - for instance, the documenting the "Rise & Fall of Mahogany", with text in English and Spanish (21 March 2022) shows how the Honduran mahogany tree's changing uses from ongoing canoe carving, to western shipbuilding, to western cabinetry, adversely impacted local communities through its logging and transport in dangerous conditions.

A participant had worked on the University of Delaware's ThingStor, a digital collection of objects that document antiquated items in literature for those unfamiliar with them. Exploring objects such as a doubloon, pewter plates, a tea urn, a silver rattle, or a marble table inventoried on the ThingStor prompted questions about how these minerals made their way into the object - information that is not included in the artefact classification information the same way other functional, literary, or 'origin' content are. The participants built proposed Instagram carousels that documented the marble table, showing how colonial dispossession of Indigenous communities and canal infrastructure building in the north-east United States led to a vogue for marble furniture in an effort to invoke the white-washed classical civilisations of Rome and Greece. This project demonstrated the possibility to show inter-museum links between minerals collected as specimens in mineralogical collections with artefacts composed of some minerals in socio-cultural institutions. Similar work on making visible natural material elements of socio-cultural objects and the gendering of labour involved in their mobility had been undertaken at the Victoria and Albert Museum on wool caps and tortoiseshell snuff box (Daybell *et al*., 2020), and we see similar possibilities to make visible these traced processes that highlight how minerals, networks of trade and production, and commodity goods are connected.

As a tool for anti-colonial interventions and re-heritagisation, we argue that considering the labour of mobility and acquisition in public-facing materials serves as a tactic for exploring the routes, forces, actors or agents, and processes that make minerals mobile. Part of the larger processes of extraction from mineral exploration (including searching for new mineral prospects, evaluation of economic potential and infrastructural possibility) and exploitation; attending to and foregrounding processes of acquisition, circulation, and reconfiguration in mineralogical collections can make visible the networks of science and systems of capital that underpin(ned) the Industrialised world. For instance, the British East India Company historically traded both opium as well as gems and minerals such as silver between its Indian colonies and China (Lintner, 2000). The configurations that facilitated these movements of mineral specimens were also essential to the movement of people, both forced (including enslavement) and voluntary such as the migration of miners or forced displacement of communities for mining. By following the routes of licit and illicit commodities, past and present, we can unearth the complex interrelation between natural science collections, colonial and imperial histories, and the collection's connections to contemporary extractive practices.

iii. Labours of care, maintenance and engagement

While contemporary labours of museum maintenance, care, and engagement are distinct from past labours of extraction with respect to differentiated power dynamics, labour conditions and risk exposure; it would be remiss not to discuss the institutional labours that are so integral to all museum operations as both a tool for anti-colonial practice and a reflective point of intervention. Staff from curators to the front-of-house engage in daily processes that utilise the collection to create experiences for visitors. Collections care and maintenance includes the careful management and handling of objects under display, storage, or in transit, while labours of engagement concerns itself with building relevance, engagement and exploring avenues for renarrativising collections and objects.

Recent work to make visible these practices and

processes has seen a rise in, for example, open storage spaces (e.g. Yale Peabody Museum), public viewing of museum workers at work through open labs (e.g. Field Museum and Burke Museum's *Testing Testing 1-2-3: Work in Progress* exhibitions which gave visitors a chance to watch staff scientists analysing or preserving specimens), or showing the processes of returning stolen objects (e.g. Technical Museum of Vienna). Showing the labours of care, maintenance, and development of the public space of museums and their collections rejects the hegemonic motif of 'tidying away' (Macdonald, 1998) traces of the labour of exhibitions at technoscience museum and its commensurate creation of a voice of 'objectivity' for the museum. We introduce this theme in the paper as, in the feedback from the workshop, we asked participants what they felt was still missing from the discussions we had had though the sessions and many noted that it was those working in the institution today (e.g. "staff that work at museums and archives", " volunteers") whose experiences we had not engaged with sufficiently. Here, we re-trace the ways that the workshop made such forms of labour visible and what these contribute to the practice we aimed for.

The recurring theme for better institutional support structures that can facilitate change within the museum was a shared concern for participants and speakers throughout the sessions. One topic, raised through a selection of experiences shared within the group, was the affective impact on individuals and groups within institutions to make change, and the challenges of reaching sustainability in worker-facilitated transformations within an institution or collection. These ranged, in the experiences of the group, from challenges with securing longer-term funding to continue work, time in long-term positions to continue work on projects, or long-term positions altogether. There was a prevailing sense that work that tackled anti-colonial and anti-racist themes seemed to be particularly likely to be seen as beyond the usual job-remit of individuals. Compensating, supporting, and crediting all forms of labour is in itself an anti-colonial practice. Cognizant of this dynamic, the UtC workshop recognised the labours of participation done by attendees and speakers who were offered honoraria out of recognition of time invested and knowledge shared. One session led by Florence Okoye made visible the labour of undertaking research on how mineralogical galleries are received by the public. Documenting a 2017 interactive exhibit that sought to connect mineral specimens in the collection at London's Natural History Museum to the lives of visitors through seeing them as components of mobile phones; the research also captured how visitors relate to the displays as they stand and the working practices that went into doing the research in the gallery. Emergent in this talk was the importance of financial support in sustaining research and longevity in (especially anti-colonial) practices in the museum, a sentiment echoed by other participants.

Labours of care and maintenance in the institution are also visible by highlighting collaboration within an institution, between institutions, and with interested parties beyond institutions. Different collaborations surfaced through the project: Ramalingam talked about her work on the collaborative project *100 Histories of 100 Worlds in 1 Object*; Okoye described and analysed collaborative knowledge-making with members of the public at the Natural History Museum; and Heath's practice included researching the collection at Bryn Mawr in collaboration with students at the University. Stimulated by this, one of the interventions proposed in this project that might see collaboration between museums in the Global North and Global South around meteorites in their collections and where they had been collected from, particularly exposing the artifice of nation-state-based origins against rocks that came from beyond Earth itself. We also tied this emphasis on collaboration into the bedrock structure of the workshop. We aimed towards building a community where different types of expertise were brought together.

This work to value different ideas and perspectives was recognised by participants, with one respondent noting: "Everyone knows something" in the workshop feedback; and others finding that this workshop helped them see "collaboration" and "connections" as a key tactic for doing anti-racist and anti-colonial work in the museum space. As a tactic for anti-colonial work, collaboration facilitates a shift from the single authoritative voice constructing an abstract and apolitical voice of science, working instead towards a polyvocality that encourages resistance to the totalising power of knowledge systems. In recognising that workshop participants, other institutional professionals, students, or museum-goers are active knowledge participants with their own existing knowledge, we demonstrate the process of making heritage on the local scale, and ask how this personal knowledge could be valued in heritage contexts. As Harisson (2012, p.10) argues, this model of heritage facilitates 'more democratic decision making,' connecting heritage with systemic issues such as environmental change.

Acknowledging the forms of labour and knowledge systems that are integral to the museum industry also exposes ongoing relations of production that introduce a human element to the collections and are bound up with the public-facing functions of museums. While conditions of labour differ significantly from historical labours of extraction, institutional support structures that affect the impact and sustainability of worker-facilitated change were a shared theme from speakers and participants. Failures to adequately support and value worker labour through the provision of financial and human resources often led to short-lived and forgotten anti-colonial and anti-racist programming.

Reflecting on the challenges of providing invisible work for collections care, Kiersten Latham (2007) indicated levels of invisibility at an institutional level as well as from the public with ramifications for whose labour (worker) and the kinds of labour (the work itself) is prioritized and valued:

> *I realized that there are at least three levels of invisibility in the museum world. The museum itself is somewhat invisible to our public. What we do, as a whole, is not well-understood, or even thought of, by much of our public. On another level, within the museum, the work of caring for our material heritage is often not understood by other museum staff, administration or the board. The ramifications of this are very serious. And what's more, the work of preserving and protecting our cultural heritage is not seen by most of the visiting public.*

Seeing institutional labour as co-relation and co-productive is instructive for highlighting opportunities for collaboration. Institutions, workers and patrons form an active congregation that dynamically engages in the continued heritagisation of museum spaces and collections. These forms of labour extend beyond mineral collections under public ownership to private collections care which remains largely unexplored in the past and present contexts.

However, our collaborations were imperfect. Our participants noted, as we did, that we lacked local Indigenous representation in the project, considerations of repatriation and reparations as well as multispecies perspective (Figure 4). Despite our efforts to bring local knowledge on land relations, geology, and mineralogy in collaboration with the Nanticoke nation on whose unceded territory the University of Delaware is located, we were unsuccessful in this regard. While we introduced literature from Indigenous authors globally, we acknowledge the issues with thinking through anti-colonial work, situated in now-Delaware, without the inclusion of Indigenous communities, scholars, or students from the area. We encourage those seeking to replicate such a project to ensure that similar issues are considered and tackled in their planning and execution. Additionally, though our project took an intersectional approach to these themes, as one participant noted, this meant we did not fully address "social justice beyond race, class, and into issues around disability and access." Both engaging post-intersectional approaches (Nash, 2019) and a specific focus on access and disability going foward would tackle this. Bringing labours of collections care, maintenance and engagement illustrates the dynamic processes of heritagisation and the many people who participate in it with taking place through the engagement of many actors that all museums are key figures in.

Reflections: A mineralogical museum in/for the future?

Creating the mineralogical museum as a space of Enlightenment scientific knowledge performs an agential cut - the active making of a separation between two fundamentally interlinked phenomena (Barad, 2003) - between the collections of rocks, minerals and gems and the labours that has gone into getting them where they were today. The rock material and the work on the collection are not intrinsically separated, but rather require individuals and institutions to regulate their separation. Our paper has demonstrated how we can challenge the naturalisation of these actions. Instead, we have utilised labour as a tactic to unpack anti-colonial orientations that make possible re-heritagisation of mineralogical museums. However, we argue this is not the *only* lens that can be used as a tactic - but one of many. Labour perspectives (on excavation, acquisition, and maintenance - but also more that we have not documented here) gives a particular spatiotemporal orientation to the museum and mineralogical collections. For example, as we have documented it here, there is a focus on the place-specificness of labour (e.g. labour *at* the museum) that can imply linear temporality to work, that sees different genres of labour as sequential work - doing things one *after* the other, or only looking in particular places - rather than as networks of ongoing labour in the contemporary period as well as completed transits and of the past.

Additionally, this focus has the potential to circumscribe particular labours as 'of legitimate concern' to the work of anti-colonial museum practice. Where, for example, would activism labour (within or without the museum) sit within

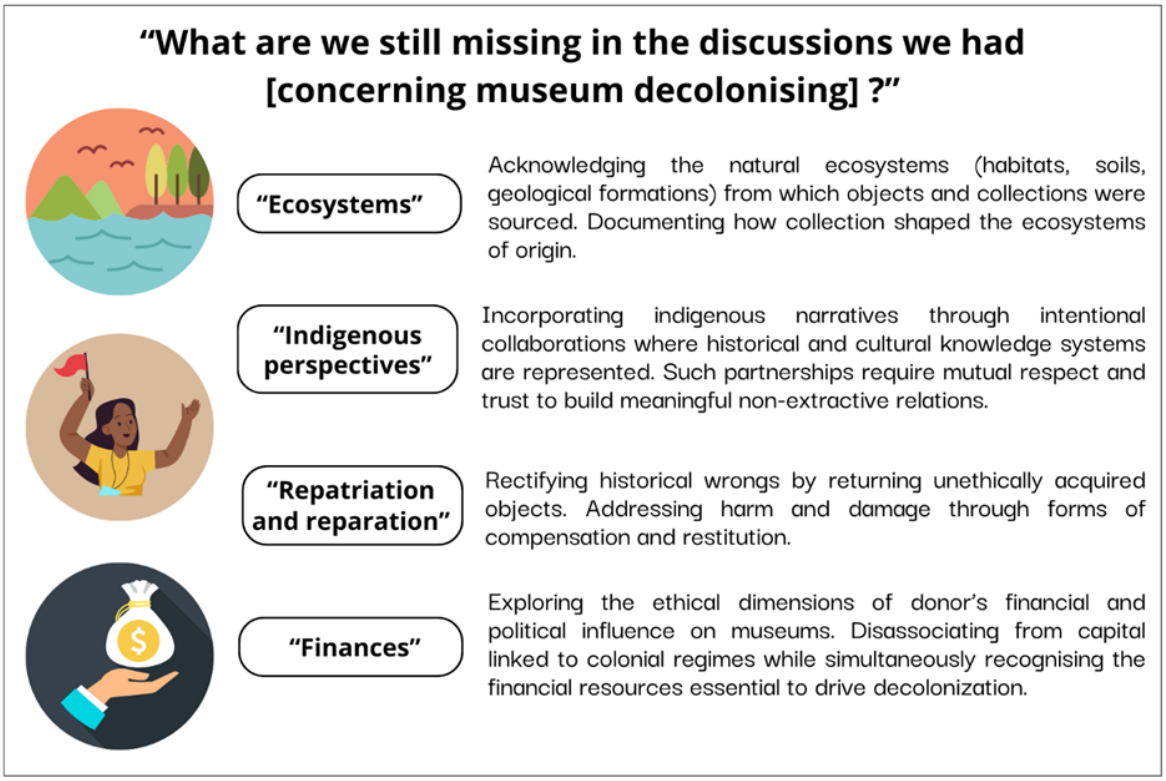

Figure 4: "What are we still missing in the discussions we had…?" - An illustrated compilation highlighting workshop participant responses to the question, with accompanying details based on post-workhop evaluations and discussions.

the lens we have outlined? Is there a way to make space for activist labour in these narratives, labour that works to stymy the 'productive' labour of the mine? What of labour in the museum: our formulation of 'care and maintenance' here, prioritises what is often curatorial labour with a collection over and above other museum labour (security, janitorial, exhibition maintenance, back-of-house) that has the potential to slip our resistance of tidying actions away in the making of exhibitions (Macdonald, 1998)? How could we include the labour of advocacy and protest that precedes the repatriation of mineralogical objects, as evidenced by the work of the Confederated Tribes of Grand Ronde that culminated with the Evergreen Aviation & Space Museum in McMinnville return of their portion of the meteorite Tmanowos (Ross, 2019)? Can we make space for describing the labours of ongoing collaboration with source communities across countries? Where our workshops raised questions that focused on individuals through labour, we might focus on making visible systems of power and capital (and, as a corollary, knowledge) instead.

In acknowledging the limits of a focus on labour, we offer other such lenses that future work might pick up as a way to formulate tactics - which themselves are but some among many possibilities. For example, legacies of mineral extraction that persist in the form of degraded landscapes and fragmented social networks may be strands of continuous linkages between museum collections as repositories of objects sourced from such sites. What, then, might a focus on sites and their landscapes bring to the museum that a focus on labour cannot? We also offer a turn towards more -than-human onto-epistemologies: what might questioning what the distinction between life and non-life (Reinert, 2016) that the separation of mineralogical collections from other parts of natural history collections reproduces, do? Might this reshape where and how the mineral collection exists?

Finally, we reflect on what drawing on a framing of heritage as a process has given us access to in this paper. Seeing heritagisation as a process gives agency to those working to change the collection by showing the collection as something always already under construction. Inversely, rather than understanding the status quo as neutral or natural, from which any (socially just, reparative) work might move, understanding heritagisation as a process illuminates that retaining the old story is also an act of making heritage as much as the

process of developing new heritage narratives is. As Gelsthorpe (2021, p.21) argues, a focus on the process of making of displays illuminated the multiple reasons that things do not change:

> *There are a few practical reasons why this research has not happened before and other reasons that reflect racism in the museum sector and wider society.*

Gelsthorpe (2021) shows that the retention of (racist) displays is in part enabled by believing that they do not need re-framing, as much as practical reasons of limited time and labour. Seeing heritage as a process also foregrounds who gets to participate in recognised heritage, and who gets to define what heritage is. As Harrison (2013, p.4) argues, this lens permits us 'to hold up as a mirror of the present' and articulate a 'set of values that we wish to take with us into the future'.

Conclusion

In this paper, we have documented the 'Unearthing the Collection' workshop that took place in March 2022. We have employed theorising of (re) heritagisation, and the making of heritage as a process as lens on the project. We argued that it is important not only to find and understand entanglements of mineralogical collections, but also use tactics to bring this knowledge to public spaces. We showed how using 'heritage as a process' as a lens to analyse our workshop drew attention to the labours involved in collections made visible through the workshop, and have focused on three different types of labour in the contexts of mineralogical museums that emerged. In the discussion of the paper we worked to show how this orientation to labour as process is only one tactic that could be used in the re-heritagisation of mineralogical museums, and that heritage in all contexts including mineralogical museums are ongoingly remade - and that it is as possible to engage in thinking and doing differently as much now as at any time.

We see this paper as a call to action for those working in (and/or training those who will be working in) scientific collections that are especially perceived as 'objective' or 'neutral' to integrate critical work on anti-colonial and anti-racist perspectives not only into understanding their own collections but into the public-facing content their institutions are producing and maintaining. We argue that similar questions serve equally well in thinking through the process of heritagisation and tactics for making these entanglements visible to publics in other parts of natural science collections; as many of these shared both similar forms of labour (extraction, acquisition to care, preservation and engagement), as well as identical networks of collection and mobility. The Enlightenment scientific structure that spatially separates the rock and the plant specimen in the museum itself, for example, was not observed during the collecting mission. This is not new - we are building on existing dialogues in the journal (Das and Lowe, 2018; Gelsthorpe, 2021; Heath and Robbins, 2022) that argue the same, as well as in history of science literature on museums that theorise the fundamental "role of natural knowledge in the construction of empire (and vice versa)" (Alberti, 2005: 560). Our paper sustains this conversation and has expanded it to pluralise who can participate in it through running a work-shop for aspirant heritage workers. We have also introduced an existing theoretical framing of heritagisation into the novel context of scientific heritage. We look forward to continued action within mineralogical collections and their host institutions, in teaching about museum and heritage futures, and in working with those outside collections.

Acknowledgements

The authors are thankful to the University of Delaware Anti-Racist Initiative for funding Unearthing the Collection under their 'Anti-Racist Programming Initiative.' We collaborated with the Geography and Spatial Sciences Department, and the Museum Studies Program. Special thanks to our colleagues Kenneth Cohen and LeMar Gayles for working on this grant with us. We are grateful to those we created this workshop with - particularly Florence Okoye, Chitra Ramalingam, and Selby Hearth - and our participants. Versions of this paper were presented in 2022 at the American Museum of Natural History's Earth and Planetary Sciences Department Seminar Series, to the Geological Curators Group (GCG) and The Society of Mineral Museum Professionals (SMMP)'s Uniting Earth Science Collections Symposium; and the UDARI Showcase; and we thank the audiences of these events for their helpful feedback on this content. The writing of this paper was partially facilitated through the Schlumberger FFT Fellowship 2021.

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Working with local communities to enhance the understanding and interpretation of natural history collections: lessons learnt from the *Rights and Rites* project

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Received: 31st Jul 2023

Accepted: 21th Feb 2024

Citation: Pardoe, H. S., Nicol, P., Kitto, N., Roberts, F. A., and Dunrod, J. 2024. Working with local communities to enhance the understanding and interpretation of natural history collections: lessons learnt from the *Rights and Rites* project. *Journal of Natural Science Collections.* **12.** pp. 37-56.

Abstract

This paper describes key findings of the *Rights and Rites* pilot project, which aimed to: 1) co-curate new interpretations of bio-cultural specimens from Amgueddfa Cymru's botanical collections, centering on peoples' lived-experiences and cultural understanding of the specimens' country of origin; 2) engage local community groups of Asian heritage with relevant biocultural specimens; 3) encourage dialogue and knowledge-exchange about the South Asian flora and; 4) raise awareness of the collections, to reach a wider audience. Through three interactive workshops, new connections were made with 34 members of local Welsh communities with personal and ancestral links to South Asia and others interested in South Asian culture. These workshops created space for individuals to participate in dialogue and share their knowledge about the use of plants in cooking, medicine, celebration and rituals in South Asian cultures. Selected South Asian biocultural specimens were used to initiate conversations and evoke memories connected to the specimens. Participants reported that much of the shared knowledge was based on expertise held in the community, often passed down orally through generations. Questionnaires were used to gauge the interests of the workshop participants, record their perception of Amgueddfa Cymru and to gather feedback and suggestions around the specimens and future work. Workshop findings highlight the importance of valuing expertise and lived-experience held within the local community and the necessity to work with community partners to broaden understanding and interpretation of Museum bio-cultural specimens. Questionnaires highlighted the need for more outreach and events based around collections to appeal to a more diverse audience. The project outcomes are informing the Amgueddfa Cymru strategy around decolonising biocultural collections. They highlight the need for transformations in institutional frameworks to fully support the decolonisation process, including the way outreach and engagement is valued and enabled, and how an ethics of care is central to this work.

Keywords: Decolonisation; Economic Botany Collections; interactive workshops; Outreach; digitisation; South Asia, spices.

Introduction

This paper describes *Rights and Rites,* a small participatory project that focusses on providing cultural context for collections of botanical specimens held by Amgueddfa Cymru - Museum Wales. *Rights and Rites* is part of a larger programme of decolonisation of the Museum's collections. The Amgueddfa Cymru decolonisation programme aims to address links with slavery and colonialism, improve transparency, make the Museum more welcoming to all sections of the community and, improve the representation of the collections. The priorities of the programme include: defining decolonisation; improving community access to and engagement with collections; developing multiple perspectives to support understanding; developing relationships that value community expertise, and; using this to inform future uses of collections (Amgueddfa Cymru, 2022). In response to the Well-being of Future Generations Act (2015) Wales and duty of well-being placed upon the Museum as a public body, Amgueddfa Cymru uses a cultural rights-based approach within the decolonisation programme, focusing on building cultural democracy and community agency (Lane and Williams, 2020; Nicol and Pardoe, 2022).

One widely accepted definition by Carissa Chew (2023) defines decolonisation as "a restorative justice movement that seeks to dismantle the systems, institutions, and ideologies of colonialism that still serve to perpetuate inequalities today". Decolonisation can be understood as a slow, evolving process where existing practices are taken apart, reflection is a part of the process, and actions are continually improved upon (Minott, 2019). In this work, decolonisation is continually aspired towards rather than considered as a final state (Gopal, 2021). From a museological perspective, decolonisation has become an umbrella term meaning different things to different people; both recognising and rectifying issues in the past; recognising and promoting expertise held in the community; changing Museum practices; and realising restorative justice. The Amgueddfa Cymru decolonisation programme and *Rights and Rites* project seek to encompass elements of all these approaches.

Following an audit of the collections to identify specimens with links to colonialism, curators of the botany collections recognised that over 1,000 specimens from South Asia lack cultural context. Relatively little was known about these specimens, in some cases, just the nation where they were derived, scientific name and collection details. The *Rights and Rites* project was designed to address these issues and was informed by the Museum's decolonisation programme. The Museum had already received a substantial Capability for Collections Fund (CapCo) grant from the Arts and Humanities Research Council (AHRC) to purchase new photographic and scanning equipment. *Rights and Rites* was awarded an AHRC CapCo follow-on grant (April – December 2022). The research strategy of the project was to use the new equipment to make the South Asian specimens accessible to a wider audience and to improve interpretation and documentation of the specimens. The research team identified the vibrant and diverse community of South Asian heritage in Cardiff and surroundings, who represent 10% of Cardiff's residents (Office of National Statistics, 2023), as providing an opportunity to develop new partnerships, to work together to co-curate specimens, to share expertise, as well as to raise awareness of the collections held by Amgueddfa Cymru.

In light of the need to acknowledge our positionality and situated knowledges (Haraway, 1988) as a research team, here we present the various roles of the research team. The *Rights and Rites* project team is made up of people with diverse cultural backgrounds. Heather Pardoe has English and Irish heritage. She has lived most of her adult life in Wales, with 33 years experience as a botany curator and researcher. Her role was to lead and co-ordinate the project. Nathan Kitto has Welsh heritage. His primary role was to digitise specimens, to add information to the Botany electronic database and to convey the technical aspects of the project. Fiona Roberts has mixed Singaporean-South Asian, English and Welsh heritage. She is currently undertaking a PhD focused on the Economic Botany collection at Amgueddfa Cymru (a collaborative doctoral project between the Museum and the School of Social Sciences at Cardiff University). She contributed to data analysis and reviewing literature, attending the workshops as a participant -observer. Poppy Nicol is an early career researcher and grower with Welsh heritage. They have a research interest in participatory approaches and biocultural diversity. They contributed to the methodological framework and workshop format and led on workshop data analysis. Jessica Dunrod is a Welsh and St. Kittian woman. She was Project Manager for Decolonising Collections at Amgueddfa Cymru from March 2022 until she resigned in August 2023 due to internal grievances, an indication of the challenges the decolonisation process faces in institutions such as national museums (Wightwick, 2023).

Literature review

Defining and enacting decolonisation processes in a museum context

There is currently no consensus on decolonisation's definition in the museum sector (Giblin *et al.*, 2019). This is partly due to the far-reaching and changeable legacies of colonialism - decolonisation varies in different contexts, requiring a definition open-ended enough to be applicable to different museums, while also refined enough for individual contexts to differentiate the process from wider work of race and representation (Gopal, 2021; Seppälä *et al.*, 2021; McCarthy and Tamarapa, 2022). The Decolonisation Charter at Amgueddfa Cymru (2022) highlights the difficulty in defining the term, instead foregrounding the practice of creating an emergent definition that is continuously and iteratively developed throughout the research process. Critiques of decolonisation-in-practice suggests the term is sometimes used as a synonym for wider justice work, which could be better conceptualised as anti-racism or outreach work (Tuck and Yang, 2012; Gopal, 2021).

The Amgueddfa Cymru Decolonisation Charter emphasises the complex and lengthy process of decolonisation, aiming to evolve understanding gradually through exploration with community partners (Amgueddfa Cymru, 2022). This approach highlights how the complexity of decolonisation processes requires space, money and time for reflection (Kassim, 2017; Minott, 2019; Gopal, 2021). However, it is important to consider that museums may be so deeply embedded in colonial power structures, that decoloniality may only be co-opted by them (Kassim, 2017). Azoulay (2020) suggests, "it is not possible to decolonize the museum without decolonizing the world". Others argue that while it may not be possible to decolonise museums and other institutions independently of society and economy, they can, however, be a place for these questions to be addressed, aiming at wider change (Gopal, 2021).

Despite these difficulties in defining the term and critiques of practice, museological and wider research suggests decolonial approaches can work on decentring colonial knowledge systems embedded in museum collections, reimagining histories to centre multiple, non-Eurocentric voices and developing alternative forms of engagement, while importantly thinking reflexively about the frictions invoked in these processes to build understanding (Vawda, 2019; Seppälä *et al.*, 2021). This work focuses on all areas of the museum, from recruitment, labelling and audience engagement, to repatriation, acquisitions and architecture. It can include new exhibition narratives, website content and publications, as well as different hiring policies and engagement activities (Giblin *et al.*, 2019; Ashby, 2021; Ariese and Wróblewska, 2021).

Further research on community outreach highlights the importance of focusing on sharing expertise and connecting with the needs of communities (Tuhiwai Smith, 2012; Seppälä *et al.*, 2021). Critically, it is important to create long-term strategies within decolonisation approaches so that the knowledge acquired, and relationships developed through engaging with communities are embedded into museum practice, as well as remunerating non-museum expertise properly (Minott, 2019).

In Natural History collections, decolonial approaches have developed more slowly than ethnographic collections (Martins, 2021). Emerging decolonial approaches however are focussing on exploring the troubling colonial histories of specimens, reinterpreting the silenced contributions of colonised peoples for a broader diversity of audiences – as outlined in Das and Lowe's (2018) leadership work at the Natural History Museum, London. This approach encourages museums to change potentially racist and colonial narratives to emphasise the social histories and contemporary stories of non-Western peoples, bridging the disconnect between non-white audiences and natural history collections (Das and Lowe, 2018).

Drawing upon critical decolonisation theories and participatory methodologies, museums across the globe are beginning to attempt more collaborative decolonisation processes. In the British Museum, for example, the refreshed South Asia gallery opened in 2017 and dedicated displays to the colonial and postcolonial periods of the subcontinent's history, emphasising cross-cultural exchange, transparent collecting histories and South Asian agency, setting up workshops with community groups around London to present multi-vocal views (Giblin *et al.*, 2019). In the Smithsonian Museum, community members are actively involved in curating collections (Smithsonian, 2023). Pennsylvania Museum hires and trains immigrant and refugee community members as guides, enabling diverse local community members to bring new perspectives on collections and new understandings of local community heritage (Pennsylvania Museum, 2018), the starting point of ongoing decolonisation.

Natural History collections and connections to the impacts of colonialism on the South Asian diaspora

Colonial powers, including the British Empire, ruled over one-fifth of the world's population by

the early 20th century, violently extracting resources and exploiting people (Giblin *et al.*, 2019). Natural science collections were created as repositories for colonial scientific expeditions and represent Eurocentric narratives (Ashby and Machin, 2021). Botanical science was integral to imperial goals, with knowledge of nature used to exploit natural resources, transplanting plants globally and developing plantation economies (Baber, 2016; Das and Lowe, 2018).

In South Asia, colonialism had a deep impact, producing social, economic and political long-term effects. Under colonial rule, India was conceived as a sub-continent, including what is now Pakistan, Bangladesh and to an extent Sri Lanka (Zubaida, 2009). During the 1947 independence process, the British-designed Indian partition divided the subcontinent into India and Pakistan, based on religious differences. Muslims fled to the Islamic nation of Pakistan and Hindus and Sikhs to secular India, leading to thousands of families being separated. Two million lives were lost between 1947 and 1948 (Mohanram, 2011). While famines were widespread before colonialism, their frequency and severity increased during British rule with around 25 major famines caused by repeated economic crises, including the 1943 Bengal famine, when around three million people perished (Mallik, 2022).

Colonialism has impacted South Asian ethnobotanical knowledge, relating to medicine, ritual and food, in multiple ways. In South Asia, these categories are highly interlinked, with Indian cooking embedded with spiritual beliefs, which in turn have health implications (Appadurai, 1988). Medicinal systems, such as Ayurveda and Unani were developed in pre -colonial rule under diverse religious affiliations such as Hinduism, Buddhism, Islam and Christianity. Whilst early British colonialists were curious about South Asian medicine, with early transmission between Western biomedicine and traditional medicinal systems, this largely diminished over time (Sujatha, 2020). Following colonial state policies and the establishment of the Western biomedical framework as the official system, these traditional medicinal systems experienced repression and neglect.

Today, South Asian indigenous medicinal knowledge has spread globally, finding new forms in diverse places, and it is important to emphasise the dynamic and heterogenous nature of knowledge and fluid boundaries between contemporary epistemic systems (Cant, 2020). In the UK, this has often led to aspects of South Asian indigenous knowledge being drawn into Western epistemological frameworks, removed from religious origins, and commodified within wellbeing economies (Antony, 2018). At the same time, traditional healing is often used by migrants in the UK as a resource to assert cultural identity (Cant, 2020). The colonial epistemological divide between food and medicine is often not found in South Asian knowledge systems, where therapeutic diets are considered important by traditional medicinal systems like Ayurveda (Waldstein, 2018; Aziz *et al.*, 2021).

Related to this, the globalisation and reinterpretation of ethnobotanical knowledge through a colonising lens has also impacted upon food cultures - for instance curry, arguably the dish defining the culinary history of British imperialism (Leong-Salobir, 2011). The term curry was invented by the British, homogenising a wide variety of local dishes, to designate a spicy stew typically eaten over rice (Zubaida, 2009; Leong-Salobir, 2011). Today, along with 'Indian' cuisine, which has been globalised as a homogenous category, ignoring the wide diversity of cultures and regional nuances of cuisines in South Asia, curry is found internationally, removed from the context and intricacies of its origins due to initial colonial processes (Zubaida, 2009).

History and impact of colonisation and decolonisation on botany collections in Britain

A global network of Botanical Gardens across British colonies played a key role in the expansion of the British Empire - both in the identification and classification of plants in the local flora, in the extraction and transfer of knowledge about biocultural properties of plants, in the introduction of new crops in different regions and, in the export of plants recognised as economically valuable by colonialists. Royal Botanic Gardens (RBG) Kew, for example, had a focal position in the dissemination of plant specimens from the eighteenth century to the early twentieth century. The links between Kew and India were particularly strong under the directorship of Sir William Jackson Hooker and, subsequently, his son Sir Joseph Dalton Hooker. Joseph Hooker travelled extensively in India collecting new plant species which he sent back to his father at Kew (Desmond, 1999). In 1880, Kew was offered the botanical collections of the former East Indian Company's Museum (Desmond, 2007), subsequently forming a reserve collection of Indian specimens and artefacts, to be used "for the supply of future applicants" (Cornish *et al.*, 2020). Many duplicates were sent to museums around Britain (Cornish *et al.*, 2022). Huge numbers of specimens were sent from botanical gardens and other colonial organisations in Asia to Kew from the late eighteenth century. In 1878 the Timber Museum

at Kew received over 1000 specimens of timber from the Indian Forestry Department (Desmond, 2007). Indian botanic gardens had an important role acclimatising, cultivating, propagating and distributing plants such as teak, coffee, tobacco, nutmeg, cinnamon, loquats and mango (Noltie, 1999). The Vascular collections at Amgueddfa Cymru contain several cotton specimens from the Ganeshkhind Botanical Garden, via the Imperial Institute, collected in 1938 from several locations including Multan Punjab, Kathiawar and Broach Guzarat (now renamed Bharuch).

A series of grand international exhibitions during colonial times, such as the Great Exhibition 1851, Colonial and India Exhibition 1886, Calcutta International Exhibition 1883, Empire Exhibition at Wembley in 1925 and Empire Exhibition in Glasgow in 1938 served as showcases of the resources, new innovations and craftsmanship from across the British Empire but also as a statement of power and superiority between different Western powers. Afterwards, the specimens and artefacts from the exhibitions were dispersed; several examples are found in the collections of Amgueddfa Cymru.

Context of Amgueddfa Cymru collections

Like many Western museums, Amgueddfa Cymru is rooted in a history of colonialism and continues to benefit from colonialism through loan or reproduction fees. The Museum's decolonisation project aims to raise awareness of the close links of the institution itself to colonialism, the number of specimens that came originally from the colonies and the close association between many of the Museum's important benefactors and donors and the colonies. Many of the Asian specimens held by Amgueddfa Cymru date back to the mid-nineteenth century. However, it is difficult to know the age of the oldest specimens in the collection since many of the specimens do not have a date or origin and many have changed hands several times over the decades. For example, several timber specimens were collected by the Forestry Service of India, sent to RBG Kew and then distributed to other institutions and collectors before coming to Amgueddfa Cymru.

Whilst carrying a history of extraction, Economic Botany collections are important resources for the conservation of biological and cultural diversity, preserving, transmitting and generating environmental knowledge for education and research (Salick *et al.*, 2019; Martins, 2021; Nicol and Pardoe, 2022) as well as records of a point in time. Following enactment of the Well-being of Future Generations (Wales) Act 2015, a small research project explored the Economic Botany collection's relevance to wider well-being goals, highlighting how the collection can support learning about the diverse cultural heritage connected to plants, their multiple values and potential community connections (Nicol and Pardoe, 2022). This project drew attention to the Economic Botany collection and catalysed further focus within the Decolonising Programme to explore this specific collection and its links to colonialism. Decolonising aims within the Economic Botany collection include analysis to discover the colonial histories of specimens and co-curating museum specimens with community groups (Nicol and Pardoe, 2022).

The Amgueddfa Cymru botany collections that include specimens with South Asian links include: the Economic Botany collection, Materia Medica, Vascular herbarium, Non-vascular herbarium, Botanical illustrations and Timber collection, as further detailed below.

Economic Botany Collection

The Economic Botany Collection comprises approximately 5500 specimens with either economic or cultural value from all over the world (see Cornish, *et al.*, 2020; Cleal, *et al.*, 2022). The collection includes plant-based food products, seeds, fruits, and raw materials such as rubber, fats and oils, tanning materials and fibres (Cleal, *et al.*, 2022) (for example, turmeric Figure 1). It includes global specimens, with a significant number from India, Southeast Asia and East Africa (Cornish *et al.*, 2020) and is divided into sections according to use, including medicinal plants, food and raw materials. The specimens were mainly acquired during the 1920s and 1930s, largely through donation, purchase or official collecting by curators. The main donors included the RBG, Kew, the Imperial Institute, London and Singleton Park, Swansea, supplemented by donations from companies (such as Sutton & Sons and British Oil and Cake Mills), individuals and official collecting.

Materia Medica collection

The Materia Medica collection was assembled by Professor Terry Turner, who collected plant products with medicinal properties (including roots, leaves, seeds and resins) from across the world (for example, cardamom Figure 2). The collection of 469 specimens was donated to Amgueddfa Cymru in 2007 (Cornish, *et al.*, 2020; Cleal *et al.*, 2022; Nicol and Pardoe, 2022). 91 specimens in this collection come from South Asia.

Figure 1. Turmeric is valued for its antiseptic properties (NMW 21.345.10) Nathan Kitto 2022 ©Amgueddfa Cymru.

Vascular herbarium

The Vascular Plant collection holds around 300,000 pressed plant specimens (see Cleal *et al.*, 2022). The majority of specimens originate in Wales and other parts of the UK. Around10% of the collection comes from outside of Europe. There are 141 cabinets, containing around 30,000 pressed herbarium specimens from outside Europe or that are cultivated, arranged according to Durand number.

Non-vascular collection

Amgueddfa Cymru holds approximately 400,000 non-vascular plant specimens including bryophytes, liverworts, lichens, algae, fungi and slime moulds (Cleal *et al.*, 2022). Like the Vascular herbarium, around 10% of this collection comes from outside of Europe.

Botanical illustrations

The Museum holds approximately 7000 botanical illustrations (see Lazarus and Pardoe, 2003; Cleal *et al.*, 2022). Two notable collections originate in South Asia. The first is a selection of prints from the *Plants of the Coast of Coromandel*, commissioned by William Roxburgh. The original paintings were by anonymous local artists (Carter,1988). The second collection is a set of prints of new species of rhododendrons originally collected by Joseph Hooker on his travels in India (1848-1851) (Desmond, 1999).

Timber collection

Amgueddfa Cymru holds a collection of some 12,000 timber specimens from across the world; approximately 500 come from South Asia (Spears *et al.*, 1997).

Figure 2. Specimen of cardamon from the Materia Medica collection (NMW V.2007.020.220) Nathan Kitto 2022 ©Amgueddfa Cymru.

Methods

This section outlines the methods of the *Rights and Rites* project focussing on the series of three interactive community workshops.

Digitising botanical specimens from South Asia

A key approach to making the collections more accessible is digitisation of specimens, producing images that can be shared with researchers and the wider public. The *Rights and Rites* project aimed to digitise all botanical specimens from South Asia. Several digitisation techniques were used, depending on the size and form of the specimens. Curators worked through the collections of herbarium specimens, economic botany, materia medica and timber systematically, extracting those specimens from South Asian countries for digitisation, supported by records on the electronic database and in catalogues. Specimens in the non-vascular collections of bryophytes, lichens, fungi liverworts and slime moulds are arranged alphabetically, irrespective of geographical origin, which makes it more difficult to separate specimens that originate in South Asia. Rarely did specimens have specific collecting localities or the name of the collector.

Initially 2D images were created using a high quality digital SLR camera. Micrograph equipment was used to take close up images. Subsequently new high-tech 3D scanning equipment was used to produce 3D images of 24 specimens (Figure 3). The number of 3D scans was limited by the requirements of the equipment in terms of size, texture and surface reflection.

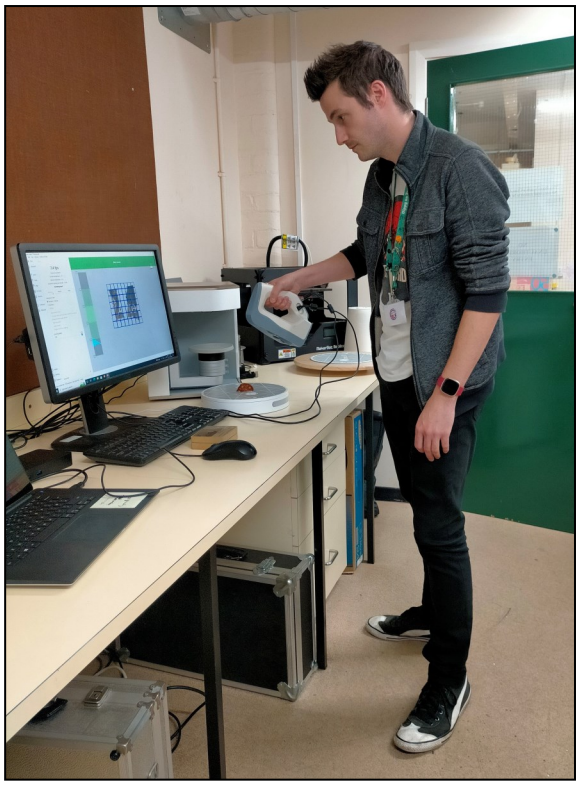

Figure 3. Creating three-dimensional images of South Asian specimens ©Heather Pardoe 2022.

The uses of the selected species as foods and medicines were researched. Efforts were also made to elucidate the provenance of the specimens, to trace the histories of individual specimens and collections and to identify, where possible, the original collectors. Some specimens were added to the Amgueddfa Cymru Collections Management System for the first time and further identified information, such as medicinal properties of the species, was added to the database in the Notes section.

However, we acknowledge that digitisation of specimens remains only a tool that can support engagement processes. Outreach and engagement processes such as community workshops are critical in learning how to make collections more accessible. The knowledge systems within which digitisation processes reside also need to be considered with a critical lens.

Rights and Rites workshops

In Autumn 2022 three community workshops were hosted, centred on plants of South Asian origin from the Economic Botany Collection. The first workshop focussed on 'Plants in Medicine', the second on 'Plants as Food' and the third on 'Plants in Ritual and Celebration'.

Workshops were structured with the aim of exploring three key topics:

1) plants as medicine, food or in ritual and celebration;
2) experience, expectations and aspirations regarding perceptions of and access to Amgueddfa Cymru's collections;
3) ideas around how participants and curators might work together to improve access to the collections and enhance the collections with community-based knowledge and cultural heritage.

At each workshop, three members of the research team (a botany curator, the Project Manager for Decolonising Collections and a qualitative researcher) acted as co-facilitators. One of the research team members actively participated in the workshop as an individual with mixed South Asian heritage. A fifth member of the project team

explained the digitisation process and shared images of additional specimens. The workshops began by introducing participants to:

1) the decolonisation programme;
2) the Economic Botany Collection and;
3) the *Rights and Rites* project.

Participants were then invited to explore a selected range of approximately 25 specimens of South Asian origin from the non-accessioned handling collection (which could be handled) and accessioned economic botany collection (which could not be handled). The workshop facilitators then used a series of prompts and questions, listed below, to guide discussions around the three broad topics outlined above.

Specific workshop question:
1) We invite you to think of a personal memory, if you have one, connected to a plant used as medicine (workshop 1), food (workshop 2), ritual and/or celebration (workshop 3). Are there any spices that you use regularly medicinally (workshop 1), in cooking (workshop 2), for celebration or in ritual (workshop 3) that are not on display?

Questions for all workshops:
2) How do you think your shared knowledge could be presented in a museum setting, if at all?
3) How, if at all, would you like to engage with diverse knowledge connected to medicinal plants?
4) Does anyone have any ideas for ways of exhibiting and working with biocultural knowledge connected to medicinal plants?
5) Do you feel that your community heritage currently is or could be part of the museum archive of spices, based upon discussions today?
6) Do you think there are ways that the communities you are part of could benefit in collaboration with the museum?

Workshop details

Workshops were attended by a total of 34 people (Table 1). The first two workshops were hosted at the Amgueddfa Cymru Clore Discovery Centre at National Museum Cardiff. The third workshop was hosted at a community space in South Cardiff. Each workshop lasted approximately two hours.

Participants were recruited predominantly through approaching community centres, projects and groups linked to South Asia (including places of worship, for example, local mosques, temples and the Hare Krishna centre) as well as building new links with community projects, yoga teachers and ayurvedic professionals. We also promoted the workshops amongst identified stakeholders, through social media and stakeholder contacts. Some participants attended more than one workshop, and a few attended all three.

Ethical guidelines issued by the British Sociological Association (BSA 2017) and Amgueddfa Cymru (Amgueddfa Cymru, 2019) were followed in the organisation, facilitation and data analysis of these workshops. We sought informed consent from all those who attended. Prior to the workshops, all participants were sent an Information Sheet and Participant Consent Form. In the workshop, we provided further space for participants to read these documents. Participants were invited to claim £50 to cover their time for attending the workshops. We emphasised that the workshops aimed to encourage discussion and that all perspectives are welcomed. If anyone felt uncomfortable with anything or wanted to discuss something privately, we encouraged them to email the research team or speak with us directly. Workshops were digitally audio-visually recorded and discussions were analysed thematically.

Analysis

In this section, key findings from the *Rights and Rites* workshops are presented.

Table 1. Details of the three workshops.

Workshop	Venue	Number of Participants
Plants as medicine	National Museum Cardiff	13
Plants as food	National Museum Cardiff	15
Plants in ritual and celebration	Grange Pavilion, Cardiff	6

A summary of responses to pre-workshop questionnaires

An average of over 70% of workshop participants were born in Pakistan or India or had Asian heritage. Most had visited at least one Museum branch prior to the workshop, in most cases National Museum Cardiff. Personal interest and cultural links were identified as the main reasons for joining the workshops. Many participants expressed an interest in spices, cooking and the medicinal use of plants. The majority of people questioned stated that they felt that the Museum was a safe, inclusive space and felt represented by the Museum.

Workshop one: Plants as Medicine

Workshop key themes

In the first workshop, the 13 participants were invited to explore selected handling and accessioned medicinal plant specimens from the Economic Botany collection (the latter are specimens held in the permanent collections, each with a unique accession number). These specimens were selected from the Economic Botany collection stores and displayed on a table in the workshop room. Participants were invited to touch and smell specimens from the handling collection, most of which had been recently purchased from South Asian food stores in Cardiff. Accessioned specimens, however, remained in glass covered boxes. The research team included handling specimens since it was felt important to support the use of senses in the process of engagement. However, tasting was not encouraged due to health and safety constraints. Participants were reminded at the start of the workshop that some items on display might cause allergic reactions.

Participants were then invited to share any personal memories connected to plants used as medicine. Participants were also asked if there were any plants that they use regularly medicinally not on display. Discussions covered a range of medicinal plants that evoked memories, including basil, cloves, garlic, ginger, onion, neem and turmeric. Most of the plants on display of medicinal benefit are also used in cooking. The only exceptions mentioned were neem, ashwagandha, betel nut (areca nut), and triphala (an ayurvedic formula consisting of three Myrobalans species amalaki, bibhitaki, and haritaki).

Turmeric

Turmeric was a popular, familiar plant regularly used by many of the workshop participants (Figure 1). In Ayurvedic terms, it is considered to have 'warming' properties. Some highlighted the antiseptic and anti-bacterial properties of turmeric, observing how it can be taken internally to sooth sore throats or applied externally to cuts and grazes. Another participant described how it is used as a paste to heal the perineum following childbirth. Several participants agreed consuming turmeric fresh is best. One participant, trained in both Ayurvedic medicine and Western medicine noted, if used in moderation, "in medicinal doses" it can "accelerate healing."

There was further discussion around dosage of turmeric. One participant shared how they grate a thumb-sized amount of raw turmeric into milk to sooth aches and joint pain. However, another participant noted that it has blood-thinning properties and so emphasised that it should be consumed in moderation. Another agreed that consumption of large quantities can lead to boils and heartburn.

Garlic

Garlic was another plant that was used medicinally by several participants. One participant explained how they consume a clove of garlic daily to support their heart and stabilise blood pressure. Another noted how garlic can be applied to eliminate fungal infections on nails. According to one participant "from personal experience, it is one of the most powerful [of plants] ….". Participants noted that "fresh is best". Another reflected how their partner prepares crushed garlic in warm milk to ward off infections.

Workshop reflections

Several participants noted that the Museum could be a valuable place to store and share local community knowledge of medicinal plants, as well as to support learning about indigenous, non-Western approaches to medicine, such as ayurvedic systems, to prevent the loss of this knowledge.

Alongside the collection of indigenous knowledge, discussions focussed on how information could be stored and shared. One participant recommended creating a digital database of herbs so that people could search and find out more about the medicinal properties of various plants. However, participants also urged caution concerning the sharing of information, noting "something like garlic is safe!" whilst other herbs, particularly those with contra-indications could lead to medical complications. The importance of engaging with the community to get to know "the good and the bad side of herbs" was highlighted.

Several participants agreed that the dissemination of information connected to plants is essential to keep alive knowledge and cultural heritage. The

importance of voice and incorporation of visual and audio indigenous voices was further discussed. Including indigenous elders' audio-recorded voices was suggested by some in the group. One participant suggested digital archives of elders talking about specific medicinal uses of plants would be an engaging way of imparting information to communities in Wales. As they reflected: "future generations may not be able to visit our country and meet elders who have imparted their knowledge." They considered how information around the use of plants as food and medicine is important for the health and well-being of future generations, as well as sustaining bio-cultural heritage. Some participants further stressed the importance of showing visually how medicinal plants grow and what parts of the plant are used medicinally, particularly if young community members are not able to see the plants growing *in situ*. Others also recommended taking the collections out to local communities to raise awareness and accessibility, urging curators that there "needs to be a lot more outreach."

Workshop two: Plants as Food

Workshop key themes

In the second workshop, there was much discussion around the integral role of spices in South Asian cuisine amongst the 15 participants. One participant recalled a personal memory of cooking up onion and garlic as their mum explained over the phone a family favorite curry recipe.

Discussion of spices in cooking also led to discussion around collective memories of racism experienced by participants connected to the use of spices in cooking. One recalled how they would avoid entering the kitchen when their mum was cooking to prevent their school uniform smelling of curry. Another participant recalled how, in the past, their father travelled by bus to Cardiff to get garlic and ginger, since they weren't widely available in the South Wales Valleys and how people used to avoid sitting next to him. One participant shared how they avoid cooking with spices if they are going out socially or to work. One participant recalled being bullied for smelling of curry and being called a "curry-muncher" in school. However, many emphasised that thankfully these experiences are now largely a thing of the past. One participant, for example, noted how nowadays their colleagues are often curious about the spices and fragrances in their packed lunch, whilst another observed "curry is part of our life".

Green/red chilli

One participant, a cookery teacher, noted how green chillies are used "in every household in South Asia just … in different forms". As with many spices, there is not a strong boundary between plants as food and plants as medicine. As well as bringing flavour, chillies have a heating effect on the body and can support digestion. They noted 'panch phoron' as an important blend of five spices (fennel, fenugreek, black or brown mustard and nigella) that is used across South Asia. There was animated discussion around regional differences in uses and combinations of spices. For example, alternative ways to cook a biryani.

Cinnamon

Two participants – a mother and daughter – both shared childhood memories of cinnamon. The mother reminisced how they used to suck cinnamon bark scraped from a tree. The daughter reflected how the appreciation of cinnamon must run in the family since she used suck on cinnamon found in her mother's spice chest!

Workshop reflections

In the second workshop, there was lively discussion around how information and specimens could be displayed and shared. When discussing a cardamom specimen, one participant observed: "it's supposed to be green but it's too old", illustrating the difference between museum specimens and familiar fresh spices (Figure 2). Inclusion of specimens that are food-safe and optimum in terms of quality as a food ingredient was felt important in order to support engagement. The possibility for sensorial engagement with the spice specimens (including with scent, taste and visuals) emerged as important factors when considering potential user engagement amongst the workshop participants.

Suggestions for future activities included: community cookery workshops, maps of spices and their routes around the world and taking specimens out into the community. One participant reflected "So many people do not know where plants come from" – such as how cardamom or cinnamon grow. Ideas to address this included creation of interactive greenhouses featuring examples of plants growing. Here, there was a focus on engaging with specimens in context - including what the plants look like as well as how they can be used, whether as food or as medicine, or both.

There was further concern about loss of knowledge about both the role of plants in supporting health and well-being and traditional recipes. Participants suggested that the Museum could raise awareness of how to use foods and herbs to support health and well-being, including via online databases as well as in-person exhibitions and events such as cookery workshops.

Workshop three: Plants in Ritual and Celebration

Workshop key themes

Discussions amongst the six participants in this workshop focussed on sensorial experiences, particularly scents, including frankincense, sandal-wood and sage incense.

Coconut

Several participants shared memories connected to the use of coconut in ritual and ceremony. One participant noted how coconut is used in the preparation of a sweet dish, with rice or semolina, often consumed during celebrations. They shared their memories of their mother cooking the dish saying, "These sorts of memories are fresh in my mind" (Figure 4). A Hare Krishna community member shared how a sweet coconut dish is made every Sunday and shared during ceremony. As well as offering a rich taste for special occasions, coconuts hold rich symbolic significance in South Asia as a symbol of fertility. In wedding ceremonies, brides wear a coconut shell on a wrist garland, whilst grooms smash a coconut when they enter. Offered as gifts at weddings, coconuts are also broken at the start of a new ventures for good luck – such as when moving house. The Hare Krishna community also view coconut as a symbolic representation of Vishnu.

Tulsi

The Hare Krishna member of the workshop presented one single tulsi leaf, explaining how one leaf of tulsi is always added during preparation of a meal because the deity Krishna particularly liked it. He also presented a string of prayer beads made of tulsi wood, considered a symbol of purification of mind, body and spirit and thought to ward off negative energy (Figure 5).

Frankincense

Participants discussed burning as a way of cleansing and purifying a space and how the use of incense, such as frankincense, can induce meditative states. They explained how incense is often used in ceremonies, and in Buddhism smoke is related to the spirit. Wedding clothes are infused with scent.

Reflections

In this workshop the burning of incense, initiated by one of the workshop participants, with fire and scent affecting the senses, supported a sense of calm and more reflective atmosphere. Across all workshops scent emerged as a means of connecting with memories and practices.

Several participants further discussed the practice of offering food before you eat. In this sense, one workshop participant reflected "all of these things" could be used in ritual. As the Hare Krishna participant explained, the boundary between food and ritual is permeable. For some people, there are exclusions of plants as well as inclusion. Alliums for example are excluded from the Hare Krishna diet since they are considered too stimulating.

Figure 4. This participant explains how coconuts are an integral part of wedding ceremonies in Pakistan. ©Kalpana Tagore 2022.

Figure 5. A workshop participant explains how tulsi beads form part of his daily meditation. © Kalpana Tagore 2022.

Findings

In this section, key findings of the *Rights and Rites* project are discussed, focussing on methods for supporting engagement in natural history collections through: 1) sensorial and participatory approaches to co-curation, 2) spaces for community dialogue, 3) outreach and 4) digitisation processes.

1. Sensorial and participatory approaches to co-curation

Within the *Rights and Rites* project, interactive methods for engagement supported new interpretations of the range of South Asian biocultural specimens from the Amgueddfa Cymru's botanical collections. Through engaging with the senses and providing an open space for interactive community-based dialogue, the research team sought to centre peoples' lived-experiences and bio-cultural understanding of the specimens.

Spaces that offer opportunity for creative response to materials within natural history collections can support the development of new understandings and interpretations of specimens. Workshop findings revealed how engaging with plants in different forms, such as by burning incense, smelling spices or handling specimens, can transform the dynamics in the space and enhance discussions by evoking old personal memories and experiences.

This relates to the field of Sensory Museology, which highlights the relationship between the senses and heritage. Frequently museum curation prioritises Western sensory preferences. These hierarchical systems of classification and value consider smell, taste and touch as the 'lower' bodily senses, whilst sight is considered the 'highest sense', related to reason and the mind (Classen and Howes, 2020; Duggal and Hoene, 2021). These sensory preferences were imposed on others during colonial rule and are still used in museums today, with curation often focusing on visual properties while ignoring multi-sensory elements and contexts within origin communities (Classen and Howes, 2020). Working with and integrating varied senses can help to rethink this hierarchy, while emphasising non-Western knowledge systems which perceive multisensory relationships between people and plants as part of decolonisation work (Classen and Howes, 2020).

2. Spaces for community dialogue

How we do research with local communities is vital within the decolonisation process. One objective of the *Rights and Rites* project was to recognise and honour expertise held in the community and to share this knowledge in a non-exploitative, non-extractive way, by developing

new partnerships with local community members and ensuring that they were recompensed for their time and their contribution properly acknowledged.

Creating open forums for community members to come together and share their expertise and lived-experience supported new understandings of plants outside of the Western knowledge systems, starting the process of dismantling the colonial frameworks within which most of the Economic Botany Collection has been interpreted to date. Processes of decolonisation within the museum context require a decentering of Western knowledge and rethinking traditional museum practices, so that diverse knowledges and lived-experiences are valued and new forms of representation and ways of working are implemented in curatorial contexts.

The workshops hosted within the *Rights and Rites* project were invaluable, but it must be recognised that this was a relatively small group that might not be representative of the broader Welsh-Asian community. Wider consultation would bring a greater range of perspectives and lived-experience. Indeed, the project would need to be considerably scaled-up to engage with all sections of the local community.

3. Outreach: Co-curating collections that are accessible, inclusive and utilised

Most workshop participants expressed the opinion in the questionnaires that the Museum was a safe space and stated that they particularly liked sharing personal stories and memories. However, several questioned the idea that they or their community were adequately represented in the Museum galleries or collections. In the post-workshop questionnaires, most participants said that they really enjoyed the workshops and felt that they now knew more about the Museum's collections and were more likely to visit the Museum. Nevertheless, several emphasized the need for more outreach events, targeted at schools and community centres, together with more in-person events in the Museum.

Many members of the workshops expressed concern about the potential loss of bio-cultural knowledge held within the community, including of traditional plant remedies. Several elders of the community, who had learnt about the beneficial properties of specific plants while growing up in India or Pakistan were anxious that this knowledge might be lost to younger generations of the community, born or growing up in Britain, who may not have the opportunity to spend time in

Figure 6. Participants were concerned that traditional knowledge should be safeguarded for younger generations © Kalpana Tagore 2022.

South Asia (Figure 6). They suggested that the Museum could act as a repository for indigenous knowledge, safeguarding their knowledge and expertise gained through lived-experience. The benefits of working in partnership with the Museum for community groups is that it is a publicly-accessible and publicly-funded institution, that can support long-term records, though considerations of decolonising wider museum practice would be an important part of creating this.

Into the future, appointing of community curators as well as extending community outreach work could play a key role in scaling such community engagement, valuing the importance of outreach, particularly within communities that may not be connected to museums. Allocating appropriate resources for outreach to be done well is critical and a reliable source of funding is essential to maintain sustained, committed, collaborative partnerships with local communities. More work is also necessary to make the research fully participatory, by working in partnership with community members to co-curate the research programme. Yet, decolonisation processes need to embed community presence within the institutions themselves for meaningful change to be enacted (Thomas, 2023). Such acts can be uncomfortable but require a kind of "staying with the trouble" (Haraway, 2016).

4. Digitisation processes

Discussions within the workshops suggested that sections of the Welsh community with South Asian heritage are reticent to visit the Museum, but their reasons are unclear – one potential reason is that they feel that their cultural heritage at present is under-represented by Amgueddfa Cymu. Digitising the South Asian specimens and populating online databases with more bio-cultural information about them is recognised as a necessary step towards making the collections more inclusive, accessible and utilised by diverse community members, working in partnership during this process. There are issues with digital sovereignty, who should be allowed access to community knowledge and how to ensure its control by owners (Hogsden and Poulter, 2012; Breckenridge, 2014). Considerations of decolonising wider museum practice are a further critical component and require engagement in rethinking institutional structures, systems of knowledge and catalogue ordering systems.

Discussion

Critical decolonisation processes

The *Rights and Rites* project highlights the continuing impacts of colonialism. The repercussions of colonial actions and attitudes have reverberated through the generations and across the globe and continue to pervade public spaces including Natural History collections and their cataloguing systems and curatorial approaches.

Enacting decolonising processes within Natural History collections requires resources (including physical and digital space) and a recalibration of values.

There have been long-term consequences of colonialism including via the construction of hierarchical and discriminatory systems of knowledge as well as prioritisation of certain forms of food and systems of healthcare over others. For example, the effects of malnutrition and conditions such as diabetes have been passed down through the generations. During famines the imposition of colonial systems meant that traditional systems such as Ayurvedic medicine were discouraged, and vital knowledge was lost. The effects of the widespread Bengal famine in 1943 are arguably still felt today, seen in higher levels of diabetes within the South Asian diaspora due to low metabolic capacity and the high metabolic load of Western lifestyles. Post-colonial studies further chart the collective trauma caused by partition of the Indian sub-continent (Mohanram, 2011). Indeed, colonisation processes have had, and continue to have, strong political ecological and psycho-social effects.

Furthermore, indigenous knowledge systems have been extracted and commercialised often to the detriment of the source indigenous communities. As one participant observed during the first work-shop "Our health is still benefitting from colonisation!" … "Who is making all the money today?" Natural History collections have a public duty of care to the knowledge contained within them and prevention of becoming embroiled within privatisation and commercialisation agendas around bio-cultural knowledge.

The ethnobotanical concept of 'food-medicines', describing food that is ingested to obtain a therapeutic action, is a useful starting point to understand how spices can be understood as both food and medicine (Aziz *et al.*, 2021). This is particularly relevant in the South Asian context where spices are integral to everyday life – as food and as medicine and, in many cases, both combined. Helping to deconstruct colonial epistemological divisions between medicine and food, the importance of therapeutic diets is stated by traditional medicinal systems like Ayurveda

(Waldstein, 2018). Arguably, context influences how food-medicines are categorised, relating to factors like education, age, plant availability and plant properties including taste and heating or cooling qualities. The latter is often important in South Asian communities, with bitter tastes, like neem, seen as counteracting sweetness, useful for treating diseases like diabetes (Jennings *et al.*, 2015). Heating plants, like black pepper, help to treat cold illnesses like pneumonia, and cooling plants, like tulsi or ginger, are used for fevers (Jennings *et al.*, 2015). Such perspectives may prompt a review of categorisation in collections such as the Economic Botany Collection at Amgueddfa Cymru. Digitisation can allow scope for multiple categories to be attached to specimens, for example, by tagging species recognized in traditional Ayurvedic systems as warming or cooling species, thus acknowledging non-Western systems of classification.

Context of research in Wales

It was significant that this research was conducted in Wales where the Senedd Cymru, the Welsh Government, have put in place a series of measures to support programmes of decolonisation and anti-racism in public bodies. This contrasts with the situation in England where the Westminster government has been less supportive. For example, in 2020 Culture Secretary Oliver Dowden outlined in a letter to national museums in England government expectations of "Arm's Length Bodies' approach to issues of contested heritage to be consistent with the Government's position" and warned that they "should not be taking actions motivated by activism or politics" (Dowden, 2020).

In Wales, the Well-being of Future Generations (Wales) Act 2015 is an innovative piece of legislation that requires Amgueddfa Cymru, as a public body, to consider their impact on people living in Wales (Lane and Williams, 2019). The Act states seven well-being goals (Welsh Government, 2015). The *Rights and Rites* project supports several of these goals including aspirations for a healthier, more equal, more cohesive, more prosperous, more resilient and more globally responsible Wales. Legislation, such as the Well-being Act, and regulations that actively supports decolonisation processes amongst public bodies such as museums, is critical for these processes to unfold in meaningful and embedded ways.

Decolonising botanical specimens from South Asia: project outputs and outcomes

The *Rights and Rites* project showed the benefit of putting a spotlight on a discrete part of the collection that has hitherto received relatively little attention, providing an opportunity to consider how to make collections more representative and accessible to the local community and also to evaluate different approaches to decolonising the collections.

The curation and documentation of the specimens has improved. Discussions during the workshops have provided new interpretations and cultural context for individual specimens and highlighted gaps in the collection. In response, new specimens have been purchased and added, to make the collections more representative of local Welsh-Asian communities. How and where to record anecdotal information is a more difficult issue. The South Asian specimens represent only a small fraction of the entire botanical collections, so it will be a lengthy process to fully decolonise these collections.

The project aimed to make the specimens from South Asia more accessible through digitisation. The application of newly-purchased scanning equipment was the initial reason for funding, so, inevitably, digitisation played a prominent role in the project. A library of 1015 two-dimensional images has been produced which can be used for reference and further research. The images are currently held in an internal library, but they will be added to the Museum's web pages, thereby increasing access for local and more remote audiences. A list of digitised specimens is available on request from the authors. The three-dimensional images have been published on the Sketchfab website. Digitisation has the added advantage that the original specimens need to be handled less, benefitting their conservation.

However, digitisation is just one tool to improve access to collections. Equally important is more extensive outreach and public engagement, so that members of the public can see items from the collections and understand the context of the specimens without necessarily visiting the Museum. Within the Museum, access could be improved by making the gallery interpretation available in more languages. Furthermore, access could be increased through more public tours of the collection, or through conventional media or social media.

The project results have been disseminated through films, tweets, blogs and presentations. Six project blogs were produced by community partners, and members of the research team. The blogs by community partners gave new perspectives on the use of plants in different

cultural contexts, promoting inter-community understanding. Results of the project were disseminated through reports and presentations to Amgueddfa Cymru curatorial staff, Museum trustees and supporters, and Arts and Humanities Research Council representatives.

Plans for the future

Work on this project has supported progress towards several long-term objectives to develop the Botany collections. One objective is to make the collections more representative of the local community served by the museum, so that all visitors see specimens in the galleries and collections with which they can identify, to feel included, welcome and respected. The workshops attracted several people who were visiting the Museum for the first time. It is essential that museum curators continue to work with and open up curation to expertise from local communities and plan events and exhibitions that cater for wider demographics within the places they serve.

The Botany collections contained substantially more specimens from South Asia than anticipated, so there are more specimens to be digitised and registered. Additional work is also needed to fully research the provenance and country of origin of the specimens from South Asia. Often the person who actually collected or created the specimens is unknown; the collection is frequently known by the name of the person that amassed the collection rather than the individual collector (see natsca.blog/2023/10/26/how… @JackDAshby @CamUnivMuseums). However, further research on archival records and specimen labels may yield new insights. Where we do know the collector or donor, understanding their personal histories can provide valuable context for the collection.

Challenges

The implementation of the project presented several challenges. The design of the funding application meant that the project design and strategy were largely pre-determined at the beginning of the project, with little opportunity for members of the community to influence the approach, so in that sense it was not fully participatory. The project was initially planned by two curators with science backgrounds, so the emphasis was on learning more about specimens in the collection, rather than critically examining the role of the curators, or perception of the Museum. The interdisciplinary nature of the project, encompassing both botany and social science, was an important consideration in the project design and was supported by the inclusion of social science researchers with an interest in participatory methods.

Another source of difficulty was the very short lead-in time to the project, only a matter of 4 months between funding approval and the project starting. This meant that new plans for project activities had to be fitted at short notice into established Museum long-term plans for events and translation, which created friction. The duration of the grant was short, only seven months, which left limited time to plan and run the workshops. There was not sufficient time to fully curate all the botany specimens from South Asia. Another issue raised by the project was conflicting demands on curators, trying to balance access to the collections with their responsibility for the care, conservation and security of specimens. This was addressed by purchasing a selection of herbs and spices for handling that were expendable and also keeping handling specimens separate from accessioned specimens. Furthermore, having developed new partnerships with local communities, it was frustrating that these could not be developed further due to lack of funding and time constraints. Nevertheless, small, focused projects such as this play an important role in the decolonisation agenda at the Museum, making it more open and responsive to the expectations of the communities it serves. Some members of the research team were further challenged by lack of support for investment of time in outreach processes by some departments within the Museum. Decolonisation processes thus need to be supported by more open and responsive internal approaches.

Recommendations

Seven recommendations for working with communities on Natural History collections from a decolonising lens are offered:

1. Participatory community workshops and digitisation processes can enhance engagement with natural history collections as well as encompassing multiple knowledge systems.

2. Natural history curators can work with the senses - including via touch, smell, sound and sight - to promote deeper connections to plant species and specimens and memories amongst communities.

3. Institutions with natural history collections need to recognise the value of and commit to investment in long-term meaningful outreach to build links with communities, including those

who are not presently engaged in the collections. This includes budgeting adequately for outreach within community engagement projects and appropriately compensating the time it takes community members to engage – this could include for example a travel and expenses fund and/or stipends, as well as new roles for community curators.

4. Institutions with natural history collections can work with academic interdisciplinary and transdisciplinary partners to foster a continuously evolving critical, embedded and reflexive lens on the decolonising process.

5. Networking and building global communities of practice can support best practice, build relationships and support knowledge exchange across communities.

6. For decolonisation processes to unfold in a meaningful way, legislation that enables decolonisation processes and principles of sustainable development within public bodies at local, regional and national level are important.

7. There needs to be wider institutional change that prioritises an ethics of care, including support for spaces for open dialogue and allyship for decolonising processes to occur.

Conclusion

The *Rights and Rites* project enabled re-examination of a small section of the Amgueddfa Cymru's botanical collections derived from South Asia. The historical labels, categories and descriptions accompanying the specimens were devised through colonial and imperial attitudes, methods and systems of knowledge. Through a decolonising lens, gaps in understanding of the specimens become boldly apparent. This knowledge gap inspired a series of workshops with members of local Welsh communities who also have South Asian heritage. Through creating space to listen to their lived-experiences, the research team gained insight into memories, traditions, languages and cultures connected to the plants from their homes here in Wales and also their ancestral homes.

The workshops provided opportunities to share knowledge of Asian plants and their uses held by individuals in the community. The handling specimens provided a sensory experience for those involved, the smell and texture of the spices in particular evoking memories of childhood experiences and familiar rituals of home. As complex narratives and deeper cultural understandings of each specimen were shared, it became clear that each can tell a multitude of histories from many different geographical perspectives. The frequent experiences of racism in South Wales often relayed through stories related to food - further highlights the importance of centring varied and diverse perspectives of community members in the museum space, including those with South Asian heritage.

In the short-term, the *Rights and Rites* project has provided cultural context for specimens in the collection, encouraged curators to consider how the collections should be developed to make them more representative of the diverse communities living in Wales and how partnerships with local community groups could be developed and enhanced. In the longer term, improved curation and digitisation of the specimens from South Asia will increase access to these specimens. As participants suggested, the digitisation aspect of this project could usefully contribute to creating digital databases with medicinal information, recipes, stories and other forms of knowledge, while exercising caution with data sovereignty and ownership of knowledge in this context.

Rights and Rites has demonstrated the power of bringing people together in the museum context. Further engagement activities need to adequately invest in and value outreach to make Amgueddfa Cymru more welcoming to everyone in the local community, as part of the broader efforts to decolonise the Museum. In addition to exploring and re-interpreting objects in our collections, the *Rights and Rites* project acted as a reminder to the research team and visitors that the museum is a public asset and that all are welcome and should feel comfortable, included and free to engage with and explore the collections and facilities.

Rights and Rites highlighted the current knowledge deficit at present in relation to spices and herbs extracted from lands during colonialism. One of the three workshops was hosted outside of the museum space, in a community space. However, all of the workshops could have been conducted outside the Museum. This entails more effort to transport the specimens safely and securely and is more costly, but this may have the effect of changing the dynamic within the workshop, creating a more informal atmosphere outside the austere setting of the Museum.

Whilst the project led to a greater understand of South Asian specimens in the collection, at the same time many more avenues for research and new questions emerged. The project highlighted

the many difficulties inherent in carrying out decolonisation work, many related to the entrenched colonial epistemologies within museum curation, administration and research. What was evident throughout was that the participants' knowledge and connection to each of the specimens, obtained though their personal lived-experiences, in fact made them the experts in this field. From a decolonising perspective the museum's job is to co-curate knowledge and collections with members of local communities, to remove perceived barriers, while remaining open to the discomfort and messiness of dismantling and transforming colonial structures. Decolonisation programmes further need time, resources and an ethics of care to prevent the burden of this uncomfortable and challenging task ahead landing on individuals or departments. This ethics of care requires more attention.

Acknowledgements

The *Rights and Rites* project was supported by an AHRC CapCo follow-on grant. The specimens were digitised partly using new scanning equipment purchased using a CapCo grant. A version of this paper was presented at the NatSCA conference in April 2023.
We would like to express our thanks to everyone who took part in the workshops. We are grateful for the support that we received from the Alice Foundation. We are grateful to Kalpana Tagore for permission to reproduce Figures 4–6.

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How to change vergency by urging divergency to inspire urgency in a climate emergency: A reflective account of using museum engagement and natural science collections to raise awareness of the biodiversity crisis and climate change

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Received: 28th Jul 2023

Accepted: 8th Feb 2024

Citation: Batchelor, W. 2024. How to change vergency by urging divergency to inspire urgency in a climate emergency: A reflective account of using museum engagement and natural science collections to raise awareness of the biodiversity crisis and climate change. *Journal of Natural Science Collections.* **12.** pp. 57-65.

Abstract

Over the last two years, Tullie House Museum and Art Gallery's Natural Science collections have undergone a large amount of cataloguing, in-house conservation, repacking, and relocation, allowing museum staff to use specimens to engage a diverse range of people, including professionals, young adults, and primary school children in a wave of projects, gallery updates and exhibitions. By combining museum learning and expertise, we explored new ways to work collaboratively with different audiences, using the collection to inspire visitors to learn about the biodiversity crisis and climate change on a local and international level and feel confident to make an impact in their own lives. This paper provides a reflection of our practise through case studies, successes, and learnings, and considers how museums can act as a platform to inspire a desire to change the world.

Keywords: Tullie House Museum and Art Gallery; climate change; biodiversity loss; engagement; natural history collections

Introduction

Sitting just below the border of England and Scotland, Tullie House Museum and Art Gallery, established in 1893, is nestled in the heart of Carlisle's cultural quarter, actively representing the Cumbrian identity and local biodiversity through collections of Fine and Decorative Art, Archaeology, Social History and Natural Science, (Tullie, 2023). Whilst the Archaeology and Social History collections document people from Carlisle and Cumbria across Prehistory, Roman, Viking, Medieval and contemporary objects, the fine art collections encompass nearly 5,000 objects, primarily British paintings, and works by local artists (Jackson, 2020).

Cumbria is a significant area for wildlife conservation, supporting 24 priority habitats (Eweda and Frost, 2014), including 84% of English willow heath and montane environments; important for RSPB red-listed species such as Dotterel (*Charadrius morinellus*, Linnaeus 1758) and Golden eagle (*Aquila chrysaetos*, Linnaeus 1758) (JNCC, 2019). Nearby translocations of the latter to the South of Scotland (Barlow, 2022) sparking hope that *A. chrysaetos* may return to breed in the area, which was the last nesting ground of the eagle before it became extinct in England, (RSPB, 2016). The county supports 278 geological and biological Sites of Special Scientific Interest (SSSIs),

more than any other English county (Natural England, 2021), and the Lake District UNESCO World Heritage Site owes its beauty both to the county's biodiversity and geodiversity.

In 1902, the museum established what may have been the first biological records centre (Sellers and Hewitt, 2020), which is now Cumbria Biodiversity Data Centre (CBDC), who work in close partnership with the Tullie House Museum and Art Gallery collections (CBDC, 2017). CBDC holds around 3,000,000 archival wildlife records dating back to 1512, and continues to be hosted by the museum (CBDC, 2023).

The significance of the rich local area and close acquaintance with prominent naturalists and organisations have made the specimens within the natural science collections at Tullie House Museum and Art Gallery an invaluable resource, providing a snapshot of Cumbrian natural history. The collection consists of approximately 350,000 specimens dating back to the 18th century, including noteworthy examples of vertebrate zoology, entomology, and geology. The collection received Arts Council designation status in 2018; an acknowledgement of the outstanding quality of the collection and its position to support research and understanding of biodiversity and geodiversity in Cumbria and the wider area (Jackson, 2020). Of great significance is the Cumbrian focus of the collection, representing both the historic changing environment, and activity of prominent local naturalists, intrinsically connected Carlisle Natural History Society, (CNHS, 2024).

Wild Ways: Cumbrian Biodiversity Gallery

In 2022, the Natural Science gallery underwent a small-scale refurbishment to allow freezing of specimens which had been on display for thirty years. This was planned to work towards the museum's phased capital development, a rolling programme of work which began in 2021 with the opening of the Costume Collection gallery and aims to subsequently redisplay all of the museum galleries to a high standard over the next decade, (Tullie, 2024).

A key part of this redisplay was to honour the previous, much-loved diorama scenes, which celebrated key habitats found across Cumbria, including the Lake District Fells and North Pennines, local rivers, peatlands, and the Solway Firth. Through visitor interaction, feedback, and some audience co-curation, favoured specimens and display styles were established. The gallery was redesigned with a traditional twist, using archival-grade dioramas and a focus on the active work and conservation across the county. This was a successful way to link stories such as regional extinctions, reintroductions, habitat management, careers, diversity in nature, climate change and the importance of natural science collections. The reinvigoration and reinterpretation of the displays recognised the role of dioramas as 'unique and essential learning tools for biological education for all' (Scheersoi and Tunnicliffe, 2015, p1). The displays are complemented with accessibility considerations, tactile areas, interactive cases, and lighting changes to increase synergetic input between visitors and cases. The experience of tactile displays in museums can foster greater diversity of visitor perception, (Weisen, 2008), whilst supporting some SEND, blind, and partially blind visitors as well, (Davidson, Heald, and Hein, 1991; Fuadianti *et al.*, 2020).

To reduce environmental impact as much as possible, the team reused scraps and offcuts of archival materials, printed panels on recyclable cardboard and repurposed old panels. We found, as expected, that exploring innovative ways to reuse materials was essential in reducing waste (Ki Culture, 2021). The team considered sustainability when sourcing materials for the displays, by investigating the environmental footprint and archival suitability of different products, exploring the carbon footprint of suppliers, reusing, and repurposing existing display furniture and materials, and avoiding purchases that included single-use plastics in their contents or packaging. The project was able to move away from foamboard panels, instead printing on Falconboard corrugated cardboard which is both long-lasting and recyclable. Old foamboard panels were repurposed as separators for stored paintings and for crafts. This was then implemented throughout the museum, in both permanent galleries and temporary exhibitions, significantly reducing our waste. Key topics such as local biodiversity, climate change, accessibility, and diversity in inspiring and positive ways, were communicated throughout, which have led to invigorating conversations with Gallery Engagers and the public.

Whale Tales: The Story of Driggsby

Driggsby, Tullie House Museum and Art Gallery's articulated juvenile Fin whale (*Balaenoptera physalus*, Linnaeus 1758) skeleton (CALMG:2016.70), was initially washed up on a Cumbrian beach in 2014, and subsequently acquired and processed by the museum (Jackson and Larkin, 2018). It was named by public vote and can be viewed in the museum reception area.

A two-year NHLF funded project surrounding the whale and ocean pollution extended over the course of the COVID-19 pandemic and resulted in an exhibition, storybook and stop-motion animation. Over 150 Key Stage 1 children wrote a story, navigating the sea with Driggsby before exploring her untimely demise, creating characters like the "golden shark" and the "plastic monster" to come to terms with Driggsby's untimely demise in a way that they could process and emote with. The children took part in beach cleans, learned about pollution, lead on the stop-motion animation, and created their own artwork which was displayed in the exhibition and brought to life by volunteers who created large, plush versions of some of the children's characters. Feedback from the schools showed a significant increase in reading level as well as improved awareness of reducing waste, reusing materials and recycling, with increased respect for nature, which was consequently imparted on to families, friends, and schools. We found that the length of time given to this was highly beneficial, and that we were not to underestimate the children's comprehension of, or engagement with, the topic. As was noted of school children in Bristol by Gladstone and Pearl, children 'expected the museum to raise its voice for nature' (2022, p53), and the power of the resulting exhibition which empowered both the voices of Key Stage 1 children and young people through protest placards in the spirit of demonstration and positive change.

Across both the project and exhibition, we found that addressing environmental issues with primary school audiences required the inspiration of passion and emotion, which was dependent on collections engagement. As Carnall *et al.* writes, '[museums] must confront issues around difficult subjects such as the human impact on the natural world, the ethics of collectionS and collecting, biological conservation, and extinction. One way to do this is to break with the traditional empirical, authoritative and apolitical conventions of museum interpretation' (2013, p55). Whilst the Fin whale specimen is mounted and installed high up in the museum atrium, there are bones from the left-side not included in the display, which we were able to bring out of the store to demonstrate the huge scale of these animals, as well as start to create emotive connections with the whale as a once-living being. Other marine collections supported this work, enabling object handling, story-telling, and creative projects inspired by seeing specimens up close.

It was important to empower the children's voices and give them the freedom to lead aspects of the project, whilst harnessing their artwork and creativity to overcome barriers to displaying difficult topics like this. Beach cleans and physical activities bestowed a clearer understanding and helped maintain positivity and the power to make a difference as an individual or group.

Once Upon a Planet

Once Upon a Planet (Tullie, 2022) was an ambitious and multi-faceted project, funded by the museums Association Esmée Fairbairn Collections Fund. It involved two years of co-curated work with communities, schools, exhibition, and collections care focusing on climate change and biodiversity, driven by young people to significantly grow our engagement with this age group currently under-represented in the museum. To ensure that this was going to have meaningful engagement, our existing Young Producer group was consulted to contribute their thoughts to the funding application. Knowing that museums have the power to use natural science collections to highlight local problems with reputable knowledge (Steele, 2018), it was essential to empower project stakeholders to contribute to the divisions of the project, outlined below.

Research

In the initial stages of project planning, student placement, Fiona Bower from Lancaster University Centre for Global Eco-Innovation, conducted her own research into the carbon footprint of Carlisle and the area around the museum. She collated and created infographics containing Cumbrian-specific information around climate change and sustainability, and explored ways of communicating these topics, as well as conducting research into sustainable display materials. This data was then used to communicate key facts in the Once Upon a Planet exhibition, including changes in local weather events, agricultural viability, and regional species loss, (Bower, 2021). Bower's work also helped to advise how we as an organisation could reduce our emissions. The museum envisions a future student placement opportunity to explore museum environmental conditions and the effect of existing systems like double doors and their correlation to pest activity and environmental readings, further reducing our carbon footprint whilst maintaining suitable conditions for collections display and storage.

Young Advisors

A key aspect of the project was our work with voluntary Young Advisors, overseen by a paid "Assistant Young People Producer" post. We

attracted ten people between the ages of 16-24, through schools, universities, careers events and social media, who met on a weekly basis to discuss environmental issues and work on the project (Figure 1). These were carried out through a variety of group-led activities including store tours exploring specimens linked to Cumbrian biodiversity loss, training opportunities (for example, a Climate Museum UK course and collections management training), evening catch-up sessions with pizza and drinks, and creative workshops. Recruitment included taster sessions, an information evening, and a simple application process supported by the Assistant Young People Producer. The Young Advisors were also given the opportunity to visit Natural England National Nature Reserves, exploring local priority habitats and associated biodiversity with Reserve Managers, followed by artist-led workshops to create artwork and exhibition interpretation in response to their experiences. Additionally, the group were given transport to neighbouring museums, such as the Great North Museum and National Museums Scotland, to learn about how the topics of climate change and biodiversity loss were approached in other heritage organisations. Allocating project funding to provide transport and training, and meeting at flexible timings including evenings and weekends helped to remove barriers to accessibility which we were told by the group, would impact their ability to contribute due to their studies, work, and financial situations.

The young people were given the opportunity to feel ownership over the collections, by shortlisting collections for the exhibition and writing their own interpretation labels and panels for their chosen specimens, depending on their desired areas of development. They also created interactives and family activities for the displays, which included visitor feedback stations, climate pledge areas, and protest placard crafts; communications from which were collated and included in the project evaluation. Time and budget meant we were not able to provide interpretation training, and in retrospect this would have been very useful to support the Young Advisors and reduce the curatorial time required to fact-check and edit the labels.

On the completion of the exhibition, the Young Advisors were given the support, budget, and resources to host "Wild Futures", a youth conservation convention at the museum, aimed at young people interested in conservation, biodiversity, and sustainability. The event gave the Young Advisors experience of event planning and management, whilst creating an exciting new opportunity for networking, information sharing, and careers advice for both the delegates and organisers.

An important concept was to continue to work with the Young Advisors and listen to their feedback past the project's end; those interested were offered a further flexible project exploring

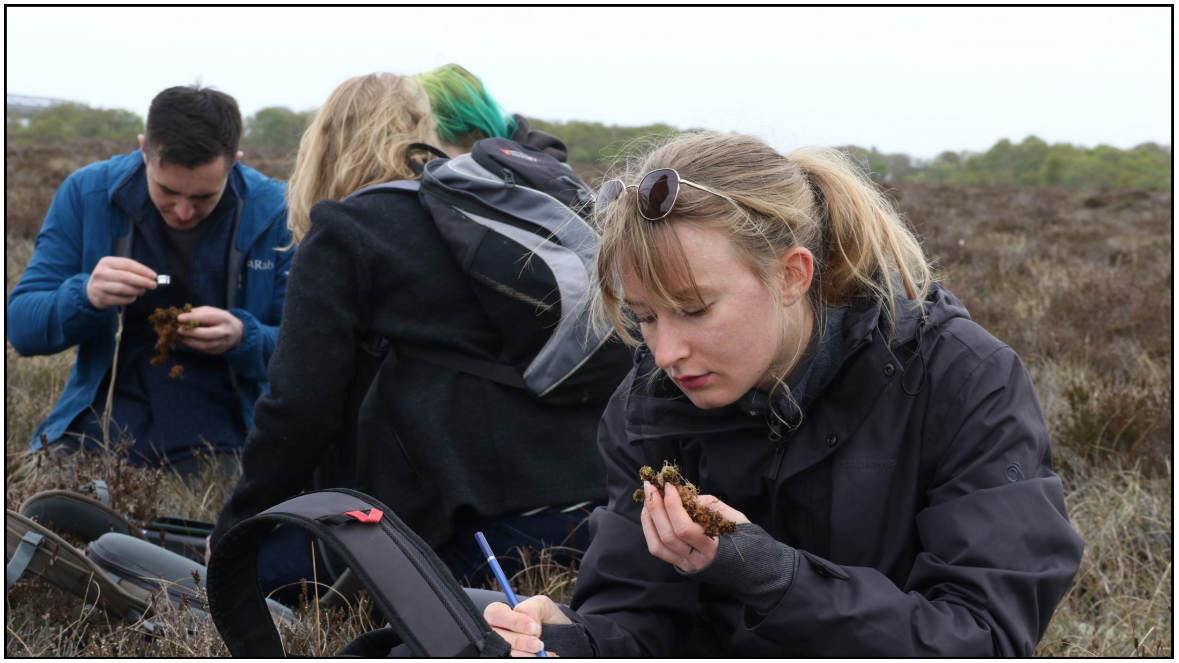

Figure 1. Members of the Once Upon a Planet Young Advisor group examine Sphagnum mosses at Wedholme Flow lowland raised bog, part of the South Solway Mosses National Nature Reserve on the Solway Coast AONB, North Cumbria. Image copyright Tullie House Museum & Art Gallery.

urban habitat connectivity and wildlife corridors in and around the museum garden, with opportunities for training and research centred around species recording and beneficial planting and garden design for species recorded in the area, to report to the museum's senior team for consideration in the capital redevelopment project. The aim of this opportunity was to continue to support relationships between the Young Advisors, Tullie House Museum and Art Gallery, and CBDC, with potential for dissertation projects and work experience to further engage and prepare the young adults for work in the museum sector and natural sciences.

Meetings were planned to fit around education and jobs, as most of those involved were studying in some capacity. It was important to provide support and reflection through social sessions, creative opportunities, and positive, hopeful approaches to the work, in consideration of the potential effects on wellbeing around a frustrating and worrying topic (Manning and Clayton, 2018).

There were varied levels of input from the young people, and that some of this needed closer management to ensure every individual had the same control over the project. The budget and time limitations surrounding the exhibition meant cuts in display materials; not all of the project work and chosen specimens were able to be included, which could have been communicated and managed better with the exhibitions team alongside managing expectations from the initial stages.

Feedback from in-person group discussions, surveys, and 1:1 informal chats was gathered, and a range of evaluation methods to support all learning styles were assessed. Reflective findings showed that the convention, creative opportunities, and trips were particularly appreciated and led to further engagement and empowerment of the Young Advisors. Some Young Advisors became volunteers in the collections, some found paid work in wildlife conservation, whilst others transferred to our Young Producer team to stay on past the end of the project. The Wild Futures convention is planned to repeat next year and has created good relationships between the Young Advisors, Cumbria Biodiversity Data Centre, Carlisle Natural History Society and local conservation organisations.

The project has given us the confidence to work closely with young people in all stages of planning, development, and delivery in other areas of the museum, ensuring that the museum is a platform for young people to co-create future projects and have their voices heard.

Exhibition

The exhibition ran over the summer quarter in 2022, themed around deep time, local habitats, biodiversity, extinction, and a call to action. Displays were co-curated and co-produced between Sustainable Carlisle, Natural England, Young Advisors and Heathlands, a local charity supporting disabled and neurodiverse individuals to access natural spaces. The partners were involved in using a mixture of art, science, and Natural Science collections to support each area. A wall of the exhibition space was given over to Angry Dan of Blank Wall Assassins, who created a thought-provoking piece of street-art, which lead to street art workshops and exploration of environmental activism. The artwork was interpreted using digital videos and text, supported by artist-led talks, school sessions, and linked craft activities.

Staff were keen to confront barriers to accessibility in the space, and took advice from Cumbria Deaf Association to create videos in British Sign Language (BSL), as well as closed captioning and BSL interpretation on digital aspects of the exhibition. An Impacts and Insights visitor survey suggested a significant increase in audience understanding and awareness around climate change following a visit to the exhibition.

Schools

Research has shown the substantial educational value of engagement with natural history collections in museums (Gkouskou and Tunnicliffe, 2017) and with outdoor learning opportunities (Prince, 2019). It was important for this aspect of the project to combine both collections and outdoor education with creative activities to intensify the children's learning and engagement. Three county schools of varying location, size, and socio-economic background were invited to participate in the project, working with Key Stage 2 classes from each organisation. The schools were chosen based on their locality to National Nature Reserves, diversity from each other, and prioritised if the museum had not engaged with the groups previously.

The programme started with an introductory assembly, during which the Biodiversity Curator and Learning Officer visited the classes to discuss the project and start the children thinking about biodiversity, connectivity, habitats, and climate change. Museum specimens and handling

collections were taken to the schools for this outreach, and the physical act of touching the specimens was a popular aspect of the session.

The children visited their closest Natural England National Nature Reserve led by museum staff and the Senior Reserve Manager, with each school focusing on a specific habitat type linked to their local area (Figure 2). These were lowland raised bog, upland hay meadow, and semi-natural woodland. The museum then hosted each school on site, where they created posters to display on the reserves, explored artwork techniques supported by a local, upcoming young artist, created stop-motion animations, and engaged with both stored and displayed collections through play, art, and poetry to create an emotional connection with our regional biodiversity. Taxidermy, osteology, and botany specimens were brought out as reference and inspiration for the artwork, and to support the learning around each species. The museum was also able to facilitate a minibeast hunt in the museum gardens, where the children learned how to carefully handle insects and other terrestrial invertebrates and discover how to use reference materials to identify the animals they came across.

At the end of the year, the schools came together back at the museum to share their learning and celebrate the project. They gave fantastic presentations to each other on their habitats and projects, created soundscapes, chose relevant specimens for their own case in the gallery and decided on how they should be displayed from what they had learned about the species and habitat. They helped create a printed magazine, which was given to each student, summarising the project, recapping the learnings, and showcasing the artwork, writing, and adventures that they had created.

This aspect of the project has built and maintained new relationships and has a legacy of further engagement between the schools, museum, and Natural England. Working with children can successfully influence communities as a whole, (Vaughan *et al.*, 2003), and witnessed the ripple effect of children involved in the project passing this new-found passion and advocacy on to family, friends, and wider schools.

Communities

The museums' "Secret Garden" space (a private

Figure 2. Year 5 take core samples and learn about the species present at Bolton Fell Moss National Nature Reserve in Carlisle, Cumbria, to understand the importance of the lowland raised bog habitat. Image copyright Tullie House Museum & Art Gallery.

green space behind the museum) was used to host art workshops and planting for our local refugee communities. This provided an incredible insight into their experiences, languages, and the biodiversity of their homelands. A key aim was to increase the access and display of our herbarium specimens, which are not currently on permanent display due to environmental requirements. The museum also wanted to explore ways of creating tactile examples of these specimens to improve accessibility in the gallery. The "Unearthed" exhibition by Amy Williams at Blackwell Arts & Crafts House (Lakeland Arts, 2023) was visited as a study trip, to think creatively about adding colour and definition through art to support pressed flowering plants.

The museum also hosted Heathlands, a charity enhancing wellbeing and health through supported daytime opportunities across the county and explored some of the stored plant collections with them, from fossil ferns to modern herbarium volumes. This was another way of engaging new audiences with the collections.

Collections Care

Part of the project allowed budget for collections care and a new curatorial project support post. This has allowed for considerably more work to be undertaken with the Natural Science collection including outreach and documentation, as well as the purchase of three new cabinets to replace unsuitable, detrimental shelving in our stores. Staff training has also been included, which demonstrates investment and the importance of the expertise.

Climate Museum UK

In partnership with Climate Museum UK, staff underwent workshops and training focusing on climate change and sustainability in a museum setting. The museum also hosted a young, local artist, Megan Bowyer, as Climate Museum UK Young Associate, to create a display inspired by the collection, exploring human interaction with nature and the archival nature of museums.

Evaluation

It was found that time and communication were the largest barriers, likely because it was spread across different departments and very multi-faceted. Evaluating throughout, and being adaptable were key to the success, and it was inspiring to watch young people gain confidence and take their experience forward, children grow in their passion and protectiveness of the environment and our local communities interact with and find inspiration from the collection. Once Upon a Planet was nominated for Museums + Heritage Awards Sustainable Project of the Year, and won the Kids in Museums Youth Climate Project Award.

Art Fund: Wild Escape

Funded by the Art Fund, the museum were able to host two weeks of "Big Nature Takeover" activities through the Easter holidays, including a collections trail, talks and handling sessions. Specimens of petrology, mineralogy, palaeontology, taxidermy, entomology, osteology, and botany supported the events through handling, illustrative reference, and demonstration. This culminated in a "Party for the Planet" event on Earth Day 2023, where the activities focused on sustainable crafts, activities, talks, and workshops around biodiversity and climate change. These workshops allowed visitors to engage with stored collections, and allowed us to offer a high standard of free, accessible activities to visitors along with a positive and actionable outlook.

Our future

As the museum capital redevelopment progresses, staff are exploring feasibility for a heat source pump to reduce our environmental impact, along with other opportunities to integrate sustainability and ethics into our future work. The staff aim to preserve, use, and grow our collections, developing them in a way that represents the county and the impact of climate change on our native species, which will inform crucial future research.

Tullie House Museum and Art Gallery will continue to advocate for local biodiversity and maintain partnerships and relationships, taking an active stance in the protection, representation, and conservation of Cumbrian wildlife through communication, representation, and advocation. Most of all, staff will continue to learn, listen and keep emboldening our stakeholders, to give a thorough understanding of climate change and biodiversity, along with the power to actively make a difference.

Conclusion

The curatorial input has been enormous, but the resulting levels of engagement have proved the effort worthwhile. The projects have worked with motivated people and maximised the potential of the collections in our care, to inspire a passion for the natural world and the energy and enthusiasm needed to help in protecting it.

Overall, school projects benefitted from longer input periods, opportunities for collections

handling, and learning across outdoor spaces and classroom environments. It was observed that young adults were empowered by being given a platform to advocate and lead on the subjects they were passionate about but required motivation and support to do so. Financial incentives, provision of food, and the exchange of training and trips in return for Young Advisor input were key in this success, as well as the paid role of a young person to lead on this aspect of the project. A climate-themed exhibition was well received when reinforced with underpinning knowledge and achievable actions for visitors to take away. A key finding across all of the aforementioned projects was that the opportunity to utilise specimens both in museum displays and as supporting resources for handling, demonstrating, and observing was a valuable tool to engage all of the different groups. It was noted increased emotive connections when people were able to handle specimens, and significantly higher levels of engagement when collections were available to examine within <1 m distance.

As a result, Tullie House museum and Art Gallery aims to continue to harness creativity, co-production, and sustainable thinking to preserve and grow the collection and inspire a long-standing passion for biodiversity, where engagement with natural science collections will sit at the forefront of displays, events, exhibitions, and collaborative practise with audiences of differing ages and backgrounds.

Acknowledgements

Neil Owen, Jocelyn Anderson-Wood, Dr Claire Dean, Lindsey Atkinson, David Gopsill, Anna Smalley, and Sarah Forster. Thanks go to the Museums Association Esmée Fairbairn Collections Fund for their funding of the Once Upon a Planet project, and grateful thanks to the Art Fund for funding the Wild Escape.Final thanks go to the Tullie staff, visitors and individuals who have engaged with and supported the work we have done, and those who stand up for nature; I hope we give you the strength and voice to continue.

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How to use object biographies to manage your data

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Received: 13th Aug 2023

Accepted: 7th Feb 2024

Citation: Winters, L. 2024. How to use object biographies to manage your data. *Journal of Natural Science Collections.* **12.** pp. 66-73.

Abstract

Natural history collections are not only a source for the earth- and life sciences, but they are also historical sources with cultural and sometimes emotional value. The histories of these objects are often not complete as peoples and cultures have been erased from their narratives. In order to be more inclusive and offer more perspectives on their collections, natural history museums need to expand their collection's documentation. Object biographies are a concept from the study of material culture that state that objects can be viewed in many different contexts, based on the perspective of the viewer. We need to document these different perspectives throughout time and space in order to fully understand our collections and make them accessible. This article outlines a metadata framework for museum collections and archives based on the concept of object biographies, along with a practical way to structure your data on a budget. It closes with further ideas for future applications of object biographies in linked data.

Keywords: object biography; museum collection; museum archives; collection history; data management; metadata framework; linked data; unheard voices; inclusivity; accessibility

Introduction

In recent years there has been a growing awareness for, and interest in, the unheard voices of history. Within the field of the history of science this has also been the case, and studies have been conducted to uncover all those involved in the natural sciences that have historically been overlooked; indigenous peoples, low-income workers, female naturalists, collectors and artists of colour, non-western scholars and many more (eg. Das and Lowe, 2018; Ashby 2021; Ashby and Machin, 2021; Gelsthorpe, 2021; Hearth and Robbins, 2022). Natural history collections cannot only be used to tell the story of evolution, ecology and life on earth, they can also tell the story of the history of science. Objects could be displayed in new ways to showcase the socio-cultural dimension of natural history, and to highlight the stories of cultures, communities and individuals. In order to do this they need to be researched through a new lens and the collection data needs to be stored and made accessible in such a way that we can access these stories. This can be achieved by using the theory and practice of object biographies.

The concept of object biographies

At its core, an object biography is the complete history of an object (see Kopytoff, 1986 for the original concept). This history is however written with a certain intent and based on theories about understanding the past. Object biographies were

first developed for historical objects for which we have incomplete or no documentation in their original time of use and which have since been recognized and treated as heritage. People wanted to understand these objects within a narrative and thus different perspectives were sought out. Object biographies became common practice within the field of archaeology and were developed further within the theoretical movements of first post-processual archaeology (Hodder and Hutson, 2003) and later symmetrical archaeology (Shanks, 2007). The theory behind this is that the past is subjective; material culture can be interpreted in any context and this can lead to different conclusions, all based on the framework through which the object is studied.

This does not mean that we cannot draw conclusions about the past based on these objects; it simply means there are many truths and we decide which one(s) get told. Now that this perspective on the past has gained prevalence, we also recognize that objects that were studied in the past might hold more or different information if we study them again. Especially older museum and university collections that have been classified and described in the past could benefit from a new description. This is what object biographies are designed for; a description of an object that takes into account the different contexts in which the object was used and the different meanings that people have attached (and still attach) to it over the centuries. Within archaeology this does not only include the original period in which it was made and used, and perhaps repurposed in a different time, but also how it was excavated, traded, collected, classified, displayed and used for research. The theory behind object biographies states that objects only carry the meaning we ascribe to them and are not intrinsically valuable. As such it is this meaning that should be documented if we want to fully understand the object. (Renfrew and Bahn provide an introduction to archaeological theory.) For an example of object biographies as a curational tool for archaeological collections, see Friberg and Huvila, 2019, with critical response to object biographies, outlined in Nanouschka, 2014.

Facilitating interpretation through data

How can a theory from archaeology help us understand natural history collections? If you apply this framework of the importance of context and meaning to natural history collections, they suddenly become a lot more than biological or geological specimens. The original period of use within archaeology becomes the specimen data that is most often recorded in natural history museums; the biology, ecology, habits etc. for biological specimens and the chemistry, formation, location etc. for geological specimens. Everything that happened "in life", before collection. What the documentation of natural history collections often lack is the human interaction, especially for the older collections. What importance did these specimens hold for the local inhabitants that interacted with them? How were they used in daily or religious life? When, how and for what purpose were the specimens collected? Who was involved in this process? How were the specimens documented, illustrated and described? How were they prepared for storage and shipped? In what (private) collections have they resided and how did they end up in their current repository? How were they classified, displayed and interpreted while part of these collections? In what research have they featured? Once we start asking and answering these questions we can give a voice to everyone who was involved with these objects and see them from new perspectives.

It takes a lot of intensive research to gather all this information and most museums do not have the time or resources to devote to it. When this type of historical research is carried out on natural history collections, it is often done by external parties and the information is not recorded with the collection itself. One way to start enabling a more diverse and multifaceted interpretation of objects is to facilitate recording this historical information for the future. Just writing it down somewhere is not enough. The data needs to be linked to the objects and to other sources; it needs to be easily found.

An object biography metadata framework

Meaning and interpretation come down to context, and context comes down to metadata. Metadata is data about data (Ince, 2009), or in this case data about an information object. An information object could be anything that holds information. More traditionally this would be a physical object on which information has been recorded, such as a book or photograph, but lately it has come to include digital objects as well as physical objects that hold inherent and implicit information, such as museum objects. (For more on museum objects and metadata, see Arna Bontemps Museum, 2023.) For every information object there are generally five categories of metadata:

1. Administrative data, which includes anything you need for management such as location, loan information, rights, access, etc.

2. Preservation data, which records the physical state of the object and documentation on any changes it has gone through while in the collection, both natural and through intervention.

3. Technical data, which documents hardware and software such as format and security data.

4. Use data, which includes the use in exhibits and research, content reuse and user tracking.

5. Descriptive data, or anything that is used to identify, authenticate, and describe collections and related trusted information resources (Gilliland, 2016).

Descriptive metadata are wide-ranging and can include any aspect of an object. The aspects that are chosen to be described will dictate what information we have on the objects and how we interpret them. Three different aspects of an object need to be described in order to enable object biographies: The object as a representation, as a human-made object and as part of a collection. The representation is already quite common; this is a specimen of a certain species and as such represents this species. It is of importance because of what it can teach us about a broader category of entities. The human-made object is usually partly present in descriptions, with details such as the collecting date and location. This description is important for what it can tell us about how people have interacted with the object. The final aspect is the object as part of a collection, or more likely, of many collections. This is important for understanding in which categories or classifications the object has been and could be placed. You can also view the three aspects as relationships: The object in relation to a

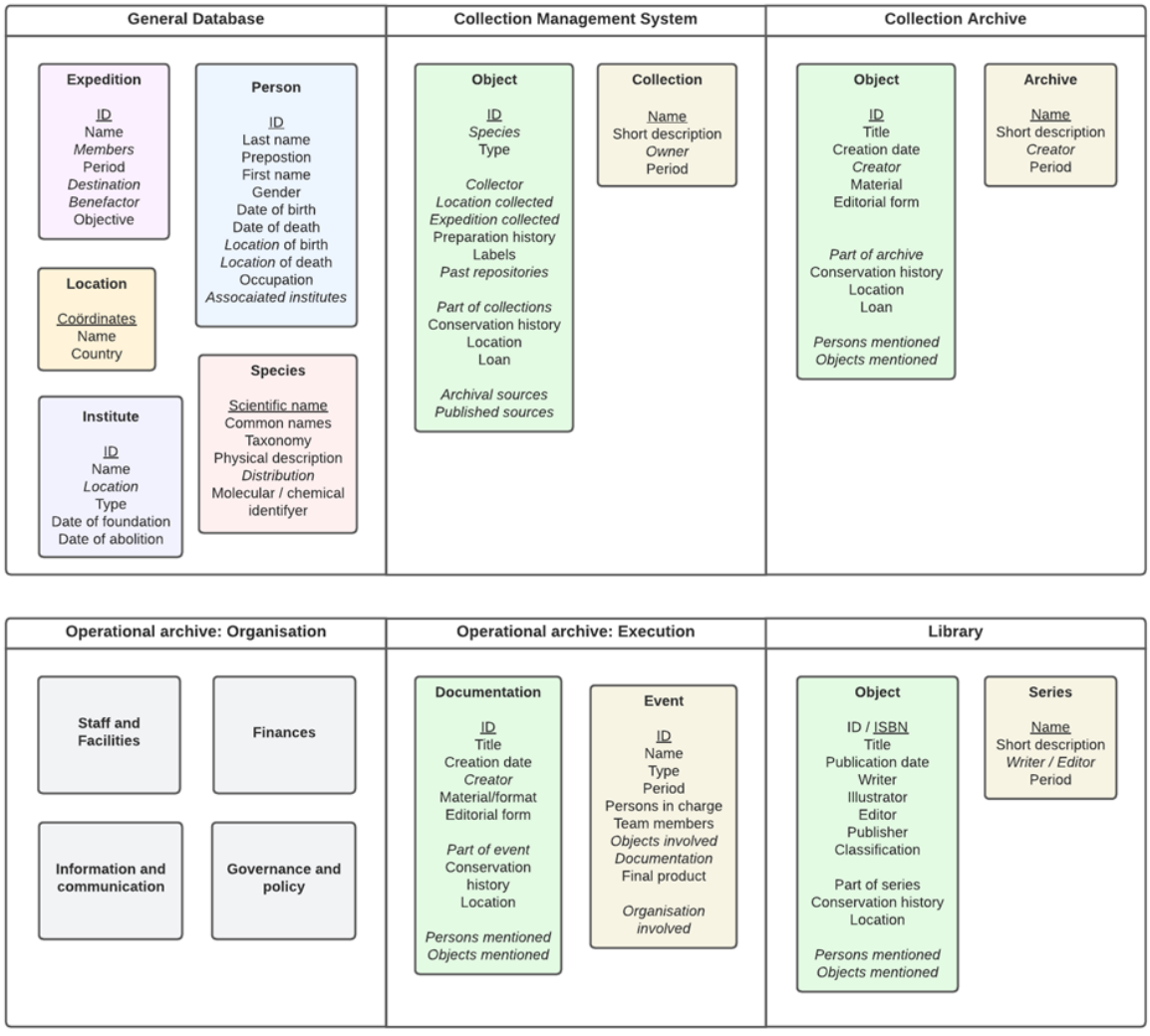

Figure 1. A metadata framework that facilitates object biographies. (Created by Lisa Winters, 2023)

concept, the object in relation to people and the object in relation to other objects. Ultimately, every relationship is fabricated by the observer.

The different objects and what metadata should be recorded for each of them is shown in Figure 1. In database terminology these are entities and attributes. Any time an attribute appears in cursive, it refers to another entity which in turn has its own attributes. For example: An object from the collection has a collector, which is a person with a name, age and place of birth. This person could have worked for a university, which is an institute, which has their own associated data etc.

Where to store what data

The metadata framework does not just show the different entities that need to be documented along with their attributes, it also shows the place where these entities should ideally be stored. Every museum needs to have a collection management system and an archive, and many will also have libraries. This article won't elaborate on collection- and library management systems since there is a lot of (free) software available that can often be customized to the needs of your institute. In these cases, the metadata framework can be used as a guideline to keep in mind when (re)designing your databases and management systems.

Apart from the collection database and the library, the metadata framework in Figure 1 also shows a general database and three types of archives. When thinking about a museum's archive most people imagine old field books from expeditions and lists with objects that were bought or donated. This constitutes the collection archive, and is mostly made up from historical material. Collection archives collect all documentation related to the museum collections, such as correspondence, collection history, and the historical equivalent of all the acquisition and management information that is nowadays stored in the collection management system.

Museums however also produce a lot of documents just by existing day to day. This is the operational archive, which should include the documentation of all key processes in the organization. Operational archives can be separated into two categories: Organisation and Execution. Organisation spans governance, policy, finances, staff, facilities and in formation and communication. Execution includes the planning and execution of research programs and trips, exhibits, (community outreach) programs, educational activities and collaboration with schools, talks/lectures given at the museum and any other activities that support the core mission of the museum. Both the collection and operational archives should ideally be managed by an archivist, to make sure all the information is well-structured, has the correct metadata and is tidied regularly (including destroying records and files that are no longer relevant).

The final place to store data in the metadata framework is the general database, which at the time of writing is more of an ideal than an existing repository. The general database should be a shared digital resource between all heritage organisations which records general information that you can link to, such as species, people, locations and institutions. While the collection management system, archives and library are specific to your museum and are managed internally, the general database is interoperable between organisations and should be owned and managed independently. You could then upload information to this platform and link to your own collections. This means the general database can link objects from different museums but it can also provide background sources on collections from other archives or libraries. In this way, natural history collections become linked to the broader heritage scene which makes them more accessible to researchers from other fields.

The general database thus reduces redundancy in the museum's own recordkeeping and could (in an advanced state) enable people to link all entities in the metadata framework through this general database. In practice this means that you could look at an object in the database, click on the collector of this object and find other objects this person has collected, alongside general information about this person and more links to the expeditions they have been involved with, the institutes they associate with etc. This advanced state requires a digitization and online publication of the objects (not necessarily open to the public), while in its most basic form the general database could be a place to store data with a one-way link from entity to entity. This means you can click on a collector of an object and find information on this person with further links to expeditions and institutes, but you can't see the other objects that this person is associated with; imagine clicking through Wikipedia articles.

If a museum's collection management system does not have a dedicated place for certain types of information, it can be easily lost after projects are done or people leave. Information is stored on personal drives or not clearly/uniformly described when stored on shared drives. This can also be the

case for physical paper archives which are not described at document - or file level; the current archivist or archive keeper might know which shelf contains what specific information while the labels only show a research field, name or date. The general rule here is: if someone else can't find it, it might as well not exist. It can be really difficult to implement new systems however, and not every museum has the resources to commit to new software or hire professionals to document and structure the existing archives. How can you use this metadata framework with as little time investment and financial aid possible?

How to get started

The most straightforward way of linking your collection management system to your collection's archive and your operational archive is by making sure your archives are well-structured and each object has a unique ID. Museum specimens get a specific ID based on the collection they are in but archival material also needs an ID in order to easily identify and link them. These ID's can then be added to each other's metadata, so we know what objects are connected to certain documentation and vice versa. These ID's and the links to other objects should be applied as soon as the documents are created, which means that anyone creating archival material needs to be aware of the importance of well-structured metadata, and the specific system that your museum uses. To this end, you should not only invest in a framework or software but also in awareness and training among your colleagues.

Archives are made accessible through an inventory in which the organic relationships between information-objects (documents, files, photo's) are visible. Objects are described on different levels, which allows you to group together objects based on operational processes. The descriptions of the different levels can be incorporated into the ID, meaning that you can know what part of the archive an ID refers to without seeing the whole inventory. Figure 2 shows an example of a digital operational archive that can be realized in folders on any operating system. Metadata can be added to the folders and the digital files, allowing for both the event and the documentation to be described (see Figure 1). Not only can you refer to specific

O. Organisation
- **O.SF. Staff and Facilities**
  - O.SF.S. Staff
  - O.SF.F. Facilities
    - O.SF.F.E. Electricity
    - O.SF.F.H. Housing
    - O.SF.F.W. Water
- **O.F. Finances**
- **O.IC. Information and Communication**
  - O.IC.I. Internal
  - O.IC.E. External
  - O.IC.T. Technology
- **O.PG. Policy and Governance**
  - O.PG.R. Annual Reports
    - O.PG.R. 2022.docx
    - O.PG.R. 2023.docx
  - O.PG.P. Annual Plans
    - O.PG.P. 2022.docx
    - O.PG.P. 2023.docx
    - O.PG.P. 2023.docx

E. Execution
- **E.Ev. Events**
  - E.Ev.2022
  - E.Ev.2023
    - E.Ev.2023.L. Lectures and Talks
    - E.Ev.2023.N. Night at the Museum
  - E.Ev.2024
- **E.Ex. Exhibits**
  - E.Ex.2022
  - E.Ex.2023
    - E.Ex.2023.GABA. The Golden Age of Botanical Art
      - E.Ex.2023.GABA.P. Planning
      - E.Ex.2023.GABA.E. Execution
      - E.Ex.2023.GABA.M. Marketing
  - E.Ex.2024
    - E.Ex.2024.DEB. Dutch Expeditions in Borneo
      - E.Ex.2024.DEB.P. Planning
        - E.Ex.2024.DEB.P.003 Brainstorm Sessions Minutes
          - E.Ex.2024.DEB.P.003.4 Brainstorm Session Minutes 22-08-2023.docx
          - E.Ex.2024.DEB.P.003.6 Brainstorm Session Minutes 05-09-2023.docx
        - E.Ex.2024.DEB.P.011 Lists of Objects
          - E.Ex.2024.DEB.P.011.1 List of Objects Concept 1.docx
          - E.Ex.2024.DEB.P.011.2 List of Objects Concept 2.docx
          - E.Ex.2024.DEB.P.011.3 List of Objects Final.pdf
        - E.Ex.2024.DEB.P.052 Exhibit Designs
          - E.Ex.2024.DEB.P.052.22 Exhibit Design Room 1.12 Map.pdf
          - E.Ex.2024.DEB.P.052.23 Exhibit Design Room 1.12 Front View.pdf
      - E.Ex.2024.DEB.E. Execution
        - E.Ex.2024.DEB.E.001 Building Contracts
        - E.Ex.2024.DEB.E.006 Exhibit Texts
      - E.Ex.2024.DEB.M. Marketing
        - E.Ex.2024.DEB.M.008 Promotional Images
        - E.Ex.2024.DEB.M.023 Podcast
- **E.P. Programs**
  - E.P.C. Community Programs
  - E.P.S. School Programs
- **E.R. Research**

Figure 2. Example of select parts of a fictional operational archive: The document ID shows which part of the archive it belongs to, in order to easily locate it and related material. (Created by Lisa Winters, 2023)

documents, you can also link to an entire folder. Even if the link isn't "clickable", you can still easily find the right document by following the path in the ID or simply search the archive for the ID. In this manner you can also store any information on the objects in your collections that doesn't fit in your current collection management system (CMS).

Collection archives can be structured in a similar way, only the path won't end in a digital file but in an ID and description linked to a location in the physical archive. Since the collection archive might be a little less organically structured, a structure such as is shown in Figure 3 can be used.

While these figures can be used as examples, there are also standards on which you can base your own archive structure. The most commonly used standard for archive inventories is ISAD(G) (International Council on Archives, 2023), which figure 2 and 3 are also based on. The structure of your archives and the ID's attached to your documents should be logical but most importantly practical in use. The only rule is that ID's must be unique.

Towards a linked future

The concept and framework presented here are a guideline to help facilitate more interpretations within one museum collection. There are however many ways to implement it on a broader scale, and to combine it with existing standards to create a fully linked network of databases.

In the aftermath of Covid-19 the practice of creating digital exhibits has become more prevalent. Many museums have put resources into digitizing their collections and archives to make them available to people from home. Publishing your digitized collections with a linked database will allow visitors to view the objects and documents in the contexts that is most interesting to them personally. It is no longer necessary to develop an elaborate story for an exhibit as the related information objects in the database will be able to provide any background information needed. Of course there is always the pitfall of having too much data available to find what you are looking for, but it could be possible to use artificial intelligence to suggest a way to progress through it. (For more information on the online museum and making digitized collections accessible, see Navarrete and Mackenzie Owen, 2016.)

As mentioned earlier when elaborating on the general database, it is possible to create an inter-museum network. This is done through the concept of linked data, where many museums use the same metadata scheme (the same types of metadata recorded in the same format) in order to link their databases online and make them fully interoperable. The idea is that there is one shared database that any museum could upload their data into, and people can search through all this information online and find related collections from all over the world. While this is a more common concept for biodiversity data, it is not widely used for the museum collections themselves. An example of a project creating such a linked database is Europeana (2023), which is funded by the European Union and aims to make

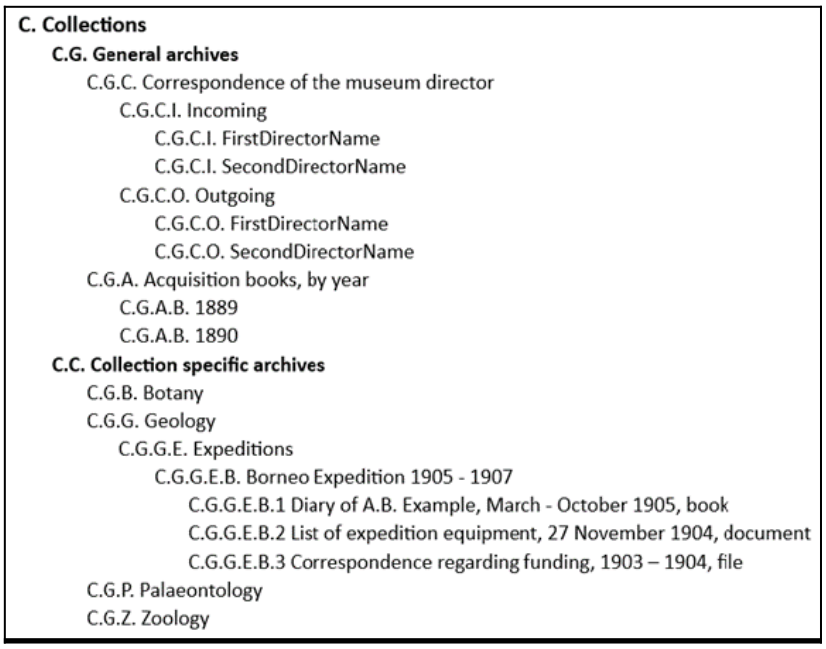

Figure 3. Example of select parts of a fictional collection archive. (Created by Lisa Winters, 2023)

Europe's digital cultural heritage accessible through one online platform. On the website you can search for a specific object or browse different collections based on shared metadata (subject, person, location, etc.). There are many local examples as well, such as the linked collections of the Dutch Rijksmuseum (National Museum of Arts) (Dijkshoorn *et al.*, 2018). Implementing this on a large scale would mean that researchers no longer have to guess what institutes hold objects or information on their topic of interest. New connections between places, people and objects could be forged that would otherwise never have occurred to anyone. Not only is this beneficial to researchers and the general public, but it can also help you gain more insight into your own collections. (See also McKenna, Debruyne and O'Sullivan, 2022, for the exploration of a new linked data framework for the heritage sector.)

The linked data ideal requires a lot of collaboration; a network of museums all working towards the same goal. Many standards already exist for linked data, but it is difficult to find a standard that fulfils every museum's and collection's need. Even the standards that were developed expressly for natural history museums do not yet include all the historical aspects and links to archival and published material. Object biographies and linked data go hand-in-hand, but you need the incentive of a network of meaning and contexts in which every perspective is welcome in order to synthesize the two. We should not implement technology for technology's sake. The ideals laid out in this section are far from reality, but it all comes down to accessibility. Accessible means that you can find information and are able to ingest and interpret it. But it also means that something is approachable, easily understood and used. It means that everyone, regardless of their background or identity, can access the museum collections and feels welcomed to do so. Object biographies allow for a space in which every interpretation is valued. Clearly cataloguing and linking your own collections can be the first step.

Acknowledgements

This article is a product of the 2023 NatSCA "How to…" conference. My original paper for this conference only included a first introduction into object biographies and how they can be used to research and display natural history collections. During the conference it became clear that lots of people are already interested in this socio-historical point view, but the main obstacle in facilitating it was documentation. This article would not exists without the NatSCA conference, and thus I would like to thank the NatSCA conference committee for organizing it and bringing together such an insightful range of topics. I would also like to thank everyone in attendance, speakers and guests, for the conversations and general positive environment to share and develop new ideas.

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Unlocking Designation through a collaborative 'ecosystem': Secrets from Ipswich Museums' application and Ice Age story

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Received: 6th Sept 2024

Accepted: 17th Jan 2024

Citation: Jackson, S. 2024. Unlocking Designation through a collaborative 'ecosystem': secrets from Ipswich Museums' application and ice age story. *Journal of Natural Science Collections.* **12.** pp. 74-86.

Abstract

Designated status from the Arts Council England has been awarded to Ipswich Museums for their Post-Cretaceous Geology Collection. This accolade recognises the collection as an internationally important, essential research resource for understanding this period of earth history in Britain. This paper reveals the focus of our application on Suffolk's ice age story, and concentrates particularly on how collaboration throughout our Designation journey has been so critical to its success. Internally, this has included the development of a cross-disciplinary Designation team to specifically develop and complete the bid. Externally it has included collaboration with previous Ipswich curators, a local geological conservation organisation, curators and collections managers and academic researchers in the field of Plio-Pleistocene palaeontological research. This process led to the capturing of critical data for the applications in the two-stage process, whilst helping us to meet the three key Designation criteria. Although the Designation award was the key goal Ipswich Museums sought, the strengthened relationships with our collaborative network of academics, museum professionals and local community have been a major outcome.

Keywords: Designation; Ipswich Museums; Plio-Pleistocene; geology; ice age; collection

Introduction

In January 2023, Ipswich Museums were awarded Designated status by the Arts Council England (ACE) for their Post-Cretaceous (Cenozoic) Geology Collection. In achieving this prestigious accolade, Ipswich Museums have gained a number of additional benefits including the stronger networks we developed. The main purpose of this paper is to highlight how we went about the Designation bid, but concentrating particularly on how collaboration was its greatest strength, shaping the applications, and meeting the key criteria. Whereas Jackson (2020) focused on how Tullie House Museum and Art Gallery met the Designation criteria in its bid, this paper will concentrate around developing Ipswich Museums' collaborative network, and in so doing, it will reveal some of the key research projects on the collection at Ipswich which have been taking place.

Introducing the Designation scheme

The founding principles of the Designation scheme were to raise the profile of collections and to promote their safeguarding (Arts Council England, 2014).The award is a mark of distinction demonstrating that an institution's Designated collection is amongst the best in England. It also

creates a sense of pride for a collection's stakeholders, providing a badge of excellence that can be proudly wielded in funding applications (although unfortunately the Designation Development Fund is now closed, which, in its third and final round of funding (2019-2022), granted £2.1 million to 28 successful museums and libraries (Arts Council England, 2023a)).

Until 2011 the scheme was administered by the Museums, Libraries and Archives Council, and is now administrated by the Arts Council England (ACE). The Designation scheme is established for non-national, Accredited, English museums, libraries and archives and a Designated collection can be furthermore defined as "a nationally significant, coherent assemblage of items; held in trust in the long-term for public benefit… [and]…is an essential research resource for its subject" (Arts Council England, 2015). There are three criteria which underpin a two-stage process, and which are formally assessed by the ACE Panel: National Significance, Outstanding Quality and Research Value – these are more explicit in the Stage 2 application. For more specific information about the Designation process the ACE guidelines (2015) should be considered (see also Jackson, 2020 for a review of the process).

There are currently 163 museums, libraries and archives with Designated collections (Arts Council England, 2023b). Whilst historically, before the change in administration, entire holdings of museum collections, sometimes across several disciplines, could be Designated as part of a single application, the current scheme only recognises applications for single collections or sub-collections. Each application undoubtedly needs to be more focused on a collection's strengths, and how a collection meets the criteria in question. This paper focuses on Ipswich Museums' bid concerning its Post-Cretaceous Geology Collection and hopefully provides some useful insights into how a successful bid can be developed. As discussed in more detail below, collaboration has been absolutely key.

The Ipswich Museums' Post-Cretaceous Geology Collection and context of the application

The Ipswich Museums' natural science collection contains at least 340,000 specimens including most notably: pinned entomology, mollusc shells, other dry invertebrates (e.g. corals, sponges), fluid invertebrates (e.g. arachnid collections), vertebrate zoology (taxidermy mounts and dioramas, skins, skeletal and fluid specimens), botany and mycology (pressed plants, dried lichens and fungi, fungi models and watercolour illustrations) and geology (rocks, minerals and especially fossils). The collection dates back to the mid-1800s and some of these earlier collections document a time when collections were brought back from across the world to inspire the people of Ipswich reflecting the Victorian Era of exploration and colonisation (for an excellent history of the Museum and its collections see Markham, 1990, and for history of the geology collection see Markham, 2012).

The different natural science sub-collections are very different to one another in their overall scope, reflecting the interests of their original collectors. For instance, whereas much of the botanical collection is focused on documenting Suffolk's floral changes, the zoological collection is more international with taxidermy from across much of the world – although it does have a strong Suffolk and wider British component too, for instance, the Fergus Menteith Ogilvie (1862-1918) collection of birds (Frost, 1989). The geological collection is also international with more than 40,000 specimens from across the world, ranging in age from the Precambrian up to the present day. However, about 30,000 of these are Post-Cretaceous in age, containing a good range of material from all Cenozoic epochs, but especially the Plio-Pleistocene of Suffolk – it was this sizeable and coherent assemblage that became the focus of Ipswich Museums' Designation application.

This focus and unique story of Suffolk's Plio-Pleistocene was key to our Designation bid, with Suffolk arguably charting the best British record for the last few million years of earth history (Harper, 2020; Harper 2021) This includes the East Anglian Crag deposits which illustrate the cooling conditions from the Late Miocene, through the Pliocene and into the Pleistocene ice age (which started 2.6 million years ago). Whilst all four of the East Anglian Crag units (in chronological order: Coralline Crag, Red Crag, Norwich Crag and Wroxham Crag) are exposed in Suffolk, Suffolk contains the only exposures of the Coralline Crag (Lower Pliocene) and has the most extensive exposures of the Red Crag (see Wood *et al.*, 2009, Fig. 1) – the only exposures in Britain to document the very start of the Pleistocene ice age. Suffolk also contains an extensive record of the fluctuating colder (glacial) and warmer (interglacial) deposits and their characteristic fauna through key internationally important sites, which are represented in the collections at Ipswich Museums. Suffolk contains four type sites for the British Quaternary stratigraphy – Easton Bavents (Baventian), Corton (Anglian), Hoxne (Hoxnian), and Bobbitshole (Ipswichian: named after Ipswich). Suffolk and the Ipswich collection also contain

internationally significant material from key sites from an interglacial dating to around 200,000 years ago, most significantly at Stoke Tunnel (Ipswich) and Brundon.

Much of the natural science collection including the geology was on display at Ipswich Museum (one of Ipswich Museums' three sites) until 2022 (Figure 1). The Museum is now undertaking an exciting £8.7 million redevelopment project which will encourage a wider audience to engage with the natural science collection and connect with globally important issues including climate change and biodiversity loss. For example, the *Worlds* gallery will take visitors on a journey back in time to understand how environments and their fauna and flora have changed dramatically due to climate change – informing visitors that such fossil assemblages can provide insights into our current global crisis.

Collaboration is key

Both internal and external team working and collaboration was key to the success of our application and meeting the Designation criteria.

The Ipswich Designation team

Throughout our Designation journey, there was a specific team in place to help with the development and submission of the Stage 1 and 2 applications. This helped with the distribution of workload, objectivity of the applications, challenging the relevance of examples and support for the lead. In the final stages of the applications, the team reviewed drafts to provide helpful comments. The team was cross-disciplinary – including two archaeologists – which fostered a more objective perspective on the palaeontological examples included and helped to ensure the application would be engaging, clear and concise.

The Ipswich team increased to 6 staff including four senior members of staff (including the Head of Colchester and Ipswich Museums), the curator of natural science (a specialist Collections and Learning Curator) and a temporary Assistant Curator of Natural Sciences. The Collections and Learning Curator coordinated the process, undertaking necessary research and writing the application and was assisted at times by the (short-term contract) Assistant Curator. The curator

*Figure 1. Photograph of our Woolly Mammoth (*Mammuthus primigenius *Blumenbach, 1799) model (IPSMG:R.1993.61) with a selection of Pleistocene fossils in Ipswich Museum before its temporary closure in 2022. Many of these exhibits including the model will go on display in our new redeveloped Worlds gallery in 2025, taking the visitor on a journey back through time including Suffolk's unique ice age story. ©Colchester and Ipswich Museums.*

would then answer to the senior members of staff of the team at regular meetings, taking a steer from them. The senior members of staff also reviewed the drafts, and as each deadline approached, the curator worked more closely with the Heritage Manager.

The former Collections and Learning Curator responsible for natural sciences led the Stage 1 application and the author, the Stage 2 application – so there was one natural science curator in post for each stage of the application.

The Arts Council England guidance and direction

Throughout the development of the bid, the ACE guidelines (Arts Council England, 2015) were frequently consulted – in our bid, a copy was printed out and available at all times for consultation. Indeed, the criteria and many of the prompts therein were committed to memory.

It proved invaluable, if not critical, to take on board the advice from the Arts Council. For example, after our successful Stage 1 application we were provided with written feedback on how Stage 2 should be developed. This was followed up at an early stage of the Stage 2 application with a virtual meeting to clarify their advice further and to make sure that our current thinking was focused in the right direction. Specifically, our application needed to focus more on the research activity at Ipswich Museums that was taking place, including examples of high-level research.

Expertise at hand: insights from a former curator

Ipswich Museums are very fortunate to still have regular involvement from a former geological curator: Bob Markham. Retired from Ipswich Museums in 1995, Bob Markham has continued to work tirelessly as a volunteer curating his collection for the Museums. This collection of well-sorted and catalogued East Anglian Crag mollusc material represents local Suffolk sites, some of which are no longer accessible (or require special permission to access them) and contains excellent geological provenance data (Harper, 2020). For example, the collection includes material from Sites of Special Scientific Interest (SSSIs) such as Sudbourne Park, which includes excellent exposures of the Coralline Crag. This contemporary collection (Figure 2) complements the more historical specimens which include many type and figured specimens (Harper, 2020).

Bob Markham acted as an adviser for both stages of the bid, providing invaluable expertise with regard to the significance and history of the collection, the geological sites from where specimens have been recovered, and the underlying subject matter itself.

Another benefit of a former geological curator was that he had worked as a curator of geology at Norfolk Museums Service before he came to Ipswich in 1965. This gave him valuable knowledge of both collections, how they related to one another and the complex geology upon which they are based across East Anglia. This helped to identify relative strengths and weaknesses of the collections and how they complement each other.

Expertise from other museums – putting the collection into context

Relating the collection upon which the application is based to other relevant collections, and

Figure 2. A selection of East Anglian Crag bivalve specimens collected by former curator, Bob Markham. Two Coralline Crag specimens are shown on the left; two Red Crag specimens are shown on the right.
©Colchester and Ipswich Museums.

particularly to those recognised by the Designation scheme, was a key part of our bid (and a necessary requirement of the application – most specifically the Outstanding Quality criterion). Our application also included recognising any unique aspects of the collection and subject areas upon which it was based, which had a bearing on all three criteria. For instance, for the Research Value criterion the (Arts Council England, 2015) guidance states, "We are looking for evidence that the collection is used to support primary research that would not otherwise be possible". Understanding how the collection fits in with the context of others, and also understanding how its underlying subject matter relates to the broader context, is key to framing the response to the National Significance criterion.

Before the application began, the former Collections and Learning Curator of natural sciences visited many different museums with natural science collections to speak with respective curators and to see their collections. This subsequent data informed the underlying focus of the application and the need to frame our bid specifically around a particularly comprehensive and coherent assemblage – our Post-Cretaceous Geology Collection, particularly emphasising the Plio-Pleistocene.

Whilst information and data critically informed the Stage 1 application, this focus and comparative investigation was developed further by the author when in post for the Stage 2 bid. Consequently, a large comprehensive Excel spreadsheet was created for the Stage 2 bid, incorporating data from other museum curators and collections managers about their respective collections.

This dataset included information about the number of Miocene boxstones, Red Crag specimens and specimens from key Pleistocene sites including Stoke Tunnel and Brundon. In many instances specimen level data and records were kindly provided by museum staff, and when this was not possible, more generalised estimates of certain sub -collections proved invaluable. This process was determined by how much each museum had digitised their collections.

Alongside the quantitative data, qualitative comparisons also proved to be critical to the application. For instance, the Sedgwick Museum of Earth Sciences at the University of Cambridge is a close Designated museum comparator, also with excellent collections of Red Crag molluscs (for a list of museums with Red Crag collections, see Larkin and Norton, 2010). Professor Elizabeth Harper kindly provided comments on the relative strengths and weaknesses of the Ipswich Museums' collection and what, in her opinion, we should emphasise in the bid, for example, the unique Suffolk boxstones (Figure 3). An analysis of our collections firstly came through a commissioned report of our palaeontology collections (Harper, 2020) but then additional data was gathered through virtual meetings, in-person meetings and visits to the collection for her own research and frequent email correspondence. This advice also helped to improve the collections: for example, through one of her report recommendations, a geological specialist freelancer was recruited to undertake detailed documentation and digitisation of our Plio-Pleistocene type and figured specimen collection. This digital catalogue was made accessible through our Colchester and Ipswich Museums' online portal (Colchester and Ipswich Museums Collections Online).

Figure 3. Photograph of a Miocene boxstone, Cardium subdecorticatum *Bell 1917 (IPSMG:R.1933.119.A7). Suffolk boxstones provide a unique glimpse into the British marine Miocene around 8 million years ago. ©Colchester and Ipswich Museums.*

Figure 4. Photograph of the type specimen of Red Crag gastropod, Murex canhami Wood 1872 (IPSMG:R.1870.76N.225) in the Ipswich Museums collections. ©Colchester and Ipswich Museums. Photograph by Douglas Atfield.

Type specimens were also made available on the GB3D website (GB3D Type Fossils), which included high resolution images taken by a specialist photographer (Figure 4).

Identifying our closest comparators proved to be a critical part of our applications. Not only were we able to obtain excellent information from Professor Liz Harper from the Sedgwick Museum of Earth Sciences to underpin comparisons between our collections, and identify areas in which our collection was unique, but we formed a stronger working relationship with this museum. Specifically, this included working with Professor Liz Harper and Director, Dr Liz Hide to develop and deliver a "Virtual Meeting on Plio-Pleistocene Palaeontology Collections" in November 2022. This online conference brought together academic researchers, museum staff including curators and collections managers, our local geological conservation group (GeoSuffolk) and enthusiasts for an afternoon of oral presentations and discussions. The inclusion of this project within the bid strengthened the application by demonstrating how we were striving to work with our close comparators – for example, also reaching out to other museums in the region such as Norfolk Museums Service to include a talk. It also demonstrated how we were developing our research network and establishing networks with international research, as well as contributing to the public understanding of the subject.

Expertise from researchers – demonstrating Research Value

Demonstrating that the applicant's collection is or has the potential to be an essential research collection for its subject is one of the main criteria which needs to be met in a Designation bid (Arts Council England, 2015). Furthermore, detailing our research activity was an area which ACE specifically requested in our Stage 2 application. The research element of our bid can be subdivided broadly into historical and new research.

Historical research

In order to identify previous researchers that had worked on our collection a variety of different resources were were consulted.

This included museum documentation and records of specimens used in research, correspondence with researchers, scientific literature which cited specimens and the specially commissioned palaeontology report of Professor Liz Harper (Harper, 2020). For example, during the mid-1800s there was a wealth of fossil discoveries in the East Anglian Crags resulting from the new 'coprolite' fertiliser industry – many of these finds came to Ipswich Museums. Thanks to detailed work of researchers at the time including renowned anatomist Sir Richard Owen (e.g. Owen, 1846: Figure 5) and prominent naturalist and geologist, Richard Lydekker (e.g. Lydekker, 1886: Figure 6), we have a much better idea about the ancient species diversity, both marine and terrestrial, which existed at the dawn of the ice age, as revealed from the internationally significant Red Crag. Furthermore, the later detailed mollusc monographs of Wood (e.g. Wood, 1848) and Harmer (e.g. Harmer, 1914), featuring many of our type and figured specimens (Figure 4) are still key references for workers wishing to study the taxonomy of Plio-Pleistocene molluscs. The collections research continued through the 1900s with the work of former Ipswich curator HEP Spencer (e.g. Spencer, 1964).

Figure 5. Photograph of the holotype specimen of Puma pardoides *(Owen, 1846), a molar from the Red Crag of Newbourne, Suffolk (IPSMG:R.1951.28.21.2) in the Ipswich Museums' collections. ©Colchester and Ipswich Museums. Photograph by Douglas Atfield.*

Figure 6. Photograph of the holotype specimen of a tarsometatarsus of the Red Crag albatross Phoebastria anglica *(Lydekker, 1891) (IPSMG:R.1951.28.31) ©Colchester and Ipswich Museums. Photograph by Douglas Atfield.*

For more recent research in addition to the above resources mentioned, a Microsoft Excel dataset included lists of recent researchers, when they came to the collection, and what they studied. Additional resources included collection reviews, and previous letters of support for an older Designation bid.

Studying the archival records, the specimen records and the scientific literature provided invaluable information. However, at an early stage of our Stage 2 application, the Designation team agreed that one-to-one, virtual interviews with key researchers would help us to understand the exact role our collection had in their research projects, why they came to our collection (was there anything unique about it?), and what the current and future potential of the collection is. It helped us to identify what the barriers to using our collection are and if they had any suggestions for overcoming them.

For example, the discussion with Professor Adrian Lister, Research Leader, at the Natural History Museum, London helped us to understand the uniqueness of our collection. In a one-to-one virtual interview he emphasised the importance of the Red Crag as the only exposed deposit in Britain to record the start of the Pleistocene ice age and furthermore that we had the majority of the fossil vertebrate material from this deposit at Ipswich Museums. That is what drew him to our collection for some of his research projects studying mammal evolution and ecology. For example, Ipswich Museums possess the only UK specimens (a pair of molars) (Figure 7) of the earliest European mammoths (*Mammuthus rumanus* Stefanescu, 1924) and is one of only a few sites across the whole of Europe with this species (Lister and Essen, 2003). These specimens have helped to understand this early period of mammoth evolution (e.g. Lister and Sher, 2001). His research on scratch patterns, or microwear, on these teeth (Rivals *et al.*, 2015) have permitted key insights into mammoth diet and ecology, showing that these very early mammoths, at the start of the ice age, were browsers not grazers, with a high proportion of large pits in the teeth indicating that they often lived in habitats which may have consisted of a mixture of woodlands and more open areas. Lister also verbally highlighted the importance of some of our interglacial material from key Suffolk sites dating to 200,000 years ago including most significantly Stoke Tunnel and Brundon. A subsequent set of data compiled by Rivals and Lister, for use in their 2016 publication (Rivals and Lister, 2016), allowed us to more

*Figure 7. Photograph of a Romanian mammoth (*M. rumanus*) molar (IPSMG:R.1955.12.10.1), from the Red Crag, in the Ipswich Museums collection. ©Colchester and Ipswich Museums.*

specifically delve into how our collection contributed to his work: for example, 46 of our wild horse (*Equus ferus* (Boddaert, 1785)) teeth from these sites (in addition to Stutton, Suffolk) indicated that even at this time, this species was predominantly a grazer. However, the pattern of scratches on the teeth indicated a, "frequent browsing element" a short time (perhaps weeks) before their owners' death – therefore, the study showed a complex pattern of diet.

Further research interviews were also conducted with Dr Juha Saarinen from the University of Helsinki, examining the ecometric work looking at relationships between mammal body size, tooth wear patterns and environmental reconstructions (e.g. Saarinen *et al.*, 2016), Professor Danielle Schreve (Royal Holloway University of London) discovering her use of collections in mammalian biostratigraphy (e.g. Schreve, 1998) and Professor Elizabeth Harper (University of Cambridge) learning about her East Anglian Crag mollusc research and discussed above in relation to collections comparisons.

However, in addition to one-to-one interviews, email correspondence also proved a useful insight into how researchers have used our collections. For instance, email correspondence with Dr Andrew Johnson from the University of Derby, highlighted the importance of our Coralline Crag mollusc collection and its past and present contribution to his research. Dr Martin Pickford from the Muséum national d'histoire naturelle, Paris provided key data about the importance of the Red Crag to his research and specifically how specimens contributed to his work on Miocene suids (pigs). Suids are excellent for biostratigraphic correlations and they help to tie down the ages of the Red Crag faunas. They also yield important information concerning palaeoenvironments and palaeoclimate, revealing that at times Suffolk enjoyed a subtropical climate (Pickford Pers Comm, 2023).

New research projects

A number of new research projects began during our Designation process. These can be broadly subdivided into: new projects for which Ipswich had already been suggested, new projects for which Ipswich had not been included yet, and new projects or investigations which were conceived during the Designation bid.

With regard to the first category, Ipswich Museum became involved in a new palaeoclimate project, led by the University of Derby. Dr Johnson had examined the Ipswich collection in 2012 as part of his ongoing research project using Coralline Crag mollusc shell chemistry to investigate Pliocene climates – this research questions the historical contention based on the fossil assemblage (see Long and Zalasiewicz, 2012) that the mid-Pliocene North Sea was 2 to 3°C warmer than the present day, and therefore its value as an analogue for a potentially warmer world by 2100. This work therefore has major implications for determining palaeoclimate from fossil assemblages in general. Johnson's most recent paper on the Coralline Crag (Johnson *et al.*, 2021), helped to provide a foundation for a successful bid to the Leverhulme Trust for a three-year project to extend this palaeoclimate research. The further use of the Ipswich collection had already been specifically

identified within the application for support of this research, which involves collaboration from scientists from the UK, Germany and the USA. Our involvement in this international project was confirmed through email correspondence and a preliminary research visit from Dr Johnson, a new University of Derby postdoctoral researcher and University of Cambridge Professor Liz Harper. The research on Ipswich material was undertaken in 2022 and we currently await the results (Jackson, 2022a).

With regard to the second category, in 2021 we became involved in a new research project for which Ipswich Museum had not yet been considered. In our interview with Dr Juha Saarinen (University of Helsinki) we learnt of a new project proposal. This was a five-year international project reconstructing past ecosystems by studying mammal teeth and skeletal measurements to model climate change of the past. The project would work internationally with colleagues across Europe (e.g. the Natural History Museum (London), Natural History Museum of Madrid), the USA (e.g. American Museum of Natural History), Africa (e.g. National Museums of Kenya) and South America (e.g. Natural History Museum Buenos Aires). The conclusion from our interview discussion was that Ipswich Museum would be a valuable partner, making a unique contribution with its comprehensive Red Crag mammal material, for which the researcher was well acquainted with, having studied it before. Specifically, the Red Crag mammal material could provide insights into the changing fauna as the environment cooled into the Pleistocene. Consequently, Ipswich Museums were included in the list of potential partner museums, and after funding had been secured later in 2021, Ipswich Museum was able to participate in the study facilitating research in November that year (Jackson, 2021). Ipswich Museums continue to support the project.

During our Designation application we also helped to instigate a new line of research investigation. The interview with Professor Lister (detailed above) led to a discussion around his ongoing collaboration with the Centre for Palaeogenetics at the Swedish Museum of Natural History and Stockholm University, in their search for the oldest mammoth DNA. In 2021, the team reported the preservation of DNA in mammoth teeth dating to more than a million years old from a frozen environment, which revealed much of the species' genome (der Valk *et al.*, 2021). However, the preservation of DNA from a warm, temperate context at a 240,000 year old site from Germany (Meyer *et al.*, 2017) indicates DNA might be preserved at European latitudes even in warmer interglacials. From our discussion around the Designation bid and increasing the research value of our collection, came a research proposal to search for ancient DNA in Suffolk interglacial sites, more specifically in 200,000 year old steppe mammoth (*Mammuthus trogontherii* [Pohlig, 1885]) teeth – if found this would be the oldest mammoth DNA from Europe. The collaboration continued with the author's role in photographing a selection of specimens and assisting with the submission of the destructive sampling request put together by the research team. The sampling took place in 2022 (Jackson, 2022b) and the results are eagerly awaited.

Expertise from local societies

In addition to academic research, the collection is also used for more local research including, for instance, members of local geological conservation group, GeoSuffolk. This includes the ongoing research volunteer work of Bob Markham, but also facilitating research interests of other members.

Their collective expertise also proved invaluable to the curation of a partial steppe mammoth skeleton excavated from Maidenhall, Ipswich in 1975 and 1976 (Figure 8). During our Designation journey, we discovered just how important the specimen was to Plio-Pleistocene palaeontology learning from academics including Professor Lister (NHM) and Professor Katharine Scott (University of Oxford). For instance, the specimen demonstrates unusually small body size of the steppe mammoth in this time interval (Lister and Scott Pers Comm, 2021). Given its importance, the Museum has been exploring the possibility of displaying this specimen in one of the new galleries as part of its redevelopment project. In the summer and autumn of 2022 the GeoSuffolk team helped the Museum to more completely catalogue the material in the store, whilst identifying fossil material which could belong to our Maidenhall mammoth individual. This collaborative effort between curator and specialist society led to the identification of further bones including ankle elements which may belong to the same individual.

GeoSuffolk also helped with the delivery of our 'Ice Age Festival' in April 2022. We presented a range of stalls with specimens on display combined with talks, an under-fives zone, and arts and crafts activities. Additionally, other volunteers from the community also helped to support the delivery of the event. Without a doubt, the support of these volunteers proved invaluable to the smooth running of the event.

*Figure 8. Previous display at Ipswich Museum of the Maidenhall steppe mammoth (*M. trogontherii*) on the bottom right hand side of the display case. This specimen will be a key feature in the redeveloped Worlds gallery.*
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Reflections on Covid-challenges

One of the biggest challenges on our Designation journey was working with the constraints of 'Covid-lockdown'. The author began working on the Stage 2 application in February 2021 at the start of his new post as a Collections and Learning Curator. This meant learning about the Post-Cretaceous Collection (and wider natural science collection) for about three months solely from digital resources including Microsoft Excel spreadsheets, the collections management system, published literature and the collaborations discussed above. This was only possible because the digital infrastructure was in place which facilitated remote working including virtual one-to-one or group meetings via Microsoft Teams or Zoom.

These limitations could have potentially created a major setback as collections access was not possible until April, and remained limited until June 2021. This also created a challenge with the digitisation of the type and figured specimen project limiting the access the freelancer had to the collection. However, flexible working was key to overcoming this challenge, focusing on tasks which could be done remotely such as literature research or work with datasets. By the time collections access was less constrained, there were still several months to study the collection in person before the deadline.

The reduced access to the collection also obviously impacted the research work which could take place – precisely at the time we were trying to increase access to our collection. It should be noted that the Museum had also been closed to researchers for much of 2020 during 'Covid-lockdown' - which only served to increase the hiatus in research. There was a strong need to re-establish connections as we were emerging from 'lockdown' before we could begin developing them further. The combination of one-to-one online interviews, discussed above, and frequent email correspondence meant we could establish contact more effectively and quickly making the researchers fully aware of our situation and limitations, but also our aspirations and aims to get them back in, as soon as possible. Research projects could subsequently be booked from the summer 2021 onward.

As some research projects effectively started only a little before the Designation Stage 2 deadline of November 2021, and some projects took place the following year, it was particularly important to include in our application what results the

researchers could potentially find, based on their objectives. Furthermore, a key document which can be included (it is supplemental rather than mandatory) in the Stage 2 application is a 'Future Planning Document' (Arts Council England, 2015). The inclusion of this document within our application helped to demonstrate how we were increasing research activity on the collection and detailed what we were planning when – this is a highly useful strategic document to demonstrate future research activity which might not actually take place during the Designation application. A (non-requested) update was subsequently provided for the Designation Panel about how the research programme was progressing in a short bullet point document – again non-mandatory but in the author's opinion helps to demonstrate that intentions are being fulfilled.

Conclusions

This paper has charted key elements of our Designation bid for our Post-Cretaceous Geology Collection. The importance of working closely to the ACE guidelines and both written and verbal comments from the Arts Council cannot be emphasised enough (reiterating Jackson, 2020). Whilst guidance (Arts Council England, 2015) provided critical prompts to address for each of the criteria, specific feedback provided direction for a more bespoke Designation bid.

Undoubtedly, significant staffing resources are recommended to undertake a Designation bid, with ideally a lead to coordinate various elements (e.g. the application, letters of support, supplemental data) and a support team. Ipswich Museums have been in a very fortunate position with the resources that it has had in undertaking this work, including a natural science curator in post to lead on each application of the two-stage process. It is appreciated that other museums (or libraries or archives), who might be applying for Designation, might not be in such a position. We have also been very fortunate to have had such an active involvement from our senior management, who directly participated in discussions around the application at regular meetings and ultimately reviewed drafts of the applications. The support of senior management is invaluable to the Designation process not only to approve the resources and support of the applications, but also in the development of the bid itself.

However, the focus of this paper has really been on the external collaborations which we have developed during our Designation journey, and which greatly strengthened our applications.

Whilst the award of Designation was Ipswich Museums' ultimate goal with our applications, the strengthened network of researchers, curators, collections managers and other museum staff, former staff and geological organisation, GeoSuffolk, through our collaborative efforts, has proved to be a thoroughly worthwhile result in its own right – which was made all the more challenging after the research hiatus of 'Covid-lockdown'. The Museum now, for instance, is involved in a number of international research projects such as the current search for the oldest mammoth DNA in Europe, and reconstructing ancient climates using fossil shell chemistry and also mammal teeth. The delivery of the 'Virtual Plio-Pleistocene Conference' of 2022 has also helped to boost our collaborative networks, strengthening, for instance, our working relationship with the Sedgwick Museum of Earth Sciences (University of Cambridge) – we are aiming to work together to deliver another similar conference in the next year or two. Furthermore, the conference has also enabled us to build up new contacts and to start building support and enthusiasm for regular Plio-Pleistocene meetings and discussions.

Every museum's (or library's or archive's) Designation journey will be different depending on the nature of its collection. For instance, Jackson (2020) highlighted Tullie House's journey with regard to its collection based on the significance of Cumbria's unique biodiversity. Whilst there are obvious differences in the focus of the applications (though each bid is fundamentally linked to its geographic region), many similarities can be drawn to our experience including its cross-disciplinary internal team (working closely with its Cumbria Biodiversity Data Centre) and also close working with its local natural history society and academic researchers. Indeed, Jackson (2020) also concluded that close working with researchers, including face-to-face meetings, was vital.

As highlighted in this paper, it is recommended to all Designation applicants: involve as many stakeholders as possible in your Designation journey, including but not limited to: ACE staff, internal staff, former staff, volunteers, local societies, other museum staff (including curators and collections managers) and academic researchers – strengthen your links with these different communities to develop a deeper understanding of your collections and amass their expertise to build a strong, successful Designation bid – and whatever the outcome, you will have a stronger internal and external museum community.
A Designation journey is worth committing to.

Acknowledgements

Anna Mercer, Senior Collections and Learning Curator (Ipswich Museums) is thanked for helpful comments on the draft. Dr Andrew Johnson from the University of Derby, Dr Martin Pickford from the Muséum national d'Histoire Naturelle and Professor Adrian Lister from the Natural History Museum are also thanked for providing helpful additions in the paper about their research. Professor Elizabeth Harper from the University of Cambridge, Dr Juha Saarinen from the University of Helsinki and Bob Markham (GeoSuffolk) are thanked for checking the relevant text regarding their involvement and also to Professor Katharine Scott from University of Oxford for agreeing to be name-checked, recognising her research contribution to understanding the Maidenhall mammoth specimen. All curators (including former curators), collections managers and other museum staff, researchers, societies, volunteers, ACE staff, in addition to the Ipswich Museums' Designation team, are thanked, including those mentioned herein, for their support of the Designation bid upon which this paper is based, and their continued support of the museum and its work. Photographer Douglas Atfield is thanked for high resolution images taken of type specimens which have been made available on the British Geological Survey GB3D site and have been reproduced herein (the Museums hold the copyright). The BGS team are thanked for their support with the digitisation process. The editor and two anonymous reviewers are thanked for their editorial work and reviews on this paper.

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From the field to collections: Developing natural history collections and collection centers in a unique region of Saudi Arabia

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Received: 12th Aug 2023

Accepted: 21st Feb 2024

Citation: Freedman, J., Collins, C., Darwish, M., and Al Johani, N. 2024. From the field to collections: Developing natural history collections and collections centers in a unique region of Saudi Arabia. *Journal of Natural Science Collections.* **12.** pp. 87-95.

Abstract

The Royal Commission for AlUla (RCU) manages a region around the town of AlUla in north-west Saudia Arabia. AlUla has a rich archaeological heritage, with internationally important archaeology collections which are mainly stored in AlUla Museum. AlUla museum was built as a center of support for archaeological research, in the region, however, the development of a new natural history collections has meant that new approaches have had to be developed to record, research and preserve the rich diversity of wildlife and geology. As a result of this, there is a strong need to develop best practice protocols for collecting and storing natural history collections, so they are safeguarded for the future research and exhibition programs. However, the location and very dry conditions in the region present many challenges to the preservation of these collections. This paper outlines the progress of the challenges faced and how current published best practice advice and guidance has to be adapted to suit the different environment of AlUla.

Keywords: AlUla; Saudi Arabia; collecting; storage; procedures; protocols; policies

Introduction

The Royal Commission for AlUla (RCU) manages the region around the town of AlUla, covering an area of over 22,000km2 in north-west Saudia Arabia (Figure 1). The region is classified as a desert, with around 21 mm (0.8 inch) rainfall per annum, and large varying temperatures reaching 50oC in the summer day and down to 0oC in the winter nights (Climate Data, 2024). Only 200km west of the Red Sea, AlUla has been an important trade route for thousands of years, as a strategic part of the Incense Trade Route through the Arabian Peninsula and as an important town on the Haj route. The region holds incredibly rich archaeological sites, dating back 200,000 years. It is where the capital of the ancient Kingdom of Dadan, one of the most important sites for trade in Arabia, dating to around 3,000 years ago, can be found (MacDonald, 2018). The second largest Nabataean city, Al-Hijir (also known as Mada'in Salih, and Hegra) can be found in AlUla, and was the first site in Saudi Arabia that was designated a UNESCO World Heritage Site (Figure 2) (MacDonald, 1997; Ansary and Abu Al Hassān, 2001; Hausleiter, 2012).

As well as the internationally important heritage sites, AlUla has a rich and diverse natural heritage. The geology is a part of the Arabian Shield, which is composed of Precambrian igneous and metamorphic rocks, Palaeozoic sedimentary rocks,

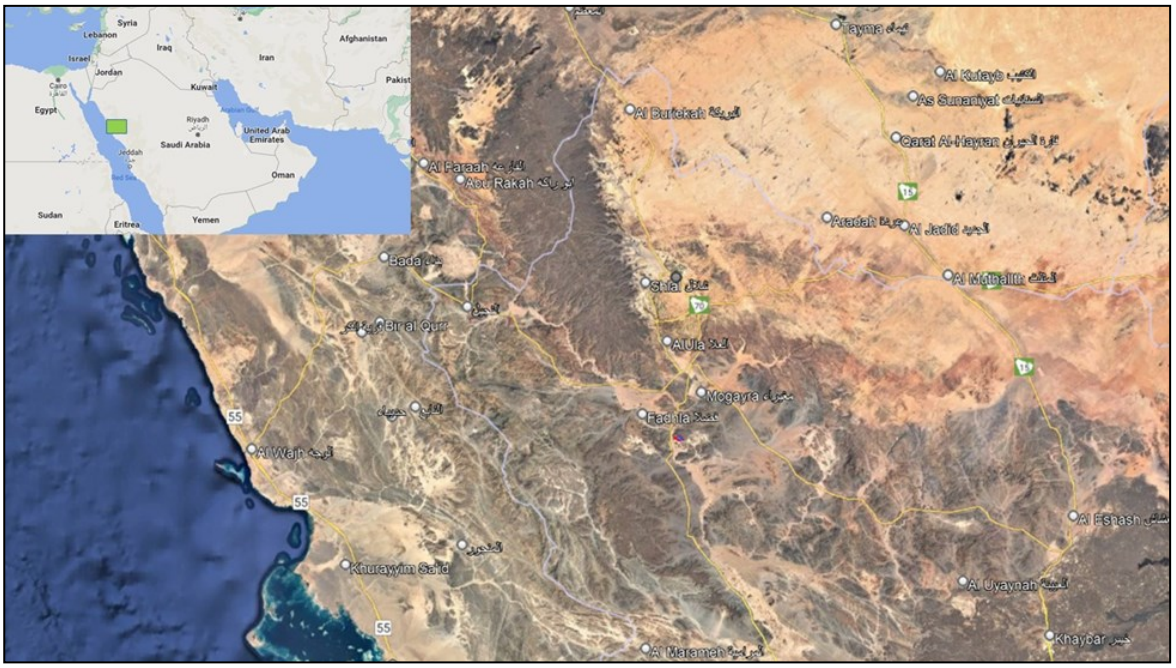

Figure 1. AlUla is located in the north west of Saudi Arabia, approximately 200km west of the Red Sea.

and Tertiary volcanic rocks (Hadley, 1987; Brown, Schmidt, and Huffman, 1989). The landscape varies throughout the region depending on the geology. In the south, jagged mountains and gravel plains dominate the land, and from central AlUla to the north, the sandstones create a different landscape of natural geological formations (Figure 3). The large variety of geodiversity has created numerous different environments for a range of endemic species of plants, insects, reptiles, mammals and birds to thrive, and over 50% of the county is protected under five nature reserves.

AlUla Museum was built as an archaeological museum and historically holds large archaeological collections, and the development of a natural history collection was not previously a priority. With the growing Wildlife and Natural Heritage team, and several new research projects across the region which involve collecting specimens, there was a strong need to develop best practice methods to enable the safe storage and preservation of the first natural history collections in AlUla. This paper outlines the ongoing work and challenges to develop and manage a natural history collection in a very dry environment.

Figure 2. One of the tombs carved into sandstone at Hegra. These tombs date to around 2000 years ago and are carved directly into the 500 million year old sandstone outcrops. (Photo by Jan Freedman)

Figure 3. One views of the stunning landscape of AlUla. The Cambrian and Early Ordovician sandstones have been naturally weathered by wind over millions of years to create beautiful features. (Photo Jan Freedman)

Royal Commission for AlUla

In 2016, Prince Mohammed bin Salman announced the Saudi Vision 2030, with the aim to improve the Kingdom's health care, infrastructure, education, infrastructure and tourism by 2030 (Vision2030, 2023). Investment has been put into mega-projects redeveloping areas, such as the Global Red Sea Project (The Red Sea Development Company, 2023), and other huge projects focusing on renewable energy (Reuters, 2018). The investment has also identified and acknowledged the internationally important heritage sites in the Kingdom, with several projects undertaking conservation work safeguarding heritage sites and redevelopments to allow tourists to visit (for examples see Arab news 2017; Arab News 2019; Forbes, 2019).

The county of AlUla is one of the major tourist destination projects, researching and protecting the heritage for people around the world to enjoy by creating the world's largest Living Museum (Vision2030, 2023). The Royal Commission for AlUla (RCU) was established in 2017 to preserve the heritage, and develop the region as an international tourist destination (BusinessWire, 2017). Along with the internationally important heritage sites, RCU has the additional focus to preserve the natural landscape, including the wildlife and geological landforms across the county.

Natural History Collections

Historically, the Museum of AlUla, now under the management of RCU, has primarily focused on archaeological collections because of the incredibly rich archaeology in the region. The county has been open to archaeologists and researchers for more than 40 years, providing archaeologists access to archaeological sites for excavation and research. These archaeology collections are well documented, and stored in buildings built in the mid 1980s. There are a small number of geological samples in the collections, mostly relating to archaeological sites. With this main focus on archaeology, the procedures and policies developed by the RCU Collections team for archaeological collections, with no procedures for the management, preservation and development of a natural history collection.

The Wildlife and Natural Heritage team within RCU consists of zoologists, botanists, and geologists who provide expert advice on the protection of AlUla's five nature reserves, study the geology, the flora and fauna, and are developing museums and visitor centers to highlight the globally important wildlife that can be found here (Figure 4). The team have developed several research projects in the region, studying the wildlife and geology, developing new lists of species and detailed geological maps. Working with external experts to collect and identify species and geological

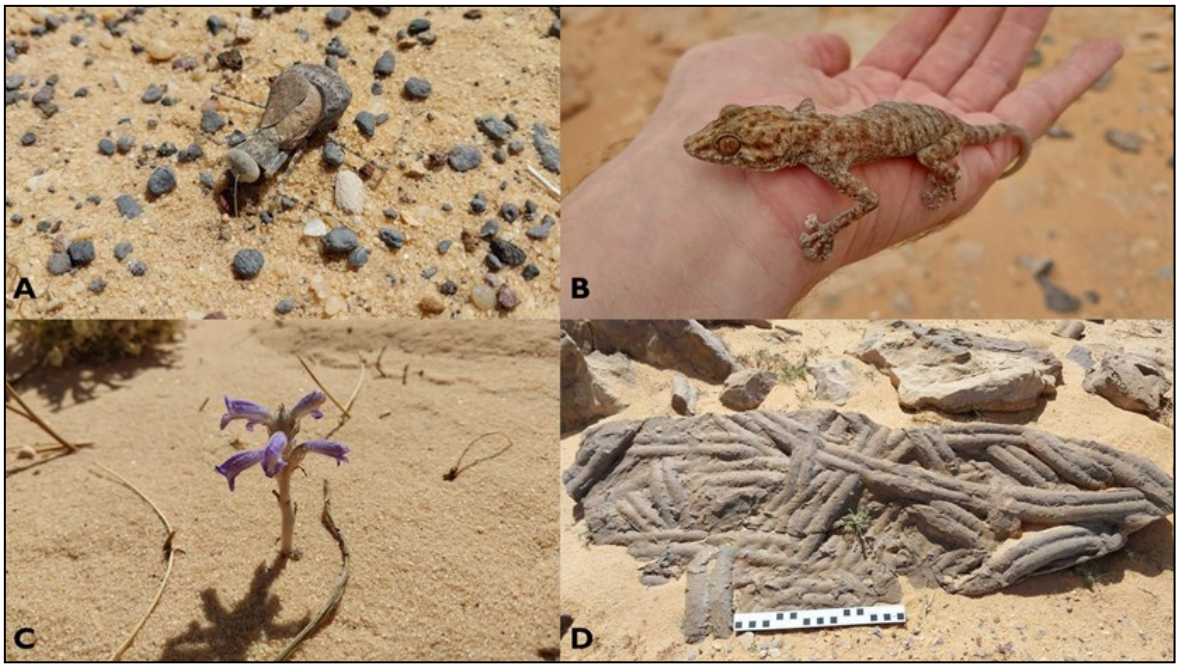

*Figure 4. A selection of the natural history of AlUla. (A) Pebble mantis (*Eremiaphila zetterstedti *Beier, 1942). (B) Fan-footed Gecko (*Ptyodactylus sp. *Anderson, 1898). (C) the parasitic plant, nodding broomrape (*Orobanche cernua *Löfling, 1758). (D) Cruziana trace fossils. (Photos Jan Freedman)*

samples, the team is beginning to build a large natural history collection.

As the external experts are brought in on contract from a range of institutions and companies around the world, there was a strong need to begin standardising the methodologies for collection, preparation and storage of specimens to ensure that they were prepared and preserved in the best possible conditions to answer our research questions and for exhibition development. The current archaeological procedures and guidelines were not written to cover natural history collections, so the authors, supported by colleagues in the Wildlife and Natural Heritage team, have begun to develop best practice guidelines for natural history collections. The aim is to standardise all the collecting of natural history collections, so that they are deposited with all the data associated with the specimen, and stored in the best way so as to preserve them for RCUs future research and exhibition programs.

Developing best practice

AlUla presents a number of unique challenges for storage and management of natural history collections. These include the lack of infrastructure for storage, lack of experienced and professional staff to prepare and manage these collections, and the varying standards that are being applied to the collection and preservation of these collections. By 2026, RCU will have established a centralised storage facility, developed to LEED Gold, Estidama Pearl 4, which guides and rate the sustainability performance of a given development throughout its lifecycle from design through construction to operation.(AbdelAzim and Aboul-Zahab, 2017; Ongreening, 2024).

Natural history collections are not only an important record of a country's ever-changing biodiversity, but an important resource that can be used to preserve ecosystems at risk and to rebuild a damaged ecosystem (for example see, Lane, 1996; Lamov, Keith, and Hochuli, 2009; Alagon, Sandlos, and Wiersma, 2012; León-Lobos, *et al.*, 2012; Arzuza Buelvas, 2018; Gann, *et al*., 2019; Wildman, *et al*., 2022) The development of a properly integrated collection based natural history facility is important for the future management and preservation of the Saudi Arabia's biodiversity: such a storage facility would provide an important central resource for biodiversity and collections-based natural history research in the region. The new natural history collections will preserve a morphological and genetic record of the region's biodiversity.

To ensure the collection is fully representative of AlUla's biodiversity and geodiversity and safely preserved for the future, the following elements are required:

- A fully integrated strategy that aims to preserve the bioinformatical and geo-informatical data and objects, in the landscape, nurseries and collections of AlUla.
- Detailed understanding of the different data sets, samples and materials needed to fully record the biodiversity and geodiversity of the area.
- Resources to preserve the collected samples, and associated data sets that are a record of the region's environment.
- Experienced and knowledgeable staff who can ensure the maintenance and development of these objects and data.
- Facilities for staff and appropriate housing for the collections to ensure they are preserved for the future.
- The infrastructure to ensure that the data and collections are fully integrated and accessible to regional, national and international users.

There are relatively few collections based natural historians working in the Kingdom of Saudi Arabia, and no national collection. With the exception of the Geological Survey of Saudi Arabia, geological collections, and small herbariums in the Jazan Region, and in Riyadh managed by the National Center for Vegetation Cover, there are very few natural history collections which safeguard the country's fragile biological or geological diversity to international standards. Consequently, there are no facilities available to properly prepare and store the range of materials and objects and few trained staff that can prepare and maintain these collections to global standards.

A critical element of developing such a collection is to have staff who are knowledgeable about the long-term preservation and management of these collections. These staff will need a range of skill sets from taxidermy and plant mounting, to DNA sampling and collection storage and preservation. There are very few preparation and conservation staff in Saudi Arabia who are experienced in managing and working with natural history collections. RCU is therefore developing a new group of young, trained staff to support the management and preservation of these collections, alongside natural history specialists within the RCU Collections Section ho are working hard to conserve the regions fauna, flora and geoheritage.

There is no integrated methodology or strategy for collecting and preservation of collections and natural history materials across in Saudi Arabia. Similarly, the materials and equipment needed to correctly store and preserve the wide range of natural history collections are very difficult to source inside the Kingdom and generally need to be imported from outside Sadui Arabia. RCU is currently implementing a coordinated strategy for collecting which combines a collecting strategy with the future use of collections as Voucher, Research or display materials. The aim to ensure the preservation of collections for future generations with relevant staff, storage and technical facilities required to support these collections.

Standards and best practice applied in Saudi Arabia?

RCU's current approach to collection and storage is on a project-by-project basis. The collecting and packaging techniques are ad-hoc and based on the established practice of the differing groups contracted in to undertake field work and collecting for the research project. RCU outsources most of its activities to external companies, including Biopolis and RBG Edinburgh who bring their own 'best practice' to the collection development activities. Importantly there is no agreed protocol to manage the objects from field to storage, which would ensure that objects are correctly tracked into the collections, undergo a coordinated preparation and preservation process, and then stored in the correct environmental conditions to ensure their stability. While the collecting practice is to a high international standard, the packaging, storage, and process for moving the specimens to RCU storage for research need to be improved. The lack of agreed pipeline processes for handling, sampling and stabilising these, in particular when the research teams plan to undertake a range of morphological and genetic studies on these items, can lead to loss of data.

At the beginning of 2023, RCU held a workshop in Paris to review natural history collection conservation and collecting standards, working with staff from the Wildlife and Natural Heritage team, the French partners of RCU, AfAlula, and several external experts who had worked with RCU in the past. Our aim was to improve RCUs approach to the collection, storage and sampling methodologies, and to improve its data collection and retention.

The workshop defined the need to develop:

- standards that reflected the needs of the natural history collections collected in a dry desert environment.
- service contracts to develop better delivery of collections care and collection management.
- develop training in natural history conservation and collections management.

Object Stability and the environment

There is a lot of material in the literature about best practice environmental conditions for storing natural history collections (for example, see Child, 1994; Carter and Walker, 1999). However, although they can be treated as initial guidelines, they cannot be followed for preservation of many types of natural history specimens that are collected in AlUla region, as the environment outside is very different to other regions of Saudia Arabia, and the regions from which traditional conservation standards are derived. Generally, conservators have observed that organic and inorganic material, from AlUla are found to be more stable at a lower RH range than would be considered practical for items in a collection developed and stored in for instance, in Europe or North America. While they are more brittle, material was seen to deteriorate more quickly even after slow acclimatisation to what would be considered standard humidity levels of 40-60% relative humidity. Because the stability ranges of materials collected in the region appear to be different to those traditionally found in Europe or North America, RCU has developed environmental guidelines for items collected in AlUla. These initial guidelines show how we are having to review our approaches to stabilisation and storage of collections and rethink how we collect and then stabilise and store natural history collections.

The environment in AlUla is dry, over the last few years ranging between 18 and 28 % RH, with external temperatures ranging from the low single figures during the night-time in winter to the high 40s and low 50s in high summer. The climate is also changing and over the last 18 months the area has seen increasing rainfall which has changed the environmental conditions so that in the last year average humidity has been rising to 35% RH in the spring and early summer months.

Traditionally, collection storage rooms have only been temperature controlled, as most materials collected from the area are more stable at the lower relative humidity conditions that they are found in, and transferring them into higher humidity environments causes serve problems. Because there was only seasonal change in humidity outside, the collection storage environment very much mirrored the relative humidity's outside conditions. As there is no humidity control in place, and collection spaces are being subject to broader ranges of humidity, collections teams are now starting to observe changes in collections that were not seen in the past.

To document the changing environment and to enable the teams to assess the effects of the changing climate on collections, RCU has developed an integrated environmental monitoring platform to track the changes in climate across the county, both outside and inside buildings. The data from this system is helping the conservation teams to put in place better passive environmental control mechanisms that improve our management of the storage environment, while also meeting our goal to keep energy usage down and maintain a sustainable storage environment.

Staff are now reviewing how we can adapt 'international best practice', for the preservation of the range of natural history materials. The starting point for this has been the Clothworkers best practice documentation, which looked at the standards currently being used in Europe and North America for preparing and conserving natural history materials (Collins, 2015). The best practice documentation is based on information collated on Botanical materials (for example, Royal Botanical Gardens, Kew, 2023), DNA sampling and storage pipelines, skins and osteology, herpetology, wet collections (Cersoy, *et al.*, 2020; Neumann *et al.*, 2022), entomology, and geological materials (Garret, 1989; Duckworth, Genoways, and Rose, 1993; Child, 1994; Carter and Walker, 1999). These standards are being drawn into a new guideline for natural history collections in the Kingdom of Saudi Arabia, that will define best practice in terms of documentation, preparation and preservation and storage techniques. These standards that are being developed by RCU are by their nature, 'living documents' that are reviewed on a yearly basis and updated as the teams learn more about how to stabilize objects to maximize the data they hold and a new pieces of data are required. This work incudes the development of pipeline process maps required to ensure objects are better preserved for research e.g. DNA, proteomics etc., and exhibitions and display, so we can build a more sustainable collection that is of practical use for future generations (Rogers, *et al.*, 1990; Hammond, Spanswick, and Mawn, 1996; Gemeinholzer, *et al.*, 2011; Campbell, *et al.*, 2012).

Examining current published best practices for the storage of different types of natural history collections, such as those mentioned above, allow for baselines to be worked from, and developing these standards to suit the environment specific to AlUla. This will also enable the teams collecting natural history specimens in the field to ensure when materials are collected on contract that there are standardised and agreed practices in place to ensure that holistic preservation of objects and their proper documentation. This not

only includes the storage, but also the labels that are associated with the specimens when they come into the RCU collections. Historic locality information has been incorrect, misspelt, or not complete (McEachern and Niessen, 2009), so any collecting that is undertaken includes templates of labels that will be used for each specimen.

The new best practice guidelines being developed will include:

- Collecting policies highlighting the types of material we want to collect for future research and education uses.
- Standardised labelling for all types of natural history collections, so that researchers or external organisations undertaking field collection will collect with the correct information.
- Environmental standards for preservation and storage natural history items and associated Samples.
- Pipelines for collection, packaging, processing and handling of natural history materials.
- Preparation procedures for herbaria, zoological and entomological items.
- Conservation and Preservation procedures for natural history.

These new guidelines will also define protocols and control mechanisms that are being developed for a new collections facility in AlUla. The new 25,000 m2 facility will be the first Collection and Conservation Facility of its type in the Middle East. Benchmarked against a range of international facilities including, Smithsonian, Museum Support Centre (MSC), and Louvre Liévin, it will include 5000m^2 footprint for storage space. This new collections store will include dedicated DNA storage space , plus dedicated and specialist space for herbaria, geological and palaeontological, and zoological collections. This will be a unique facility for collections support in the Middle East that will provide new benchmark conditions for preservation of natural history collections as well as a center for developing training courses in natural history collection preservation in the middle east.

Summary

The Kingdom of Saudi Arabia does not have published guidelines or standards for collecting or storing natural history collections. These procedures and protocols that are being developed for the collections in AlUla can be used as a best practice for the safeguarding of collections in the Kingdom for the future. This is the time to develop procedures and policies for natural history collections for RCU. Because natural history collections here are very new, there are very few historic backlogs, or poor collections that need serious conservation work. Producing collecting policies, labelling standards, and conservation standards now, means that all collections will be collected and stored in the best possible conditions, preventing any deterioration of the specimens.

Several global digitization programs have amazes enormous amounts of data from museum collections, including iDigBio (Integrated Digitized Biocollections), DiSSCo (Distributed System of Scientific Collections), GBIF (Global Biodiversity Information Facility) and ALA (the Atlas of Living Australia). Recently these organisations are working more closely together to enhance the data available for researchers (Nelson and Paul, 2019). Available online, and accessible anywhere in the world, researchers can use the historic information from museum collections to undertake huge amounts of work, examining habitat destruction, extinction, ecological loss, and climate change, on the global scale (Raes, *et al.*, 2019). However, this global scale research has gaps in the data. In some instances, the data is there, but not uploaded due to time and financial constraints. In other case, the data is not there because it hasn't been collected yet, like in Saudi Arabia. There is a huge gap in the global record for zoological, botanical and geological specimens across Saudi Arabia. Historically there have been very few collections amassed, and even less made available digitally. Developing natural history collections in AlUla not only helps understand the biodiversity and geodiversity at a regional level, but also at the global level, and the data that is associated with thee specimens will enhance the studies by researchers around the world.

There is a richness of wildlife and geology that has only very recently been opened up for research in the Kingdom of Saudi Arabia. By developing collections here, there will be a baseline for conservation initiatives and long term strategies to help protect environments across the region. Additionally, these collections provide a rich archive of data that cannot be found anywhere else in the world.

This has created a unique opportunity to develop best practice standards from the beginning. These collections can be used for research, education, display and more, and by working towards best practices that are developed for this unique environment, will ensure that these specimens are preserved for the future. The richness of the biodiversity and geodiversity is only just beginning to be explored.

Acknowledgements

Thank you to the support from our colleagues in the Wildlife and Natural Heritage Team. Thank you to Ingrid Périssé and Margaux Falciasecca at Afalula for organising and hosting the collecting procedures and policy workshop in Paris in January 2023. Thank you to the two reviewers for their useful comments on improving this paper.

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The well-travelled octopus: from Dunedin to Dublin in 1886

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Received: 14th Aug 2023

Accepted: 7th Jan 2024

Citation: Crane, R. 2024. The well-travelled octopus: from Dunedin to Dublin in 1886. *Journal of Natural Science Collections.* **12.** pp. 96-104.

Abstract

A large octopus *Macroctopus maorum* (Hutton 1880) (NMINH:2009.53.25) was bought in 1886 by A.C. Haddon for the Dublin Museum. It had been preserved using hot-glycerine an innovative method devised by T.J. Parker in Dunedin. This article traces its passage from one side of the world to the other through the auspices of Julius von Haast, New Zealand Commissioner for the Indian & Colonial Exhibition (1886), London. The preservation technique used by Parker, an evolutionist, zoologist and museum curator is described. Private correspondence between Parker, Haddon and Haast are complemented by contemporary newspaper reports in this account of late-nineteenth-century museum natural history.

Keywords: A.C. Haddon; Dublin Museum; T.J. Parker; Otago Museum; Indian & Colonial Exhibition (1886); Julius von Haast; glycerine preservation technique; octopus; nineteenth-century science

Introduction

It is uncommon for the details surrounding individual nineteenth-century museum specimens to survive. Most often legacy specimens are without any documentation and sometimes only the barest detail about acquisition survives. This scenario is all too familiar for anyone working in natural history museums. The corollary is also true, historians come across information about specimens but cannot match it with extant collections. The story presented here re-connects an octopus (NMINH:2009.53.25) with its past. In compiling information about the history of Otago Museum, I came across correspondence from T. J. Parker concerning an octopus that he had sold to Dublin. Paolo Viscardi (Keeper of Natural History, National Museum of Ireland) responded quickly to a request for information with pictures of the same beast which had been in place since the original sale (Figure 1). The rest as they say is history.

This article contributes to the recent interest in provenance research applied to natural history specimens. The octopus made the 19,000km journey from Dunedin to Dublin in the mid-nineteenth century, via the Indian & Colonial Exhibition held in London. The title of the exhibition conveys the essence of colonialism and the octopus was part of the deep interest in collecting and displaying specimens. This was integral to the process of exploitation, colonisation and economic development of the youngest British colony - New Zealand. It was a distinct curio and gazed at with equal wonder by naturalists and non-naturalists in Dunedin, London and Dublin.

*Figure 1. Preserved New Zealand octopus, (*Macroctopus maorum*, Hutton 1880) (NMINH:2009.53.25) on display at the Natural History Museum of Ireland, Dublin before being removed for conservation in 2020. (Photo: Paolo Viscardi)*

Historically, the men of science controlled, catalogued and measured the octopus as they did with other creatures. Such inventory science practices can be viewed as a step in the colonisation process, but the octopus was also the focus of a significant commercial transaction. Natural history trading of individual specimens conducted by the sober, educated men on both sides of the world engaged in museum-building was part of a large commercial enterprise (Ville 2020).

Background

Thomas Jeffery Parker FRS (1850-1897) came to Dunedin in New Zealand's South Island in 1880 to take up an appointment as Professor of Biology at the University of Otago. He was one of fourteen candidates for the dual position (Anonymous 1880c) of Curator at the University Museum: one of the others was Alfred Cort Haddon FRS (1855-1940), but Parker had more experience and better connections than the slightly younger man (Haddon, 1880). Parker had worked for Thomas Henry Huxley FRS (1825-1890) in South Kensington for the previous eight years as a demonstrator.

While there in the 'intervals between the courses of instruction he organized a teaching collection' of specimens and began a programme of research (Howes, 1898). The appointments board was based in London under the aegis of the New Zealand Government Agent and was chaired by Huxley. Parker's arrival was eagerly anticipated in the colony, which had only been formally settled by Europeans in 1848, 'Otago is fortunate in obtaining in the new Professor a pupil of the most eminent living English biologist,' a local reporter enthused (Anonymous 1880b, Anonymous 1880a).

Most New Zealand colonists took a utilitarian view of science, regarding the activities of scientific workers with approval insofar as such work had obvious practical benefits. The results of the year's activities of the Otago Institute 'to mankind are recognised as eminently beneficial, not merely in the actual accumulation of knowledge, but also in adding comforts and facilities to life,' proclaimed the president, Alexander Montgomery (1862-1933) (Anonymous 1883). This utilitarian view of science adds weight to the nineteenth-century

presumption that science viewed either as knowledge gained, or as an activity, was a mark of progressive cultural achievement. To nineteenth-century minds, the progress of science from 'primitive superstition to complete understanding' linked inextricably to the notion of societal progress and nationhood (Kohler, 1999). This belief expressed itself in zoology in the desire to list the nation's fauna.

Parker played his part in such cataloguing, or inventory science, and described a new species of sea cucumber giving it the name '*Chirodota dunedinensis* n.sp.' presumably in honour of his new home (Parker, 1880):it is now called *Taeniogyrus dunedinensis* Parker, 1881 (WoRMS, 2023). Parker puzzled over the oddity of New Zealand's creatures and wrote articles based on a stranded oarfish, kiwi, and extinct moa (Parker, 1886a , Parker, 1892b , Parker, 1891a). The kiwi, he wrote, 'is the most anomalous and aberrant of existing birds and … may be considered as one of the proudest possessions of our colony' (Parker, 1891b).

Beyond opportunistic and inventory science Parker sought to understand evolution. 'With the publication of the *Origin of Species*, in 1859, a better day dawned for biology,' Parker pronounced in a public lecture to inaugurate the new session of the University in May 1881 (Parker, 1881a). It was a 'better day' as far as Parker was concerned because Darwin had 'by the immense array of well-arranged facts and sound generalisations' brought the study of biology 'within the all-embracing law of evolution, thus making belief in the theory of special creation once [and] for all impossible to the student of nature' (Parker, 1881a). While the underlying doctrine of evolution formed the theoretical basis zoologists seldom debated the mechanism amongst themselves (Bowler, 1989). Parker's particular contribution to the science lay in an investigation of the phylogeny of the moa family (Dinorthidae), the developmental embryology of kiwi (*Apteryx spp.*) (Parker, 1891a; Parker, 1892a; Parker, 1895).

The Otago Museum opened its newly built neo-classical doors in 1877 with an array of material left over from the Dunedin Industrial Exhibition held in 1865 (Anonymous 1877; Crane, 2017). Parker set about imposing order on the collections and acquiring as much as possible, as quickly as possible. By 1882 a local reporter noted that Parker 'had a mania for skeletons' (Anonymous 1882) (Figure 2). This apparent mania was driven as much by Parker's teaching responsibilities as by his research preferences. He held classes in the museum for those studying zoology as well as those who were compelled to study a course of comparative anatomy for their medical degrees. He determined that his students should have access to 'a collection in which each of the main groups of animals is represented by one or more examples' (Parker, 1885b). As an ardent evolutionist, Parker set about re-creating teaching methodologies he had learnt in London and advocated a practical hands-on approach rather than book learning. Parker was absolutely wedded to the Huxleyan method of using typical examples from each major taxonomic group. So much so that he wrote a major textbook with his friend and counterpart based in Sydney, William Aitcheson Haswell FRS (1854-1925). Much altered through

Figure 2. Interior Otago University Museum, taken about 1885 showing Parker's 'mania for skeletons'. (Photographer: Burton Bros. Te Papa C.011760)

several editions, this unimaginatively titled *A Textbook of Zoology* is still in print over 120 years later (Parker and Haswell, 1897; Crane, 2015). They used typical animals as the basis for each chapter to explain the diversity of life and many of them, like the cuttlefish (*Sepia cultrata* Hoyle, 1885) were antipodean examples.

At monthly meetings of the Otago Institute held in the museum, Parker showed new acquisitions to members. This was the local branch of the New Zealand Institute which had been set up under a Parliamentary Act in 1867. This ensured it had some government funding and in this respect was crucially different from British learned societies. The government grant of £500 was swallowed up with the publication of the national and annual *Transactions and Proceedings* however, local branches were expected to be self-financing (Anonymous, 894 , [Various], 1883-1898; Reid, 2007). Whilst the Otago Institute was one of the strongest of the federation of institutes set up under the Act, it nonetheless struggled to attract new members or retain those for whom science was of passing interest. From membership lists, it is clear that members were drawn from educated and professional ranks and included, engineers, teachers, surveyors, clergy, medical men, as well as all the university professors.

The octopus

On 13 May 1884, Parker exhibited a large octopus together with a skeleton of a *Regalecus* sp. Ascanius, 1772 (a ribbon- or oar-fish stranded on a nearby coast) and a small collection of NZ fishes ([Various], 1883-1898). We are not told the species of octopus in the minutes of the Otago Institute but elsewhere Parker calls it *Octopus maorum* (Hutton 1880) (now called *Macroctopus maorum*) (Parker 1885a). The local newspaper reported the meeting, adding typically inaccurate details. 'The scientific and artistic exhibits attracted much attention from the large number of visitors who attended the affair Professor Parker had on view an immense octopus, which measured 9ft across. It would have been an ugly customer to come in contact with when alive' (Anonymous 1884b). It was reported on again a couple of months later 'the collections have been enlarged by the preparation of a considerable number of specimens by the Museum assistants one of the most interesting being a large stuffed octopus from the harbour' (Anonymous 1884a).

Parker capitalized on the large octopus giving several lectures throughout the city comparing it to the largest yet discovered in Newfoundland at 5ft across 'but as patriotic colonists,' he flattered his audience, '[they] would be pleased to hear that we had beaten that record, and that there was at the Museum the other day an octopus with arms 5ft 5in in length, and with, over 300 suckers on each arm' (Anonymous 1885b). A local reporter recorded this fact was greeted with much laughter and applause. As part of his column 'Notes from the Otago Museum' in *Nature,* Parker compared the stuffed (he called it mounted which was more accurate) female octopus with a larger male which he, and Edwin Jennings (the museum taxidermist), were able to measure but unable to preserve (Parker, 1885a). Parker described morphological differences in the number and size of the suckers between male and female (Parker, 1885a; MolluscaBase, 2023).

In 1886 a large international exhibition, the Indian and Colonial Exhibition, was mounted in London. 'The main purpose of the Exhibition is to draw attention to the economical and commercial aspects of the colonies and India; in doing so necessarily the introduction of a considerable amount of science is involved,' the weekly magazine *Nature* reported (Anonymous 1886a). Julius von Haast (1822-1887), the curator at Canterbury Museum in Christchurch was appointed the New Zealand Commissioner and began a process of collecting exhibits from all over the colony. He visited manufacturers and organised shipments from woollen mills, tanners, plumbers, jewellers, leather workers, meat refrigeration and preserving companies, fish-curing establishments, soap & candle makers, furniture makers, and from the governmental Public Works department a collection of building stones. He was pleased with his efforts as the promises of support 'had surpassed expectations' (Anonymous 1885a). In Dunedin Parker and Jennings collected several of their best examples of glycerine-preserved mounts which they had made over the preceding three years. Parker wrote to Haast with a long list of things: 'The collection now sent includes 43 stuffed fishes, 99 fishes in alcohol, four cartilaginous and four bony fish skeletons, mounted octopus & 7 or 8 crustacea, & a group of tuataras & mutton birds' (Parker, 1885c).

The bill of lading for Parker's shipment listed fourteen cases and included stands for mounting the larger specimens. Parker advised Haast 'it will be necessary to get in London a support about 4ft high for the Octopus (high enough for people to look underneath)'(Parker, 1885c). Parker suggested that Haast may need help in setting up the displays and informed him he had written to his friend and former colleague in London: 'Mr G.B. Howes,

lecturer on Zoology, at the Normal School of Science, S. Kensington & ask him to call on you at the Exhibition Building and arrange for his laboratory man Redsull to fit up the skeletons & mount the spirit specimens' he also sent a photograph 'to assist in putting up the skeleton' (Parker, 1885c) (Figure 3).

The New Zealand Court successes were widely reported in the New Zealand papers for instance:

> *'Professor Fowler[sic], the President of the Zoological Society, pronounces the skeleton of the grey shark (I think it is) preserved according to a new and highly effective process, by Professor Parker, of Dunedin, the most perfect thing of its kind he has ever seen. The British Museum authorities have already cast greedy eyes at this exhibit. The octopus, preserved, or rather carbolished, by Messrs Jennings and Bourne [Jennings' assistant], has also deeply interested zoologists'* (Anonymous 1886b).

The effort in setting up and sending so many large specimens was rewarded by sales to other museums. Haast organised a lucrative sale for Parker and sold a substantial part of his collection, including the stuffed shark, ribbon fish (*Regalecus*) and other fish specimens to William Henry Flower FRS, Director at the British Museum (Natural History) for a total of £203 0s 0d. (Haast, 1886a). Parker had expected higher prices. 'I think Flower has got a bargain with *Carcharodon* [great white shark] etc. but I would far rather let him have them at a smaller price than I expected than have them returned' (Parker, 1886b). Nevertheless, he was grateful to Haast. 'I am very glad to hear that so many of my exhibits have gone off' (Parker, 1886c). Parker put a different spin, however, on his thank-you letter to Flower: 'I am very glad to hear that you have decided to take some of my specimens, both my assistants & I feel quite proud at being represented in the National collection' (Parker, 1886d). Parker could not disguise his emotional investment in the sale.

Flower was impressed when he initially encountered the cartilaginous fish at the exhibition and Haast passed on the compliment. Haast wrote to Parker, from London during the exhibition: 'your work is very much admired & Prof. Flower told me the other day, that it was funny that they had to come to an Antipodean court to learn something' (Haast, 1886c). But by the time the exhibition closed in November, Flower had lost confidence in Parker's process. Haast wrote to Parker: 'considering that the skeletons were constantly losing the Glycerine, I think I did very well. I saw Prof Flower this very afternoon as he explained his doubts of the skeletons keeping for any length of time' (Haast, 1886b). Parker promptly reassured Flower. 'I don't think you need be under any apprehensions as to the permanency of the glycerine jelly process. The things ought to be kept in a dry atmosphere & looked after occasionally. … my skeletons … remain for months without any sign of "sweating". … If a really impervious coat of varnish could be

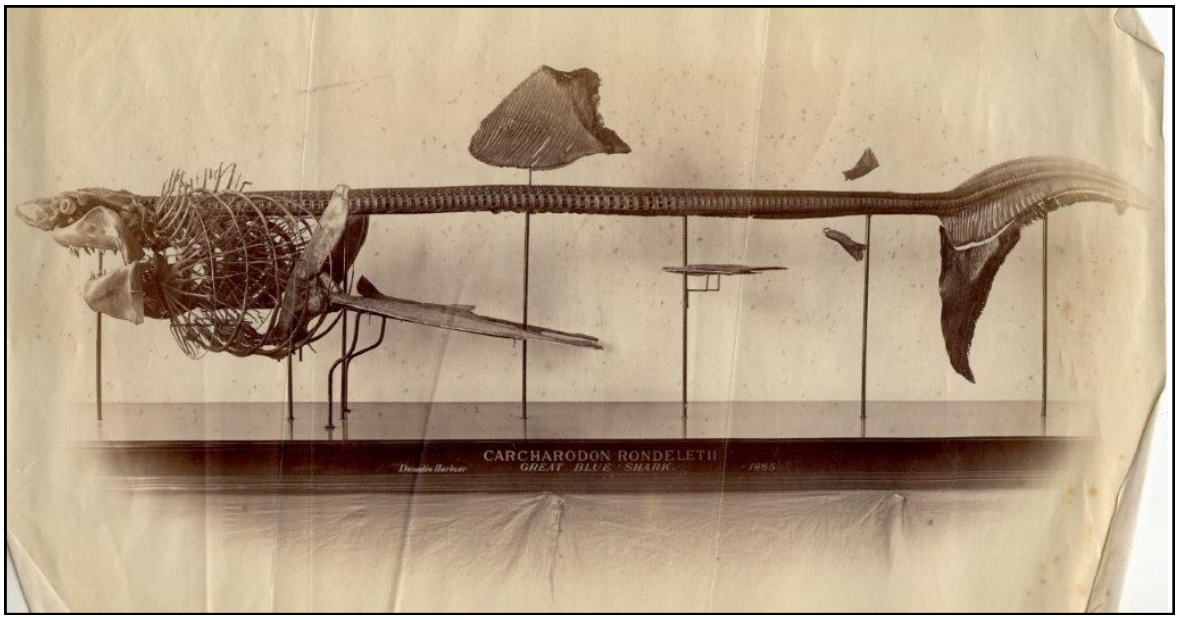

Figure 2. Great Blue Shark Carcharodon rondeletti *(now called* Carcharodon carcharias *L.) preserved using Parker's hot-glycerine method and mounted for display at the Indian and Colonial Exhibition, London, 1886. (Photographer: Unknown. Otago Museum Collections P465-25.)*

given to the whole specimen I [am] certain there would be no more trouble at all' (Parker, 1886d). Four months later, in March 1887, Flower, by now happy with his purchase, wrote to Parker: 'you will be glad to know that your shark is safely lodged in a case in the Great Hall of the Museum. When I removed it from the Exhibition it was in a sad state from the damp having got to it and it was all flabby and dripping. But after a month or two in the dry air of this place it quite recovered' (Flower, 1887).

Haddon had been appointed as professor of zoology at the Royal College of Science in Dublin in 1880 visited England regularly (Fleure, 1941). He visited the Indian & Colonial and confirmed his agreement to buy specimens in October: 'we shall be very pleased to have the Octopus for the Museum for £15. As some other purchases are being made for the Museum in the Exhibition the octopus might be sent along with them. We will, however, let you know in good time' (Haddon, 1886b). Meanwhile, on the other side of the world, Parker was anxiously waiting for news from Haast: 'You don't say anything about the stuffed fishes, spirit collection, octopus and tuataras. If you can get good prices for them all the better, if not I shan't be at all sorry to get them back especially the fishes' (Parker, 1886b). But of course, the sale had been made in the time it took for the letters to be exchanged around the world. Haast dutifully passed the sale information onto Parker: '…. I sold as I think I told you the Octopus to the Dublin Museum for £15 & a portion of the stuffed fishes & spirit of wine specimens to the British Museum & sent the money to your father [who lived in London] I tried very hard to sell the rest of the stuffed fishes but in vain, …' (Haast, 1886b). As there were other things that Haddon bought, he had to make it clear to Haast which Dublin institution was paying for what, so he clarified: 'The Octopus was for the Science & Art Museum the payment of which will be by the ordinary official routine. As the skeletons are for the institutions in the College & the Museum. I enclose a cheque for them presently and will arrange after their allocation on their arrival' (Haddon, 1886a). Parker acknowledged receipt of the payment for the octopus and the fish, 'the money comes very opportunely just now as the income of the Museum is much reduced … Jennings is very pleased that his birds have sold. I received the draft for £203 from my father [the anatomist William Kitchen Parker] who tells me that he has had from you the £15 for the Octopus & will forward it at once' (Parker, 1887). And so, a female octopus made the journey from Dunedin Harbour to Dublin's Dead Museum where it has remained on display ever since.

The process of preservation

The octopus was not stuffed like other taxidermy specimens with a skin moulded over an artificial body as was usual for mammals and birds. Rather, it was preserved using a method devised by Parker of impregnating the tissue with hot-glycerine and subsequently dried. Parker acknowledged a previous method of using glycerine, instead of alcohol, to preserve specimens but took it one step forward (Miall, 1878). Parker's innovation was a long, messy and tedious process. He, and his taxidermist Edwin Jennings, experimented on a range of vertebrate soft parts. The stomachs of a penguin, a cow, a porpoise and even a whale survive in the Otago Museum although they are fragile. Parker cut sections away from the wall of the shark stomach and intestine to demonstrate to students increased surface area that allowed better digestion of food. He was proud of his method and used it mostly on cartilaginous fish skeletons. Even if it was, by his own admission, a 'slow, troublesome and expensive' process it was nevertheless 'well worth the trouble' as it gave the museum specimens that could 'be handled like ordinary skeletons, and at the same time have their form almost unaltered, instead of being either in the form of spirit specimens or in that of the shapeless and brittle abominations which usually do duty for the skeletons of cartilaginous fishes' (Parker, 1881b). Preservation techniques are an aspect of collecting natural history material often overlooked, a point that historian Samuel Alberti makes in discussing what happens to specimens once they arrive at the museum and before they are displayed (Alberti, 2009). Consider the experimentation that went on, the space required for numerous animals in various stages of processing, the patience necessary for weeks of effort for what was an uncertain outcome, and the constant maintenance of the processes by the Parker and Jennings.

For cartilaginous fish the fresh carcass was first cleaned by dissection, then the skeleton and soft parts were placed in methylated spirits for two to three weeks, which hardened them. Sometimes, if the specimen was large, it was cut carefully into parts then transferred to vessels containing glycerine fluid. Parker gave detailed recipes for two versions of the glycerine fluid both used alum and he recommended using only a small amount. One recipe 'A', contained corrosive sublimate (mercuric chloride) and Parker advised using earthenware vessels of various sizes 'I find that a small pudding basin, a vegetable dish, a soup tureen, and an earthenware foot-bath, or "tongue pan," form a very useful series of vessels' (Parker, 1881b). The second 'B' recipe used phenol instead.

Specimens were then soaked in melted glycerine, kept at a steady temperature of about 40˚C for two to four days. Finally, the specimen was drained and stretched across a made-to-measure trellis to dry for several weeks and when the surface was no longer sticky two or three coats of varnish was applied. Parker wrote up the process and published it in the annual volume of the *Transactions of the New Zealand Institute*; he provided information on several of the fish and the selection of internal organs. But exact details of how the octopus was preserved were not included because it had its turn with the hot-glycerine process three years after Parker wrote the paper. He experimented with crustaceans including a crab *Halimus hectori* now called *Trichoplatus hectori* (Decanets, 2023) and acknowledged 'my friend Professor Haddon, when curator of the Cambridge Museum, employed glycerine for preserving Crustacea, but I know nothing of the way which it was used' (Parker, 1881b).

Forty years after Parker and Jennings collaborated to preserve the octopus, the hot-glycerine method was revived by W.B. Benham FRS (1860-1950) the museum's second taxidermist. Edwin Herbert Gibson worked hard to complete a small shark in time for the opening of the new museum being built in Auckland. Benham explained to Gilbert Archey (1890-1974), director of the Auckland War Memorial Museum 'the cartilaginous skeleton has to be supported & tied with silver wire – otherwise the cartilage gets discoloured whenever it touches metal: when I sent a similar preparation to the Biology Museum I charged £20. Gibson is doing the work in Museum time' (Benham, 1929b). It is unclear which institution Benham meant by 'the Biology Museum' but nontheless Archey was happy with the reduced price for a fellow New Zealand Museum and also thankful that it had arrived just in time: 'They are really splendid exhibits and we should like you please to thank Mr Gibson for his fine workmanship, and also for the careful packing which resulted in their arrival here without a flaw' (Benham, 1929a). It was not a method they used often and there are no Gibson preserved specimens in the Otago Museum.

Conclusion

Placing this study in a broader historical context it is clear New Zealand historians have overlooked invertebrates, like the octopus, as a site for the creation of primary scientific knowledge. This octopus is only the second article about the history of New Zealand's invertebrate fauna to emerge in recent years (Galbreath & Cameron, 2013). Reflecting on why this might be the case it is worth noting that colonialism in New Zealand has focussed on Māori or birds. The demise of New Zealand's native avifauna has been laid at the hands of hunter-naturalists like Walter Buller (1838-1906) and Andreas Reischek (1845-1902). The avian collections formed by both men were dispersed beyond New Zealand and their current whereabouts were the subject of a large study by ornithologists at Te Papa Tongarewa Museum of New Zealand (Bartle & Tennyson, 2009). Controversially, Reischek also collected Māori ancestral remains which are now the subject of repatriation claims under government mandate and organised by The Karanga Aotearoa Repatriation Programme operating from Te Papa. (O'Hara 2020; Corlett, 2021; McClure 2022; Te Papa 2024).

The octopus is currently stable and housed offsite pending conservation treatment as part of the Dublin Dead Museum's major rebuilding project. It is hoped that in due course further details about the specimen will be revealed when it is conserved. Doubtless there are further studies that could be undertaken on the specimen itself, but here, for the first time the specimen and its traces in the archives are joined. While it is possible to consider the octopus as an embodiment of colonisation after all it was shown at the Indian & Colonial Exhibition, that was only part of its importance. The commercial transaction forged a relationship between both the Dunedin and Dublin curators. This current research it has re-forged links between the two museums on opposite sides of the world.

Acknowledgements

I wish to thank Paolo Viscardi Keeper of Natural History, National Museum of Ireland and the various archivists at the Alexander Turnbull Library, Wellington, the Auckland War Memorial Museum, the Hocken Collections the University of Otago, and the National Library of Australia, Canberra. My thanks also are due to the editor and the two anonymous reviewers.

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The Deterioration Phenomena (DP) Method: An efficient approach to collection surveying

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Received: 28th Jul 2023

Accepted: 21st Feb 2024

Citation: Royce, K. 2024. The Deterioration Phenomena (DP) Method: an efficient approach to collection surveying. *Journal of Natural Science Collections.* **12.** pp. 105-125.

Abstract

Collection assessments are a well-known and widely employed tool for examining the overall state of a collection and identifying any processes which may be causing negative changes to collection items. As such assessments can be time- and resource-intensive, a well-designed method is critical for easy and effective data capture, analysis, and replication within a reasonable timeframe. The difficulty in striking this balance has produced nearly as many methods as there are museums, but there is still a high degree of subjectivity, ambiguity, and variability in both procedure and result. The Deterioration Phenomena (DP) Method was designed in an attempt to tackle these challenges. It can be quickly performed on an entire or substantial fraction of a collection. This coverage is achieved by recording only the presence or absence of pre-defined visible 'Deterioration Phenomena' (DP). The extent and severity of these criteria are purposefully not determined in order to minimise surveying time, reduce variability due to interpretational bias, and solve the quandary of assigning quantitative values to subjective perceptions. The DP Method has been successfully applied to four mineralogical collections, and provided ample data to determine and understand local deterioration processes. As the methodology is easy to adapt - through selecting DP that are applicable for the items being surveyed - it is hoped that the DP Method will be adopted within and beyond natural history collections to monitor change over time and to elucidate deterioration causes and pathways.

Keywords: Deterioration Phenomena Method; conservation; condition assessment; collection survey; care of collections; natural history collections

Introduction

A condition assessment is a non-invasive survey conducted to systematically examine the immediate condition of an object or collection (Taylor, 2005). Whilst there are various reasons for performing a condition assessment (see Taylor and Stevenson 1999: 20), they are most commonly employed to aid collection management, improve decision-making, and garner additional resources (Taylor and Watkinson 2003; Norris, 2015; Forleo and Francaviglia 2018; Kosek and Barry 2019). As these assessments can be time- and resource-intensive, a well-designed method is crucial for capturing as much relevant and useful data as possible. This is often easier said than done, however; variability can easily be introduced into the process by a number of factors. Be it the object, environment, surveyor, or means of documentation, each affects the reliability of the data being produced if not adequately controlled or mitigated (Taylor and Watkinson, 2007; Taylor, 2013).

Previously developed methods used generic forms (Figure 1) with broad and often ambiguous terminology in order to be applicable to multiple or mixed-media collections. However, such terminology introduces interpretational bias (Taylor and Stevenson, 1999; Taylor and Watkinson, 2003; Taylor, 2013). If criteria are broad, overlap, or are not well defined, their interpretation will vary as each person applies their own frame of reference to determine what the terms mean for a given context (Taylor, 2013). Terms such as 'good' and 'bad' - which are commonly used for ranking condition (Ashley-Smith, 1995; Taylor, 2013; Gioventù, 2018; Kosek and Barry, 2019) - are qualitative and subjective. Most may know what contributes towards 'good' or 'bad', but as there is no standardised definition for either term, each person will define them differently according to their past experiences and knowledge of the material being assessed (Taylor, 2013).

As illustrated in Figure 1b, commonly used criteria do not directly convey what forms of material change can be seen in the object, but rather focus on the potential causes of the change (e.g. chemical or biological agents). This approach introduces interpretational bias (Taylor and Stevenson, 1999), as one is not just recording what is seen, but rather determining what caused the effects and then translating it into the categories of the form. Causes are often difficult to determine as they necessitate inferences and assumptions. This multi-step thought process introduces variability by requiring additional information - such as knowledge of environmental conditions, housing materials, and how these react with objects - that is often not readily available (Taylor and Stevenson, 1999; Taylor and Watkinson, 2003) or is only known to a select group. The surveyor may not fully or correctly understand the potential causes of damage or may only search for the specific causes that confirm their suspicions (Taylor and Stevenson, 1999; Taylor and Watkinson, 2003), resulting in attribution error and false data.

Even if the cause of material change is obvious when looking at the object, others may interpret it differently at a later stage if the cause is not

a

National Museum Condition Survey

Dept.		Location								
Date		Sub-location								
Identity no.	Description	Complete-ness	Integrity	General condition	Stability	Damage	Disfigure-ment	Cons. urgency	Storage conditions	Curatorial assess.

b

COLLECTIONS CONDITION AUDIT

Condition grades:
1: GOOD: Good conservation condition, stable
2: FAIR: Disfigured or damaged, no immediate action
3: POOR: Probably unstable, needs remedial work
4: UNACCEPTABLE: Actively deteriorating

Damage categories:
MAJor structural damage
MINor structural-cracked, bent, loose
SURFace flakes, crazing, lifting
DISFigurement - stains, scratches
CHEMical - acid paper, corrosion, rubber breakdown
BIOlogical - mould, insect, rodent
OLD - sub-standard repairs
ACCretions of dirt, grease, deposits

Survey code: 2002-C Initials: SK Date: 7.7.2002
Collection: COSTUME
Sub-collection: ACCESSORIES
Store: BH-TOP
Location: SC3 S4

			Tick								1-4	
Inventory no.	Object name	Materials	MAJ	MIN	SURF	DISF	CHEM	BIO	OLD	ACC	COND	Remarks
1294-36	Hat	straw, silk	✓								3	
A5434	Hat	silk		✓							1	
A21052	Hat	wool						✓			4	live moth
A5549	Hat	wool						✓			4	" "
A1890-154	Gloves	leather		✓	✓						1	
1995-55	Gloves	wool									1	

Figure 1. Examples of forms used for condition assessments. One form (a.) uses subjective, value-based terminology (from Taylor and Watkinson 2003), whilst another (b.) uses terms more aligned with possible types of material change, but there is still some uncertainty and overlap between the categories (from Taylor 2013).

accurately reflected in the form (Taylor and Stevenson, 1999). An example seen both in Figure 1b (the two wool hats) and Keene (2002) is biological deterioration: "combined with condition grade 4 [it] implies pest infestation or active mould growth" (ibid. 148). Keene (2002) here admits that there are two possible ways to interpret the same results. In the case of the two hats, we only know that they are being affected by an active pest infestation because of the notes. These notes can easily be divorced from the main data (that of condition grade and damage type) during bulk analysis of one or more collections. Thus the urgency of an active infestation becomes invisible beyond the form.

This example evidences that there should be no implied meaning in the survey form, and that specific types of material change need to be clearly differentiated. Thus, the selected criteria should allow for the surveyor to clearly record what is seen in order to avoid false impressions and misunderstandings in subsequent review of the results.

Perhaps the simplest way to ensure clarity is to record the effects of material change, rather than the causes, as effects are easier to identify and document (Taylor, 2013). This can be done by selecting phenomenological (i.e., visually observable) criteria applicable for the collection being surveyed (for examples, see Sully and Suenson-Taylor, 1996; Kosek and Barry, 2019). Although the exact number and terms used may vary between collection or material types, criteria should be specific, mutually exclusive, comprehensive, and well-defined to minimise subjectivity and accurately record condition without collecting redundant information (Sully and Suenson-Taylor, 1996; Taylor and Stevenson, 1999; Taylor, 2013; DeMouthe, 2017; Kosek and Barry, 2019).

A Different Approach

One may wonder whether it is truly possible to objectively evaluate condition, given the difficulty in constructing and performing assessments. However, as the problem of condition is akin to that of damage (Royce *et al.*, 2023) - due to the difficulty in quantifying the subjective - arguably the solution is the same: decouple the tangible from the intangible and focus solely on material changes. This is achievable through approaching collection assessments as a bottom-up process (Figure 2), and introducing a state survey as the initial step within the process in order to more holistically understand a collection.

The first step is a state survey which collects information about the collection's current state via a physical examination. This can be supplemented with analytical tests and imaging, and or a review of surrounding infrastructure (including environmental conditions and housing materials) if any concerns are raised during examination. As Figure 2 illustrates, this survey is the foundation upon which the rest of the assessment is built. It is during this stage that one collects arguably the most critical information, as lacking a clear understanding of the collection's present situation will fail to provide any effective actions. For example, if one sees evidence of a pest problem, but does not investigate whether it is active, what pest species are involved, and what parts of the collection are being attacked, any actions taken could result in a misestimation or waste of resources, all at the collection's expense. Thus it is critical to know collection state to move forward into the other parts of the assessment.

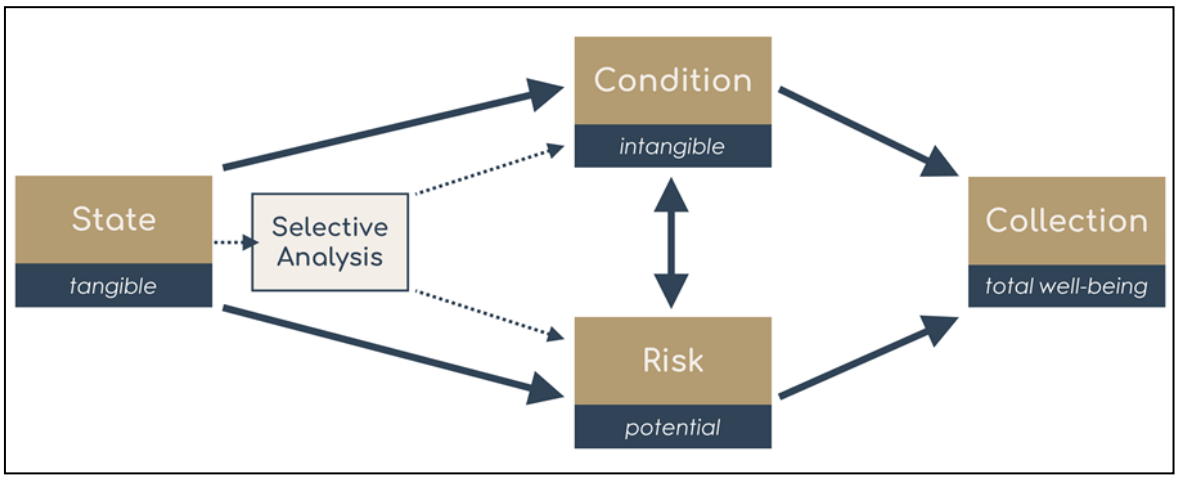


Figure 2. Flow chart illustrating a collection assessment approach.

Separating state from condition not only addresses many concerns regarding subjectivity, but also facilitates data analysis. Whilst data relevant to object state can be recorded in previous assessment methods, the state data may not be extractable or statistically assessable. Having an analysable data set at this stage helps to identify key areas of concern and deploy immediate actions to address urgent hazards (like a pest infestation) and stabilise the collection, if necessary.

Whilst the state survey deals with the physical aspects of a collection, the condition assessment addresses the intangible. This is where aspects such as the object's history and environment and stakeholders' experiences, perceptions, and positions (Royce, 2023) are used to contextualise the collection's state and identify its current values and uses. Information acquired during this phase would be derived from collection documentation (e.g., collection registries, environmental data), institutional documents (e.g., policies, mission statement, exhibition plans), and stakeholder opinions (collected via polls, interviews, social media, etc.).

Whilst state and condition are useful in assessing the current status of a collection, they cannot predict potential future changes. As such, it is critical to include a risk assessment (such as those outlined in Taylor 2005, Waller 2013, and Pedersoli, *et al.* 2016), which uses both the tangible and intangible to make evidence-based predictions of what would happen to the collection were varying scenarios to occur. The data from the state survey is used to identify probable agents of change, likely exposure and outcomes, and any potential synergies between agents. This is again contextualised by the information from the condition assessment, which is used to accurately characterise the magnitude of risk and loss. The results of the risk assessment can then be fed back into the condition assessment - hence the two-way arrow in Figure 2 - to determine how values and uses would change if damage were to occur.

This approach in and of itself is not truly novel; previous collection assessment methods all include the determination of state, condition, and risk to some degree. However, by consciously dividing a collection assessment into these three discrete parts (Figure 2), one can collect the correct information at the right time, and each part can be allocated to different individuals or teams (if the resources are available). When the information from the three parts is united, a holistic understanding of the collection emerges, which facilitates identifying efficacious targeted actions that address priority concerns, be they major revisions to infrastructure or maintenance of current procedures. As this new approach contains a relatively novel element (the state survey), an equally novel method needed to be developed.

The Deterioration Phenomena (DP) State Survey Method

The Deterioration Phenomena (DP) State Survey Method was intentionally designed to collect semi-quantitative and statistically robust data pertaining to the state of collection items whilst avoiding or mitigating the aforementioned biases and shortcomings of pre-existing methods. This was achieved chiefly through its signature feature: the use of phenomenological criteria, named 'Deterioration Phenomena'.

Deterioration Phenomena

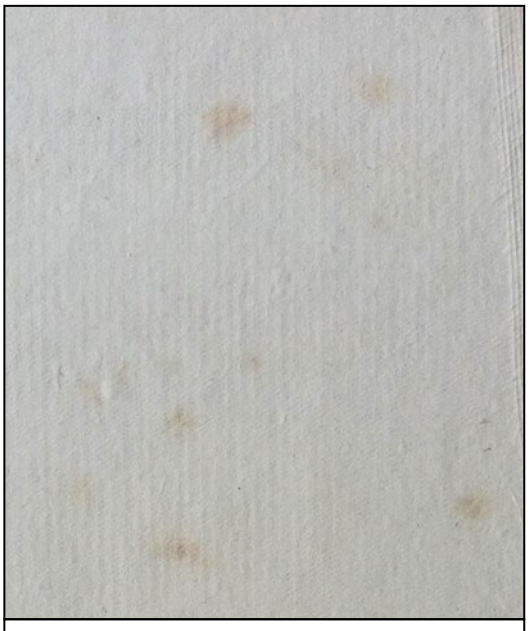
Deterioration Phenomena (DP) are criteria that are visual indicators of material change and are specific to the collection being examined. By selecting DP that are applicable for the items being surveyed, the DP Method can easily be adopted to other collection types, even those beyond natural history.

Some general examples of DP found on a wide range of materials are 'cracking' and 'colour change'. These are important visual changes that one could anticipate to find in most, if not all, collection types. More specific examples include 'dimpled' for minerals, or 'foxing' for paper. Be they specific or general, it is critical that the chosen DP are simply and explicitly defined both verbally and pictorially (Figure 3). This ensures that all parties involved, both in the present and future, have as similar of an understanding of the criteria as possible.

Only the presence (1) or absence (0) of DP is noted. There is no grading, scaling, or determination of the extent or severity of a given DP. This is a very deliberate part of the method's design, first and foremost to maintain one's focus on state, rather than condition. It also essentially simplifies the process to a series of yes or no questions (i.e., Is this DP present; yes or no?), thus avoiding the variability inherent to categorisation. Because categorisation it is a two-step thought process (Taylor, 2013), it necessitates drawing upon external information to classify the observed changes, be in abstract terms (e.g., good, poor, unacceptable) or numerical ('on a scale from 1 to 5').

Categorisation also takes substantially more time than spotting the changes themselves because of

Dimpled
Shallow divots in the mineral surface



Foxing
Orange to brown discolouration of paper, usually away from foredges and present as discrete spots or blotches.

Figure 3. Example DP definitions, each with an image that visualises how the change is exhibited within the select material type.

the degree of thinking involved. This results in spending more time per object, which significantly increases both the total time required to complete the survey and the data's accuracy due to the increased likelihood of questioning one's perceptions and judgements.

Even if the extent or severity of criteria were measured quantitatively, collecting these measurements would still take a significant amount of time and arguably provides too much information. Whilst such information may be important to know for an individual object, it would be superfluous at a collection-scale, bogging down both data collection and analysis. Further information regarding specific material changes can be collected at a later date for selected objects which have been determined to be of concern.

Simplifying the surveying process also allows for it to be completed by non-experts, including volunteers, who may never have seen specific types of objects before and lack the contextual information necessary to determine condition. Thus, a lack of personal familiarity would not necessarily hamper data collection.

Applications and DP Used

For the author's doctoral research (Royce, 2023), the DP State Survey Method was employed on the mineral collections held at four UK museums (Table 1): Oxford University Museum of Natural History (OUMNH), National Museum Cardiff (NMC), National Museums Liverpool (NML), and the Sedgwick Museum of Earth Science (Sedgwick).

A pilot was first performed on 22 of the Minescan Reserve specimens at NMC to confirm that the chosen DP were applicable and sufficiently defined. The specimens surveyed - and those of the Minescan project more generally - are ore body samples from mines across Wales, and were collected as physical records of the local geology. In addition to pyrite, the Minescan specimens are largely comprised of various ore (e.g., arsenopyrite, chalcopyrite, sphalerite) and gangue minerals (e.g., quartz, calcite).

Study 1 was conducted with the systematic mineral collection held at OUMNH with the purpose of corroborating the Mineral Susceptibility Database (Royce *et al.*, 2023) to a museum collection. Study 2 was then performed on the pyrite specimens held at the four aforementioned museums in order to elucidate how pyrite oxidises in the museum context. Preliminary results from both of these studies can be found in the author's doctoral thesis (Royce, 2023); detailed findings are to be published at a later date.

Table 1. Summary of the studies conducted, including details of the collections and the length of the surveys.

Study Number	Specimen Type	Museum	Number of Specimens	Percent of Collection	Time Taken (hr)	Average Rate (spec./hr)
P	sulfide ore bodies	NMC	22	0.7–1.2%	—	—
1	systematic collection	OUMNH	13,716	40%	181	79
2	pyrite	OUMNH	358	63%	6	61
		NMC	482	72%	11	54
		NML	135	52%	3	45
		Sedgwick	298	82%	8	44

Table 2. The evolution of DP applied to subsequent studies.

X = Discarded
X → = Redefined
→ = Retained

Pilot		Study 1		Study 2
Wet	X →	Dimpled	→	Dimpled
		Slumped	→	Rounded
Corrosion	→	Corrosion	→	Corrosion
Tarnish	→	Tarnish	→	Tarnish
Efflorescence	→	Efflorescence	→	Efflorescence
Powdery	→	Powder	→	Powder
Crumbling	→	Crumbling	→	Crumbling
Flaking	→	Flaking	→	Flaking
Pitting	→	Pits	X	
Breakages	→	Breakages	→	Breakages
Cracking	→	Cracking	→	Cracking
Abrasion	X			
Delamination	X			
Porosity	X			
		Dull	→	Dull
		Dark	→	Dark
		Pale	→	Pale
		Opacity	→	Opacity
		Colour Change	→	Colour Change

During the pilot, a preliminary set of 13 DP were trialled (Table 2). Four DP - 'wet', 'abrasion', 'delamination', and 'porosity' - were then discarded as they were not frequently seen in specimens or were difficult to define or identify. This however resulted in no DP to capture specimens which are hygroscopic or prone to deliquescence. 'Wet' was then redefined as 'slumped' (which was later rephrased as 'rounded') and 'dimpled' to capture these specimens. Whist pitting was maintained from the pilot, it was eventually dropped as pits were very rarely seen.

The main difference between the sets of DP used for the pilot and the subsequent surveys is the addition of colour criteria. Although colour is perhaps the most variable and qualitative of an object's properties, it plays a significant role in our visual experience. Changes in colour also often correlate with other changes in an object, especially in minerals (Royce *et al.*, 2023). Thus, it was determined that colour-based criteria would be included, but greater focus would be placed on changes in lightness ('dark', 'pale', and even 'dull') than in hue ('colour change'). This is because lightness is a universally recognised attribute of colour (Kuehni 2003), and changes in lightness are easier to identify and describe than those in hue (or chroma) regardless of one's chromatic vision (i.e., whether one is colour blind or not).

Pre-Survey

The three parts to the DP Method are pre-survey, surveying, and post-survey (Figure 4).

The pre-survey is crucial. It is a time of preparation: of identifying aims and objectives and collecting any pre-existing information in order for surveying to go as quickly and smoothly as possible. The first step is to identify what collections are to be surveyed and why, as these decisions shape how one approaches data collection and analysis. Using Study 2 as an example, pyrite specimens at OUMNH, NMC, NML, and the Sedgwick were surveyed to identify:

1. the state of the specimens,
2. any museum-specific deterioration patterns, and
3. any trends in deterioration which may elucidate how pyrite deteriorates in the museum environment.

Included in this first step is identifying which parts of a collection will **not** be surveyed. For Study 2, only specimens that were recorded to be primarily or exclusively composed of pyrite were surveyed. Specimens which contained pyrite as a secondary or associated mineral (be it with fossils, rocks, or other mineral specimens) were excluded. Additionally, only the specimens housed within the main sequence of drawers were surveyed; (extra)

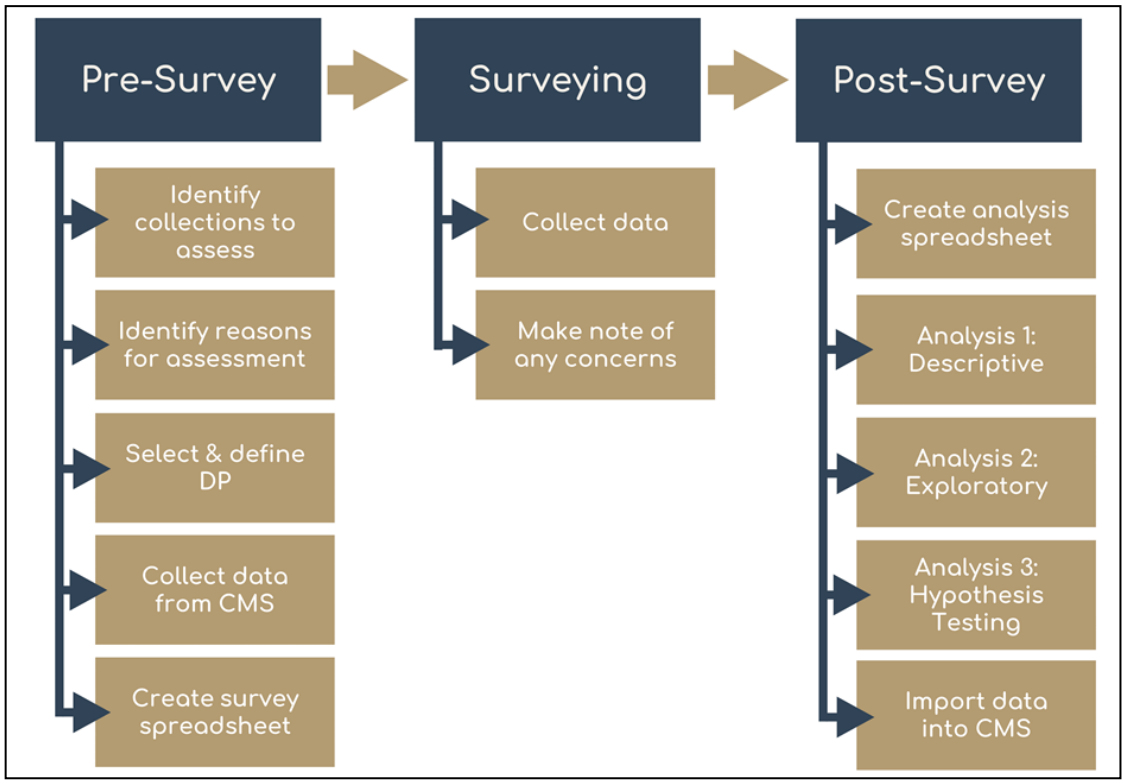


Figure 4. The three phases of surveying and the actions taken during each.

large and prepared specimens (e.g., slides, micro-mounts) were excluded. These choices were made primarily because excluded specimens were often stored elsewhere and would require significantly more time and effort to access.

Once the targeted collections are determined, DP are selected to reflect how the component objects deteriorate. A glossary of the chosen DP (Appendix 1) is then made, consisting of definitions and images like those seen in Figure 3. After this, relevant pre-existing information pertaining to each collection is retrieved from the institution's collection management system (CMS). What is deemed relevant depends on the overall purpose of the collection assessment, but should always include 1.) accession or object numbers, and 2.) the basic name or identifier of the targeted objects (e.g., pyrite, pheasant, platter). These two bits of information are key to ensuring that all subsequent information, including the survey data, is attached to the correct object. For both Studies 1 and 2, the following information was requested:

- accession/object number,
- primary mineral,
- associated mineralogy,
- locality, and
- accession/collection date.

The CMS data is then used to structure and populate the survey spreadsheet, which is divided into 6 main components (Figure 5).

1. **Worksheets** are used to divide the collection into its component groups (e.g., main mineral groups). This avoids having tens of thousands of objects in one worksheet.

2. The **Organisational columns** act as a means of sorting items by how they are found in the store and within the component groups. This allows for one to anticipate what is coming next.
   For example, minerals are often arranged by an organisational system (i.e., Hey, Dana, Strunz), which functions similarly to the Dewey Decimal System used in libraries. In these organisational systems, the main mineral groups are subdivided, either according to chemistry or crystal structure, and each mineral species is assigned a (alpha)numeric identifier. If a collection is arranged by such a system, one can sort the survey spreadsheet by the species identifier and then accession/object number. This allows for specimens that are stored together in the drawer to appear together in the spreadsheet, speeding up data entry.

3. The **Location columns** contain information pertaining to the objects' exact location in the store (i.e., cabinet, drawer, and or shelf).
   If this information is not already known, collecting it during the survey will prove beneficial and time-saving when searching for a specific object in the future. Recording the exact location may also be required for hazardous objects (i.e. asbestiform, radioactive).

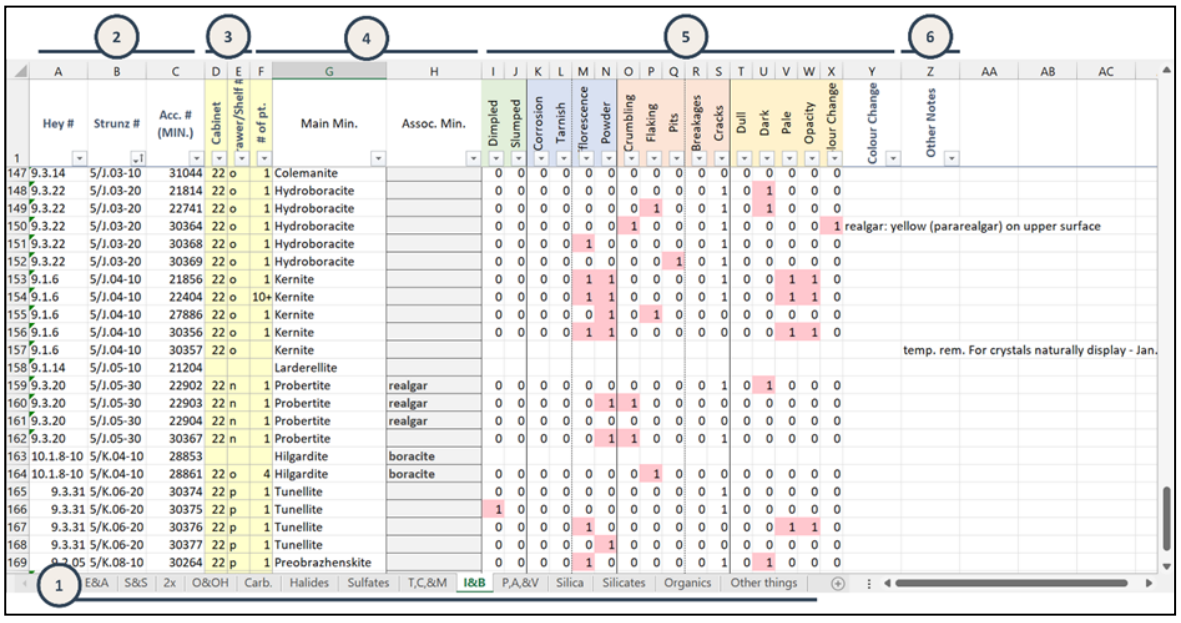


Figure 5. The six components of a (completed) DP survey spreadsheet.

4. The **Identification columns** correlate to immediately obvious visual characteristics (i.e., species, associated materials, colour). These aid surveying by providing visual clues that ensures one is attributing data to the correct object in case of a mix-up in the accession/object number.

5. The **DP columns** are the main data collection fields. Here, one enters either a 0 or 1 depending on whether the DP is absent or present.

6. **Additional notes columns** can be included to document any curatorial or conservation actions that may need to occur. This may include missing labels, specimens, or parts; need for repair or treatment; temporary removal; and the presence of hazardous material.
   An example column one may wish to included is a 'To Action' or 'Priority' column; a field for the rapid identification of objects needing immediate actioning. Ideally, this should be a binary (0/1) field like the DP columns, but institutional gradings can be applied for consistency. These notes columns can be used to identify key areas of concern within the collection and later facilitate resource allocation for collection care and development.

Surveying

Surveying itself is fairly straightforward: examine the object for the presence/absence of the chosen DP then type in the corresponding series of 1s and 0s. It took the author on average about a minute to examine and enter the data for each specimen (Table 1). Whilst there are no true time restrictions for examining an object, one should spend only as much time as necessary to identify DP in order to mitigate questioning one's perceptions.

Whilst the DP Method was designed so that one could survey every object in a collection, doing so is not always feasible or necessary. For both Studies 1 and 2, certain specimens were not examined; namely those stored in microenvironments (both bagged and boxed), bagged for asbestos, or were part of well-represented species (e.g., quartz, calcite, fluorite) that comprised hundreds (and sometimes thousands) of specimens. Microenvironments were not disturbed in order to maintain their climate, assuming they were still as conditioned. Asbestiform specimens and those in anoxia were often double bagged and difficult to examine. The bags often reflected the overhead lights or were not entirely transparent, obscuring detail. The anoxic bags were also only transparent on one side, limiting how much of the specimen could be viewed. As for the well-represented species, the author's personal skipping method was as follows:

If a species contained more than 50 specimens, a minimum of 50 were surveyed in order to use parametric statistical methods. At least 25% (but no more than 200) of each species' specimens were surveyed to ensure sufficient statistical representation. When skipping occurred, whole drawers were skipped. These were selected by a quick scan of all of the drawers and their contents. Those that contained other species were always surveyed. Those which contained many obviously 'worse-for-wear' specimens were flagged, and most (if not all) of these drawers were surveyed. If these accounted for 25% or more of that species' specimens, no further drawers were surveyed. If they did not, additional drawers were included. These were usually those that either contained one or two 'worse-for-wear' specimens, held fewer specimens than the rest, or were not high enough to require using the step-ladder to access.

Post Survey: Analysis

The primary purpose of analysis is the identification of deterioration; chiefly, what types of deterioration are occurring and to which specimens. This is achieved through examining the deterioration phenomena that are recorded as being present. Whether the deterioration is active, however, cannot be determined by visual observations alone and is out of the scope for the survey.

Descriptive Analysis

Analysis begins by identifying how to collapse the data into meaningful subsets in order to identify trends. Subsets can be defined in various ways, but perhaps the most useful for initial analysis is defining the subsets by 1.) species, 2.) object type, or 3.) component group. For both Studies 1 and 2, subsets were defined by the primary mineral species, for which five descriptive statistics were calculated (Table 3). The 20 entries of Table 4 will be used as a worked example to explain this phase of analysis.

After importing the survey data into a new work-book for analysis, the first metric to be calculated is the Total DP ($\sum$DP). The $\sum$DP is the sum of all DP observed in a singular object (i.e., the sum of all the 1s and 0s in a given row). For example, specimen 00201 (sulfur; Table 4) has a $\sum$DP of 2 because two DP ('powder' and 'cracks') were observed. The $\sum$DP are then used to calculate the Average DP ($\bar{x}$DP): the average $\sum$DP of all the specimens being examined. In other words, the $\bar{x}$DP represents the average number of DP seen in a (sub)set of specimens. The $\bar{x}$DP for the ten sulfur specimens listed in Table 4 is 2.

Table 3. The five descriptive statistics and how they are calculated in Excel.

How Data is Being Examined	Descriptive Statistic	Abbreviation	What it is	How to Calculate
Individually	Total DP	∑DP	Sum of DP seen in 1 object *Row Summary*	Formula: SUM
Collection-wide OR *Grouped into Subsets*	Average DP	$\bar{x}$DP	Average DP seen in all objects *Column Summary*	Formula: AVERAGE or Pivot Table, 'Values' *Value Field: Average*
	Number of specimens	# of sp.	Number of objects in a (sub)set *Column Summary*	Pivot Table, 'Values' *Value Field: Count*
	Percent DP	%DP	Percentage of objects displaying each DP *Column Summaries*	Pivot Table, 'Values' *Value Field: Average*
	%DP Patterning	—	Colour coding of %DP to facilitate data examination	Conditional Formatting *Highlight Cell Rules: 'Greater Than' &/or 'Between'*

Table 4. Survey and descriptive analysis results for 20 select specimens (ten each for sulfur and galena). Five DP (Dimpled, Rounded, Pits, Opacity, and Colour Change) were omitted here as they were absent from these specimens.

Mineral	*Sulfur*										
Accession #	00201	00202	04533	04549	04591	04594	08345	10284	10285	10286	%DP
Corrosion	0	0	0	0	0	0	0	0	0	0	0%
Tarnish	0	0	0	0	0	0	0	0	0	0	0%
Efflorescence	0	0	0	0	1	1	1	0	0	0	30%
Powder	1	0	0	1	0	0	0	0	1	0	30%
Crumbling	0	0	0	0	0	1	1	1	0	0	30%
Flaking	0	0	0	0	0	0	0	0	0	0	0%
Breakages	0	0	0	0	0	1	1	1	0	0	30%
Cracks	1	0	0	0	0	1	1	0	0	0	30%
Dull	0	0	0	0	0	0	0	0	0	0	0%
Dark	0	0	0	0	0	0	1	0	0	0	10%
Pale	0	0	0	0	0	0	0	0	0	0	0%
Total (∑DP)	2	0	0	1	1	4	5	2	1	0	x̄DP: 2

Mineral	*Galena*											
Accession #	04965	11059	11071	12827	15289	15427	18712	18922	19281	21516	%DP	**Colour Code**
Corrosion	0	0	0	0	0	0	0	0	0	1	10%	0–24%
Tarnish	0	1	1	1	1	1	1	1	1	1	90%	25–49%
Efflorescence	0	0	0	1	0	0	0	1	0	0	20%	50–74%
Powder	0	0	0	0	0	0	0	0	0	0	0%	75–100%
Crumbling	0	1	0	1	0	0	0	0	0	1	30%	
Flaking	0	0	0	0	1	0	0	0	0	0	10%	
Breakages	0	0	0	1	0	0	0	0	0	0	10%	
Cracks	0	0	1	1	1	0	1	0	0	1	50%	
Dull	1	1	1	1	1	1	1	1	1	1	100%	
Dark	0	1	1	1	1	0	0	1	0	0	50%	
Pale	0	0	0	1	0	0	0	0	0	0	10%	
Total (∑DP)	1	4	4	8	5	2	3	4	2	5	x̄DP: 4	

∑DP and x̄DP are useful in summarising the state of specimens, but they must be used with caution, for they are **NOT** indicators of the extent or severity of deterioration. A higher ∑DP or x̄DP does not always correlate with concerning deterioration.

Both specimens shown in Figure 6 have a ∑DP of 5, but display different DP. The DP seen in the sulfur specimen (Figure 6a) largely correspond to the siliceous sinter matrix in which the sulfur crystals are imbedded, and indicate the matrix's friable nature and susceptibility to physical forces (e.g., poor handling, vibration). The DP of the galena specimen (Figure 6b & c), however, are much more concerning as they are suggestive of surficial oxidation. This oxidation occurs when the relative humidity is greater than 65% (at 20°C) and may potentially lead to efflorescence as the mineral alters to the lead sulfate, anglesite ($PbSO_4$) (Swartzlow, 1933; Howie, 1992). Thus the nature of one's response to change is not governed by a single value but by the "patterns of change" (Kosek & Barry, 2019: 202) formed by the DP.

When reviewing multiple objects of the same type, one determines areas of concern by examining the patterns formed by the Percent DP (%DP). Each %DP is the percent average of the DP's occurrence within the subset being studied; it is the sum of the 1s and 0s of a given DP column (e.g., 'cracks') divided by the total number of specimens being examined, and displayed as a percentage. Three of the ten sulfur specimens in Table 4 were recorded to have displayed a crack of some kind, thus the %DP for 'cracks' would be 30%.

%DP patterning is produced by colour coding the %DP and is used to determine potential reaction types based on the DP observed. For mineral specimens, reaction types may include surficial oxidation, oxidation at depth, pollutant-induced oxidation, efflorescence, surface wetting, and physical forces. These reaction types are then categorised as first or second order depending on the percentage of specimens that exhibit these patterns. First order is a reaction that generally affects greater than 50% of specimens, whilst second order is that which affects less than 50%.

Determining which reaction types may be affecting the collection does require some knowledge of

Figure 6. ***A.*** *Sulfur specimen OUMHN.MIN.08345 is in multiple parts and displays noticeable cracks and crumbs. Efflorescence and a dark soot-like coating is also visible upon close examination.*
B and C. *Galena specimen OUMNH.MIN.15289 exhibits b.) a distinct dull and dark tarnish on all crystal faces, as well as c.) cracking and flaking on the bottom of one large crystal.*
Images used with permission courtesy Oxford University Museum of Natural History.

the material's deterioration, but the reading required to identify which DP to use for the survey may often provide sufficient understanding for correlating signs of change to potential causes. Even simply categorising potential reaction types into 'physical forces' and 'other' is extremely useful and can result in targeted action to address sources of the former.

Exploratory Analysis

During the second round of analysis, supplemental information is included to contextualise the survey data by determining how the peculiarities of an object are related to its present state. Supplemental information may include additional object data (e.g., locality, habit, age), environmental data, results from analytical techniques (e.g., colorimetry), and details of the housing materials. Numerical data can be studied alongside the DP columns, and categorical data can be used to categorise or filter further subsets.

This round of analysis can be classified into two categories: 1.) mapping, and 2.) comparison and correlation (Table 5). The latter can manifest in a variety of ways due to the type of additional information used. Yet both can be considered as preliminary bivariate analysis; the relationship between object state and another variable - such as location - is being explored.

Supplementary Statistical Analysis

The data produced by the DP Method is amenable to statistical methods used to examine intervariable relationships and to test hypotheses. Such examination augments descriptive and exploratory analysis, and can be used to investigate how and why certain changes occur. The exact statistical method chosen will depend upon the question posed. For instance, Student's *t*-test could be used to examine whether there is a statistically significant difference in the state between two similar collections stored in separate locations, whereas Principal Component Analysis (PCA) could be used to examine whether situational variables (e.g., museum, habit, locality) affect specimen state (Royce, 2023). Whether there are indeed any questions, however, will depend on the survey's goals (as identified in the pre-survey; Figure 4) and or the findings of the descriptive and exploratory analysis.

Discussion

Many have asserted (Drott, 1969; Glud and Johnsen, 2002; Xavier-Rowe and Fry, 2011) that - given the lack of staff and other resources - the best way to extract meaningful condition data from large collections is by randomly sampling and surveying no more than 10% of its objects. Yet often forgotten is the fact that sampling is "a compromise measure" (Drott, 1969: 119) that provides at best an approximation, and that it is critical for a sample "to be as representative as possible of the entire population" (ibid., 120). Even though the number of objects surveyed are often in the hundreds when following this approach (Table 6), there remains the question of whether the results are truly representative of what is occurring in the collection, especially when the collection in question is highly heterogenous or mixed-media (e.g., social history and anthropology). Also often omitted from reports is the substantial planning and effort required to not only determine an adequate sample size but also to randomly select and then find the objects to survey (Drott, 1969).

Table 5. Types of exploratory analysis conducted post-survey.

Category of Analysis	**Descriptive Statistic**	**Types Additional Information**	**Purpose**
Mapping	$\bar{x}$DP	Drawer & cabinet numbers	- $\bar{x}$DP are mapped onto the room's cabinets and drawers - Used to reveal hot spots that may indicate sources of deterioration (e.g., leaks, pests)
Comparison & Correlation	- $\bar{x}$DP - %DP Patterning	- Locality - Habit - Housing material - Associated material - Collection or accession date - Analytical data - etc.	- Comparison of %DP patterns according to additional info - Examining relationship between $\bar{x}$DP/%DP & additional info - Used to determine difference in stability &/or reaction types

Table 6. Examples of surveys and the percentage of the collections covered.
** (Exact) values not provided by authors*
† Calculated estimation based on values provided by Kosek & Barry 2019 and the British Museum 2023. The reported survey was a pilot study; assumedly subsequent work will survey a greater proportion.

Collection Type	Number of Objects	Percentage of Collection	Citation
Freeze-dried Leather	660	17%	Sully & Suenson-Taylor 1996
Still Photographs	656	< 10% *	Glud & Johnsen 2002
Homogeneous Objects/Materials	*	2%	Xavier-Rowe & Fry 2011
Mixed Materials	*	5%	
Iron Gall Ink Drawings	100	~ 0.09 – 0.13% †	Kosek & Barry 2019

The DP State Survey Method foregoes the need for such "tedious" (Drott, 1969: 125) sampling procedures due its ability to quickly provide data for large proportions of a collection, regardless of size and variability. As Table 1 demonstrated, 40% or more of a collection can be surveyed in a reasonable timeframe utilising this approach. The DP Method thus ensures greater sampler presentation and provides a firm, rigorous statistical foundation for any subsequent decisions and actions.

The use of phenomenological criteria is what allows for the surveyor to cover more ground. Newey and co-authors (1993) found that surveyors required about a minute to determine and record the condition score of an object (a single criterion). With the DP Method, one can capture the presence/absence of 15 criteria in the same amount of time (Table 1). This evidences that it is possible to collect more data by forgoing the time-intensive thought processes required to determine condition.

The data produced by the DP Method is more descriptive and quantitative than a condition score as well. As previously discussed, condition scores are highly subjective and can imply multiple types of material change. The DP Method results are far less ambiguous; the string of 1s and 0s convey exactly what is and is not present, allowing one to visualise an object's appearance. This greater clarity of object state facilitates:

- analysis of change over time,
- interpersonal review and communication of results, and
- Locating the object at a later date.

This does not mean, however, that subjectivity is completely removed. All survey methods will contain some degree of subjectivity and variability, as survey data is primarily collected via human observation (Royce, 2023). While using the presence/absence binary with visual criteria does mitigate variation induced by categorisation, variability may still occur depending on whether surveyors can see the selected criteria on a given object. Many factors influence vision; having adequate lighting and an unobstructed view can aid observation, but cannot compensate for physiological variation (e.g., colour blindness, astigmatism). Increasing the number of objects surveyed is a means of accounting for this variation; the larger the dataset, the less of an affect an individual observation has. Thus, surveying large portions of a collection has an additional benefit of reducing variability.

Further investigations and developments are still necessary to confirm that the DP Method is indeed more efficacious and advantageous than pre-existing collection surveying methods. In particular, work addressing reproducibility and inter-surveyor variability ought to be conducted (Table 7). Potential studies may include:

- a multivariate analysis of results conducted by multiple surveyors to examine the effects of knowledge, training, or even visual perception, and
- the determination of a minimal percentage required for surveying to adequately characterise collection state.

Table 7. Currently identified areas requiring further development and suggestions for addressing them. From such research, suitable means for the routine usage of the DP Method for collection monitoring could be established.

Areas for Development	**Suggestions for Future Work**
Surveyor Variability and Subjectivity	Comparison of results produced by multiple surveyors with different levels of: - knowledge of the collection (i.e., conditions, history) - knowledge of object/material and its deterioration - training - vision (i.e., focusing powers, colour normal v. colour blind)
Confirming Adequate Characterisation of Collection State	Test of sampling procedures, comparing results for: - different percentages of a collection surveyed (e.g., 10% v. 25%) - variations in what is decided to be omitted from surveying
Reproducibility and Efficacy in Monitoring Changes over Time	Comparison of results produced: - by multiple surveyors - at various intervals in time (e.g., 6 months, 1 year, 5 years)

Conclusion

The DP State Survey Method was developed to produce semi-quantitative, statistically robust data pertaining to object state via the use of phenomenological criteria. The presence or absence of these visual criteria, and the patterns that are produced, are used to characterise collection state and determine any potential reactions occurring within it. By simplifying the process to a series of 'yes or no' questions, greater portions of collections can be surveyed in same amount of time as other methods. This benefits the data in three ways - improved collection representation, increased statistical rigor, and decreased variability - resulting in a better characterisation of collection state.

The DP Method can thus provide greater familiarity of a collection and an improved understanding of a collection's composition, inherent properties, and most common forms of material change. Such insights contextualise survey data, facilitate analysis, and ultimately lead to more informed decisions.

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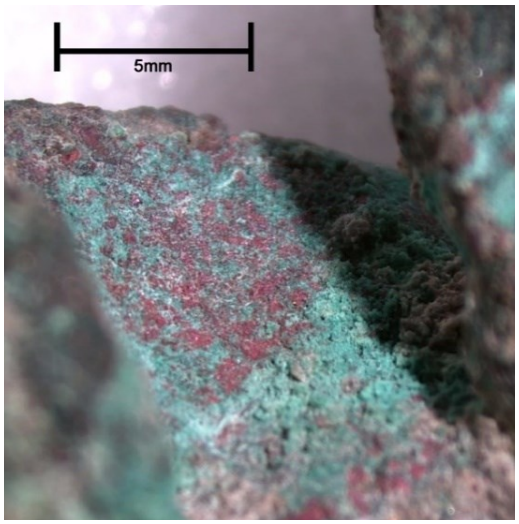
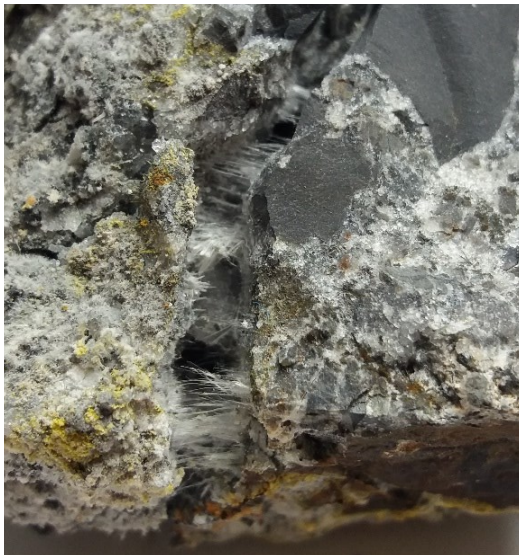
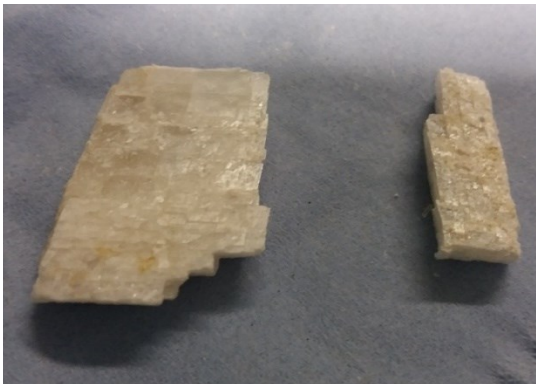
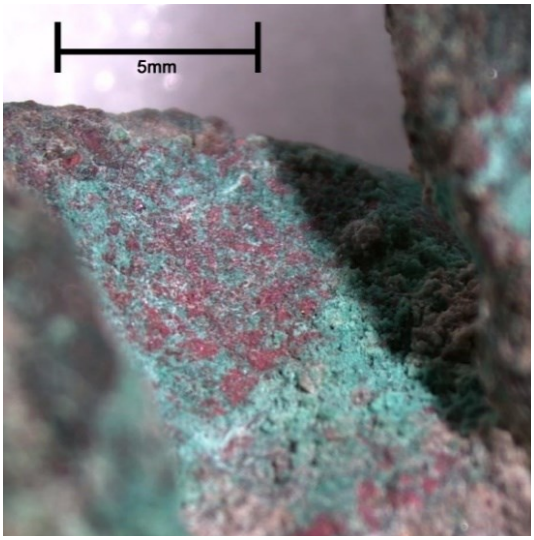
Appendix 1. Phenomenological criteria used during the state survey, with definitions and photographic examples.

Criteria Definition	**Example Images**
Dimpled Shallow divots in the mineral surface	
Rounded Mineral appears 'melted' with smooth edges	
Corrosion Voluminous amorphous products on mineral surface May be localised or extend across a wide surface area	

Criteria Definition	**Example Images**
Tarnish A coating on the mineral surface Coating may be darker, metallic, iridescent, or different colour than the original colour of mineral	
Efflorescence Crystalline growth on surface and or within cracks of the mineral	
Powder Amorphous grit covers the mineral surface Often comes away on glove with touch	

Criteria Definition	**Example Images**
Crumbling Mineral falling apart into many round, distinct pieces, usually of various sizes	
Flaking Mineral surface removed in distinct, angular pieces Denotes flakes free from or loosely attached to the mineral body	
Breaks Distinct pieces have come away from the main body Differs from *flaking* in that the pieces are thicker and more three-dimensional Differs from *crumbling* in that the breaks are usually clean and sharp	

Criteria Definition	**Example Images**
Corrosion Voluminous amorphous products on mineral surface May be localised or extend across a wide surface area	
Cracks Splits in the mineral surface Can be of various length, widths, and depths, but does not go completely through the specimen (depth-wise)	
Dull Lustre of a mineral has changed or become absent (i.e., no shine) e.g., the finish of a metallic mineral has become sub-metallic or is no longer shiny	

Criteria Definition	**Example Images**
Dark Coloured mineral is a darker shade of that colour or black	
Pale Coloured mineral is a lighter shade of that colour or white/colourless	
Opacity Mineral has become 'clouded', translucent, or opaque	
Colour Change Mineral colour altered from one distinct colour to another distinct colour that is not white or black (e.g., blue to yellow), or has developed an iridescence	

Conservation of extensively falling out hairs and feathers in a Rowland Ward's 19th century diorama

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Received: 20th Oct 2023

Accepted: 21st Feb 2024

Citation: Castelain, L. 2024. Conservation of extensively falling out hairs and feathers in a Rowland Ward's 19th century diorama. *Journal of Natural Science Collections.* **12.** pp. 126-135.

Abstract

Pest attacks can lead to severe damage for taxidermy specimens. It is particularly damaging for items that have scientific or historical value. In a monumental diorama signed by Rowland Ward (1848-1912) that had been attacked by moths, important conservation measures had to be carried out. The entire fur of one koala and two fruit bats were completely detached from the skin, and two birds were losing their wing plumage. Fortunately, hairs and feathers were still located in their proper place. Tests were implemented in order to find a solution to preserve and undertake remedial conservation on the specimens. The method needed to be as least invasive and as most reversible as possible, and easily practicable because most of the work had to be done inside the undismantlable diorama (e.g. hair gluing was performed vertically and upside down). A mix of methyl cellulose with white glue was chosen to glue fur, while wings were injected with low viscosity hydroxypropyl cellulose diluted in acetone. The final result was very productive, and allowed for recolouring of the specimens.

Keywords: Natural history; taxidermy; conservation; restoration; adhesive; diorama; Rowland Ward

Introduction

Highly degraded taxidermy specimens can be a serious issue for conservation and restoration in natural history collections. Pest infestations have caused severe damage to taxidermy mounts in museums across the world, with historically specimens showing very sever deterioration. Pests are especially damaging because they eat every type of organic material on a specimen that has not been poisoned. Pests targeting taxidermy mounts can essentially be divided into two groups: dermestid beetles and moths (Pinniger and Harmon, 1999).

In birds, the wing bones and feet are dried flesh, and similarly in mammal taxidermy mounts and study skins, the feet and hands are dried, so these are edible to pests. In most cases, bird skulls are still inside and may attract parasites when they are not perfectly cleaned during skinning. The same is true for small mammals. Hooves, claws and whisker pads are often a source of problems, as well as tails and pads (mammals) and the base of tail feathers (birds) that must be degreased as much as possible. The inner layer of mammal skins is still consumable after tanning when not properly thinned down, and hair will fall out where moths have eaten the thin layers of flesh holding the hairs to the skin. Finally, the plumage can be entirely consumed if not de-greased.

Through centuries many different types of preservatives were used to prevent insect damage (Williams and Hawks, 1987). Alum tanning bath (mammals) and arsenical soap (all animals) were probably the most common techniques used, sometimes combined with other heavy metals (e.g. mercury), leading to adapted collection management in museums (Marcotte *et al.*, 2017). Arsenic is currently not used, due to health and safety issues, and has been replaced with borax and other commercial products.

This paper examines how two different types of taxidermy specimens were treated after very serious infestation within a mounted diorama. Mammal specimens (a koala and two bats entirely losing their fur), and two birds (with the feathers very loosely attached) showed extreme deterioration after pest infestation. It was evident that infestation had stopped a long time ago, probably when all consumable materials had been exploited, thus pest management was no longer necessary. The majority of feathers and hairs were still present inside the case.

The aim of this case study was to find suitable solutions to reattach the fur and the feathers to the specimens. The historic significance of the diorama and the specimens themselves meant that the solutions had to combine sufficient strength and practicability, and at the same time following principles of invasiveness and reversibility.

Background and state of conservation

The case study presented here is part of a larger project: the restoration of a Rowland Ward's 19th century cased diorama displaying 24 animals from Australia, dated from c1892. Measurements without base and pediment are about 2.4 m long, 2 m high and 1 m deep (Figure 1). This diorama is currently held in a private collection.

Rowland Ward (1848-1912) was a renowned English taxidermist, who inherited his skills from his father. He created a famous workshop in the centre of London, The Jungle, where this diorama was mounted. The expanding British empire allowed him to supply museums and collectors with specimens from around the world (Morris, 2003).

Figure 1. Diorama, displaying a large range of species from Australia, before restoration. © TEMA Production, 2022.

The animals of this diorama were collected in Australia during a hunting trip in 1892 made by a Shropshire gentleman named Hugh Lewis Heber-Percy (1853-1925) (Tennants Auctioneers, 2021). Clues obtained from marsupials in the same diorama indicate that the conditions and/or techniques prior to mounting were not ideal; some legs and feet were cut off or covered with extra fur, as was the marsupium of the female kangaroo. It is likely that an improper skinning process led to maceration. The techniques used for preservation in Australia and the conditions during shipping to England are unknown; salt was a common practice, but Ward recommended alum for mammals and Taxidermine for birds (see below; Ward, 1890). Another method consisted of immersing skins in an alum-salt bath ("brine", "liquor", "pickle"; Ward, 1890); skins were arranged in a barrel for storing or transit, or dried and packed after a few days of immersion. But this operation, "*if imperfectly carried out the consequence may be ruinous*" (Ward, 1890). At this time, Australian skins might have been preserved by "*vegetable curing*", a method that Ward (1890) considered to be deleterious. In Ward's book, it is also recommended to pour turpentine onto the fur once the skin was fleshed, preserved and dried, in order to prevent insect attacks before shipping to England. "*I have sometimes unpacked trophies to discover the hair entirely removed from the pelt by the exertions of the Dermestes*" (Ward, 1890). Perhaps dermestid beetles damaged the skins before they arrived in England, but they didn't take part in further damages as none were found.

Ward abandoned the arsenical soap as early as 1890 (Morris, 2003). He developed and sold his own preservative in various forms: (i) Taxidermine n°1 was a paste which recipe remains a mystery, (ii) Taxidermine n°2 was a powder that seems to contain alum (Ward, 1890), and (iii) Taxidermine n° 3 was a special drying powder for birds (presumably borax; Morris, 2022, pers. comm.) that was to be applied after Taxidermine n°1. In the end, it seems that no preservatives are able to prevent pest attacks in the long term, and whatever the preparation method, adequate preventive conservation measures are pivotal (Hendry, 1999).

According to the auction hall which sold the diorama in 2021, the building that housed the diorama became a convalescent home for wounded officers around the first world war, and the taxidermy collection was moved to the stables, that were later converted into a garden tea room (Tennants Auctioneers, 2021), "*cold and damp most of the time*" (Morris, 2022, pers. com.). It is difficult to estimate the role played by humidity in the deterioration of furs: a few traces of mould could be identified on birds' feet and beaks, but it didn't seem to be serious. However, it is clear that it was not stored in good environmental conditions for some time.

Contacting the initial owning family revealed that the case had been opened about twenty years ago (c2000) in order to clean the cloudy inside of the windows and "*remove a very decayed creature*". No other information is available in living memory and archives. Considering that one side glass is not original, and that at least three specimens are missing (indicated by holes and traces in branches), it is more than likely that the diorama case had been opened several times since arriving in England.

In summary, we can conclude to unknown methods of preservation followed by about a hundred years of bad conditions for conservation. The examination of a few moths inside the showcase indicated that the webbing clothes moth (*Tineola bisselliella* Hummel, 1823), the most common species (Querner, 2015), was the voracious destroyer (NHM, undated).

Condition of the specimens

The specimens in the diorama were fixed into the case, with only two animals that were removable, which resulted in the other specimens having to be treated *in situ*. The whole project took about 120 hours, including cleaning, repairing bird feet, hair addition, recolouring of faded specimens, restoration of vegetation and multiple other interventions. The fine work of stabilization of loose hairs and feathers was the main issue and needed some reflection.

Reptiles (a goanna *Varanus sp.* Merrem, 1820, a bearded dragon *Pogona sp.* Storr, 1982 and an undetermined species of python) were in a good condition, except the fingers and hands/feet of the goana where flesh was crumbled between skin and bones. The inside surface of the skin of kangaroos (*Macropus rufus* Demarest, 1822) was eaten, resulting in loss of hair, particularly near the tail. The koala (*Phascolarctos cinereus* Golfuss, 1817) and fruit bats (*Pteropus sp.* Erxleben, 1777) had only the inner side of the skin affected, but, considering the presence of dejections between leather and hairs, the epidermis was also eaten resulting in the majority of the fur falling off (Figure 2).

Birds seemed to be in a very good condition except a few obvious damages (nibbled feet, fallen off primaries). However, it became evident that a

Figure 2. (Left) Hands and feet are the only parts of the koala where hair had fallen off. Fingers were dried but had not been opened during field preservation and process of preparation. (Right) Shedding of all the fur of the koala except around the nose, chin and eyes. © Liévin Castelain, 2022.

major problem was the integrity of one kookaburra (laughing kookaburra *Dacelo novaeguinea* Hermann, 1783) and one tawny frogmouth (*Podargus strigoides* Latham, 1802): skin, flesh, ligaments, tendons and bases of primaries were lost due to the larvae (Figure 3). But nearly all feathers (coverts, primaries, alula) were still located in correct position. These two birds were mounted with their wings open. Two other specimens of kookaburra (blue-winged kookaburra *Dacelo leachii* Vigors & Horsfield, 1827) and frogmouth displayed in the showcase with closed wings were not affected by moths. The Australian pelican (*Pelecanus conspicillatus* Temminck, 1824) was entirely free of any pest damage, with only the structure of small feathers had changed with the light and became brittle.

Conservation of hairs

Hair is a very fine material that is very difficult to reattach to dried skin. Injection was not possible: the risk of soiling the hairs by capillarity was considered too high in combination with a low control of the manipulation. Instead, the fur had to be lifted, the naked leather smeared with adhesive, and the fur put back in position.

Raw leather was used to undertake different testing to determine the best method of reattaching hair for the specimens in the diorama. Sheep skin was used, and it was macerated in water just long enough to make the hair slip. The skin was then fleshed and tanned in an alum bath, stretched on a plane structure and left to dry. After these operations a piece of skin was obtained with the expected texture, i.e. raw leather without hairs like a taxidermy mount which suffered from hair loss.

Different adhesives were applied to find the most suitable solution to reattach hairs, at the same time combining three characteristics: strength,

Figure 3. (Left) Frogmouth wing: bones were cleaned, skin replaced by frass, bases of primaries consumed (the first primary was still in place thanks to an iron wire added upward for the purpose of an opened-wings mount). (Right) Kookaburra wing: wrist zone (shoulder at right, last finger at left) showing that every single feather was separated. © Liévin Castelain, 2022.

Table 1. Tested adhesives with concentrations (v/v = volume per volume, w/w = weight per weight).

Adhesive	Concentration	Cleaning solvent
Methyl cellulose	18,6 g/l **(stock solution)**	Water
Methyl cellulose + ethanol*	Stock solution + ethanol (9 % v/v)	Water
Polyvinyl acetate (PVAc, white glue)	Regular commercial viscosity	Water
Methyl cellulose + PVAc	Stock solution + PVAc (11, 22 and 33 g/l of PVAc)	Water
Methyl cellulose + PVAc + ethanol*	Same as above + ethanol (9 % v/v)	Water
Hydroxypropyl cellulose (Klucel E)	2 % w/w in acetone	Acetone
Paraloid B72	30 % w/w in acetone	Acetone
Paraloid B72	50 % w/w in acetone	Acetone

* methyl cellulose was diluted with water, and PVAc with methyl cellulose stock solution, before addition of ethanol
* stock solution of ethanol is a regular laboratory 96° denatured solution

reversibility and practicability. Polyvinyl acetate and Paraloid are documented for this purpose (Graham, 2014) but it was decided to test also other adhesives commonly used in restoration, i.e. cellulose-based adhesives. Each spot received the same amount of fox pelt hairs.

After drying the hairs spots were removed to assess where gluing was efficient. The area was then cleaned by applying the appropriate solvent (water or acetone) and gently scratching with a soft plastic scalpel.

The tested adhesives and their concentrations are presented in Table 1. The addition of ethanol in water-soluble adhesives aimed to increase their wetting ability; the hypothesis was that a higher wetting ability would enhance the contact between the glue and the bases of hairs (due to increased capillarity; Ben Jazia *et al.*, 2013), and thus the efficiency of the process.

Hairs: tests

As can be seen in Figure 4, the methyl cellulose appeared too weak. The addition of ethanol as a wetting agent was not more successful, with a large proportion of hairs easily removed. Hydroxypropyl cellulose was completely inefficient, contrary to polyvinyl acetate (PVAc) which was the strongest glue and retained hairs against intensive ripping.

Paraloid B72 was the least practicable; 50 % was too thick and the rapidly drying surface did not attach the hairs. 30 % Paraloid B72 was quite efficient but has less viscosity to work vertically. The methyl cellulose-PVAc mix produced very acceptable results, even more so with higher concentrations of PVAc. Similarly to the methylcellulose, the addition of ethanol did not lead to a better result.

With the appropriate solvent, all adhesives were cleanable. Methyl cellulose and mixes of

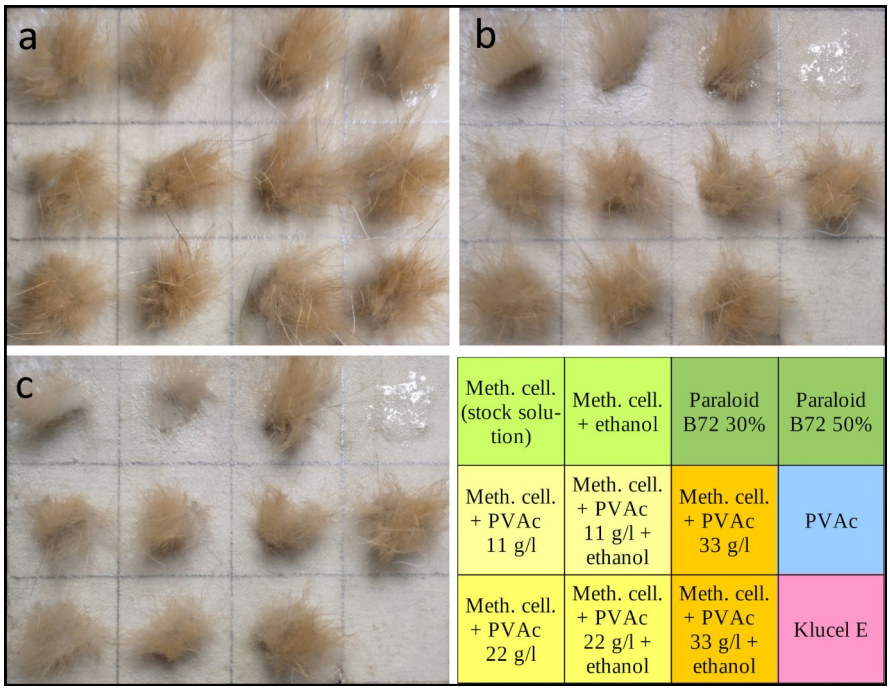

Figure 4. Hairs tufts (a) after drying, (b) after gentle pulling out, (c) after more intense pulling out. Coloured grid corresponding to the adhesives used in the photographs. All adhesives could be easily cleaned by soaking with the appropriate solvent and mechanical scratching. We can see on (c) that Paraloid B72 (at 30%), PVAc and methy cellulose + PVAc 33 g/l (with or without ethanol) are the strongest adhesives.
© Liévin Castelain, 2022.

methyl cellulose-PVAc were entirely and easily removed with water. Paraloid (acetone) and PVAc (water) were more difficult to clean demanding mechanical scratching. Soaking at the base of the tuft soiled the hairs by capillarity, especially with Paraloid, and tufts could be removed (except with Paraloid and PVAc) without substantial damage by pulling out the hairs when adhesives were dried; subsequently, dried glue could be easily removed from the skin.

The final choice was the strongest mix of cellulose-based adhesive (methyl cellulose) diluted in water with a small amount of white glue (polyvinyl acetate, at 33 g/l). The benefits of this mix are the following: (i) the white glue is unnecessarily strong while the cellulose glue is too weak so the mix provides a sufficient result that is still easily removable, (ii) the mix seems to have a good wetting ability providing good attachment, (iii) if necessary, the cellulose adhesive can be thickened in order to acquire the suitable viscosity for vertical working. Regarding the reversibility and efficiency of the adhesive, a higher concentration of PVAc into the methyl cellulose didn't seem necessary.

Koala and bats

The procedure was the following: using tweezers the fur was opened in order to lift the hairs about ~2-3 cm, enough to apply glue on the skin with a paintbrush (Figure 5). The hairs were then placed back and pushing softly with the flat hand to ensure the contact between hairs and glue. This was continued, zone by zone, until completion.

Due to debris and irregularity of the fur coat (hair bases not arranged regularly on a plane surface), it was necessary to test where reattachment was efficient and renew the process wherever required. The whole process was time consuming; about 10 hours for the koala and 15 hours for the two bats, without counting the addition of fur and recolouring.

Nevertheless, the result was very successful. Although hairs were removable when ripped out, they were sufficiently strongly attached to the skin. Not every single hair is actually adhered to the skin. But during the adjustment of colours, no problem was encountered (final result in Figure 6). Further, these specimens will not be manipulated in the closed diorama in the future.

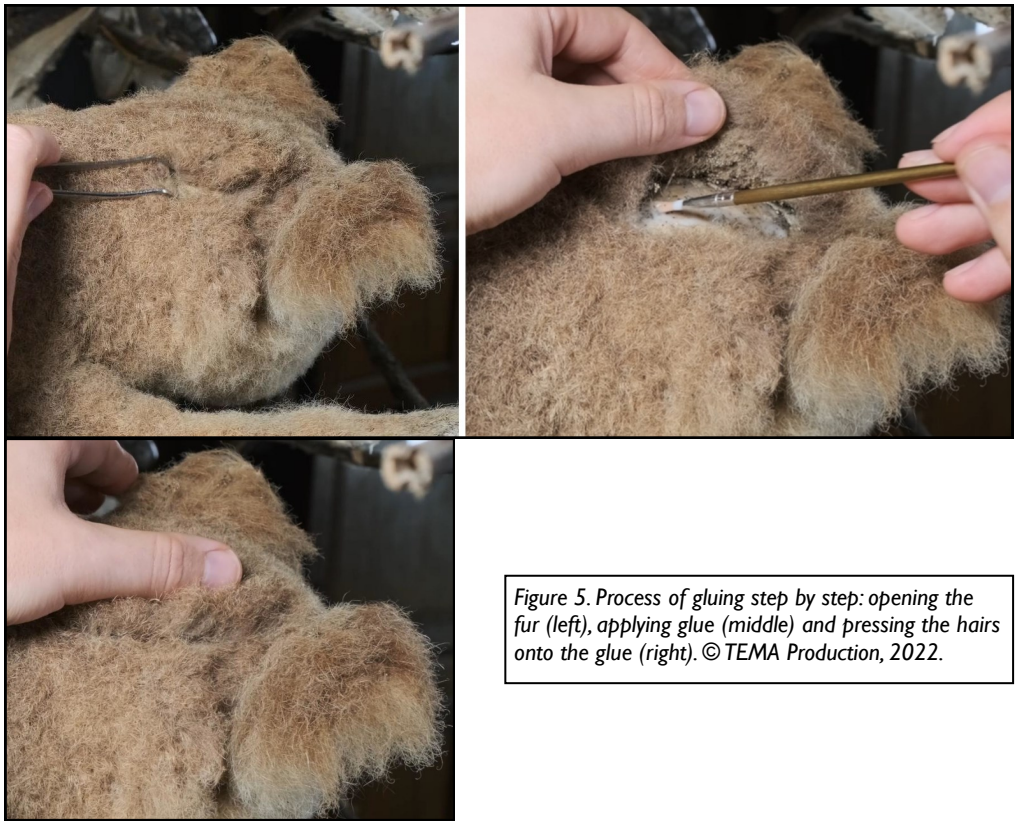

Figure 5. Process of gluing step by step: opening the fur (left), applying glue (middle) and pressing the hairs onto the glue (right). © TEMA Production, 2022.

Figure 6. The koala before (left) and after (right) gluing of the fur. Hands were covered with fur and the colour was revived all over. © TEMA Production, 2022.

The leather of the animals differed from those used for testing in being drier (or "more porous"), which should not be a problem; at most the leather would be consolidated. The moisture contained in the water-based adhesive probably relaxed the skin but no deformation was noted and a quick drying was ensured to avoid any side effects. Consolidation may be necessary if the leather has become very brittle due to humidity and mould (Dignard and Mason, 2018). This might complicate the gluing of the entire fur. Holes and cracks may be filled with Japanese paper (Moore, 2006) -as done for the flying bat- before the fur is put back. Repairs and adhering can be done at the same time.

It is possible to remove the entire fur in multiple pieces in order to thoroughly clean all the debris, repair the leather and possibly improve the control of the gluing process. It would require extreme care and a lot of time. It should be mentioned that such considerations are only applicable with dense fur where the hair mats still stick together; otherwise, hairs would simply drop individually.

Conservation of feathers

There were multiple problems with regard to the feathers. First, the only hard structure left by moths in the wings were the bones, which made it impossible to remove the feathers, apply adhesive, and replace the feathers. Second, the membrane between wrist and shoulder (propatagium and propatagial ligament) was partially eaten and had to be reconstructed if feathers were to be removed, which would have been a very challenging task. Third, an adhesive of high viscosity would not have been practicable because feathers debris would have stuck to the brush, preventing a controlled coating.

Consequently, injection seemed to be the only practicable possibility, not to exactly reattached the feathers, but to fix the plumage in its current position. The adhesive should be stable, reversible and invisible (e.i. non plasticiser). The choice went to a cellulose-based adhesive diluted in an organic solvent: low viscosity hydroxypropyl cellulose (Klucel E, 7 mPa.s) was mixed at 2% w/w in acetone, following the specification of the supplier. With a very low concentration the risk of soiling the feathers was reduced, and the process could be repeated several times to obtain the desired result. The injection of a strong and thick adhesive would have been dirty and uncontrollable. The wetting ability of acetone ensured the penetration through porous materials (duvet, frass, tissue residues, cocoons etc.). Moreover, acetone has the benefit of being very evaporative. Water - and, to a lesser extent, alcohol- may trickle for a long time if too much quantity is injected.

To test the technique, I injected the wing of a common wood pigeon (*Columba palumbus* Linnaeus, 1758). I also found a Eurasian curlew (*Numenius arquata* Linnaeus, 1758) of neither scientific nor historical value. This bird is not fluffy enough for deep injection but has a brown-and-white pattern looking more or less similar to frogmouths and kookaburras, suitable to test the surface soiling. Finally, several independent white feathers were glued together and then separated: this was done with the aim to assess how the feathers and duvet would react to the adhesive. The objective was to see if the surface of the plumage could be soiled by capillarity or droplets and if so, how easy it was to reverse the operation.

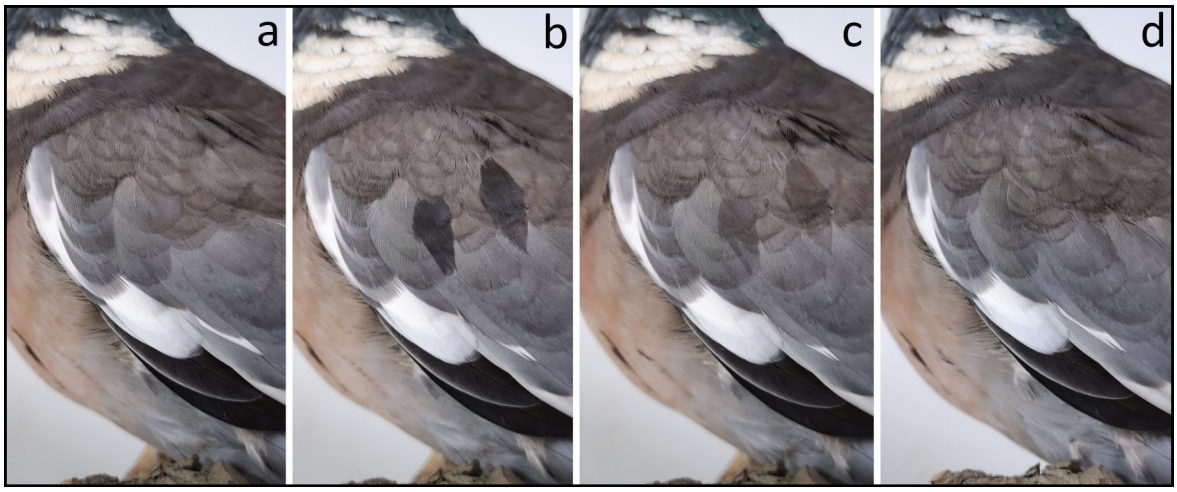

Figure 7. Wood-pigeon wing (a) before injection (the deep injection is not visible at all), (b) with two fresh spots intentionally made at the surface, (c) then after drying, and finally (d) after cleaning. © Liévin Castelain, 2022.

Feathers: tests

After a single injection in the pigeon wing, the duvet at the base of feathers began to make them stick together. They were still separable using tweezers without being visibly damaged. With caution, it was possible to inject without causing any infiltration at the surface. Nevertheless, when spilled intentionally, the adhesive produced dark stains at the surface of the plain grey colour of the common wood-pigeon (Figure 7). These stains were easily washed by rubbing cotton wetted with acetone, water or alcohol. At the end of this cleaning process, some feathers look darker than before treatment (Figure 7d) which is likely due to fat migration from the greasy duvet.

Unlike the pigeon there were very few visual effects on the spotted plumage of the curlew even if soaked with adhesive. Dark sports became darker which was hardly recognisable. Plumage colour may also change if the bird had not been washed during the taxidermy process, or if it was dirty (remaining grease, depositional grease, dust) or dyed. Such cases would demand some further testing. As well as for the pigeon, feathers adhered to each other and could easily be separated.

To further test the effect of the adhesive on feathers, a few were adhered together, then separated mechanically and cleaned (Figure 8). Mechanical separation was very easy and resulted only in "dirty duvet" (i.e. barbs sticking to each other). Mechanical cleaning, i.e. brushing more or less intensely with a toothbrush, already gave good results but cleaning using a solvent was more efficient and less abrasive to the fine barbs (acetone cleaning followed by water cleaning and drying; Figure 8).

Frogmouth and kookaburra

The process was extremely simple. Small amounts of hydroxypropyl cellulose were injected into the plumage with a syringe (Figure 9), step by step, as deep as possible in order to avoid any potential spots at the surface, even if it is a problem only with dark and plain plumage. Palpation showed that

Figure 8. Reversibility test with independent feathers. (a) Before gluing, (b) after gluing, (c) after mechanical separation, and (d) finally after mechanical cleaning (the two at left) and acetone and water cleaning (the one at right). © Liévin Castelain, 2022.

Figure 9. Kookaburra during injection (left) and after drying (right). © TEMA Production, 2022 (left) and Liévin Castelain, 2022 (right).

the feathers adhered to each other as expected; they were fixed in their current position. The plumage remains flexible and smooth with visual wholeness. Feathers are still separable from each other. Two series of injections were considered sufficient. The whole process took only a few minutes. After injection the wholeness of the plumage is preserved (Figure 9 and 10).

The choice of hydroxypropyl cellulose diluted in acetone at a low concentration has multiple benefits: (i) it is liquid enough to be injected deep into the plumage with a syringe, (ii) it has a high wetting ability to penetrate porous materials, (iii) the operation can easily be repeated to achieve the desired result, (iv) it is non-plasticising and thus invisible at the surface of light coloured feathers and spotted patterns if capillarity occurs, (v) the product is cleanable and reversible and (vi) the product remains stable over time.

Even if reversible, the conservator should keep in mind that *theoretically reversible* doesn't mean *practicably reversible*. This is why as little adhesive as possible was injected, i.e. achieve the lowest sufficient level of strength needed to stabilise the plumage.

Conclusion

Birds and mammals that have been severely damaged by moths are generally disposed of, or are stored out of view for decades. Fortunately, in the present case, nearly all feathers and hairs were still in place, and it was a challenge to deal with such an uncommon issue. Rather than a problem, it was an opportunity to save most of the material of an impressive composition signed by a major taxidermist studio.

It should be noted that the technique used to stabilize feathers has only been tested on a low variety of types and colours. It is probably not applicable with greasy plumage because the solvent may cause the fat to appear on the surface. Gluing large surfaces of hairs may not be convenient with

Figure 10. Frogmouth wing before (left) and after (right) injection. Hanging feathers of the wrist and alula (left) were glued before injection. © Liévin Castelain, 2022.

all types of furs. Conservators-restorers should implement the proposed methods only following thorough consideration and appropriate testing.

The procedures proposed here are as least invasive as possible; feathers are still removable without being damaged, at most soiled with a very small amount of cleanable adhesive, and hairs can also be removed (and preserved) by pulling out and gentle scratching. The idea was to keep manipulations to the strict minimum so that the present stabilization will not be troublesome for potential future interventions.

Acknowledgements

I thank Pat Morris for the interesting correspondence we had about Rowland Ward, and Carolin Mayer (Institute of Life, Earth and Environment – University of Namur) for reviewing the manuscript. I thank Sophie Fert and Aubin Mangeot of TEMA Production (tema-prod.com) for providing me good quality pictures of the conservation process. A documentary depicts all the conservation and restoration process. It was produced by Guy Kuypers, whose patience allowed appropriate testing. It is available on Youtube (Tema Production and Castelain, 2023).

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NatSCA AGM 2023

1pm-1.40pm, 27th April
The Potteries Museum & Art Gallery, Stoke-on-Trent Museums
Hybrid meeting
Zoom: link emailed to members

AGENDA

1. Apologies for absence

2. Matters arising from Minutes of AGM 2022

3. Reports

4. Election of NatSCA committee

5. Any other Business

6. Vote of thanks

7. Next AGM venue

Close

AGM

Please ensure you are a paid-up individual member of NatSCA to propose, second or vote at our AGM. Institutional members are non-voting members. If you are attending via ZOOM and would like to propose or second, please write your full name in the Zoom 'Chat' channel. Many thanks.

1. Apologies for absence

Belle Buchanan-Smith, Lucie Mascord & Laura Soul

2. Matters arising from Minutes of AGM 2022

Matters arising from minutes of the NatSCA AGM 2022, held in Edinburgh and on Zoom, as published in: *Journal of Natural Science Collections* (2023), NatSCA AGM minutes 2022, Vol. **11**: 121-128.

Proposal to accept the minutes of the 2022 AGM, including any amends from matters arising, as an accurate record:

Proposer: David Gelsthorpe **Seconder:** Rebecca Machin

3. Reports for NatSCA's Annual Year 1st February 2022 to 31st January 2023

Secretary's Report: Yvette Harvey

Seven Zoom committee meetings and one hybrid (October) have been held between February 2022 and January 2023. October 2022's meeting included a special vote (in accordance with NatSCA's constitution) for a Treasurer.

Trustees have faced challenges at work and home over the past year, affecting meeting attendance. Please see below (- denotes special leave and grey denotes a non-Trustee period):

	ii.2022	iii.2022	iv.2022	v.2022	vii.2022	x.2022	xii.2022	i.2023
Jack Ashby	y	y	y	y	y	y	y	y
Clare Brown		y			y			y
Belle Buchanan-Smith							y	y
Tannis Davidson						y		y
Patti Wood Finkle					y	y	y	y
Jan Freedman	y		y	y		y		
Jennifer Gallichan	y	y	y	y	y	y	y	y
David Gelsthorpe	y		y		y			
Amy Geraghty					y		y	y
Isla Gladstone		y	y	y	y	y		y
Yvette Harvey	y	y	y	y	y	y	y	y
Lucie Mascord		y		y	y			
Laura McCoy	y	y		y	y	y	y	y
Holly Morgenroth	y			y				
Bethany Palumbo		y	y	y				
Glenn Roadley	y	y		y	y	y	y	y
Laura Soul	y	y	y	y	y	y	y	y
Paolo Viscardi	y		y					
Donna Young	_	_	_	_				
Total No. present	**10**	**10**	**9**	**11**	**12**	**10**	**9**	**12**

Treasurer's Report: Belle Buchanan-Smith

Accounts summary 01.02.2022 - 31.01.2023

Income	2022-23		2021-22
Institutional Subscriptions			
Previous Years	£ -		£ 200
Current Year (bank)	£ 1,880		£ 1,938
Future Years	£ 40		
		£ 1,920	£ 2,138
Personal Subscriptions			
Previous Years	£ 20		£ 20
Current Year	£ 4,475		£ 5,455
Wrong amount	£ -		£ 30
Future Years	£ 150		
		£ 4,645	£ 5,505
Workshop Income			
		£ -	
Conference Income			
2021	£ -		£ 240
		£ -	£ 240
Donations			
Donations	£ -		£ 44
		£ -	£ 44
Other			
Misc.	£ -		
Publications	£ 12		
Bank interest			
Unallocated	£ -		
		£ 12	£ -
TOTAL INCOME		£ 6,577	£ 7,927

Expenditure	2022-23		2021-22
Running costs			
Committee Expenses	£ (333)		£ (95)
Website, Zoom etc	£ (815)		£ (1,187)
Stationery			£ -
Postage	£ -		£ (22)
Payment Fees	£ (141)		£ -
Data Protection	£ (35)		£ (35)
		£ (1,323)	£ (1,339)
Workshops			
		£ -	
Conference			
SPNHC	£ (53)		
		£ (53)	
Publications & Information Provision			
2020 Journal print & postage			£ (1,592)
2021 Journal print & postage	£ (2,174)		
		£ (2,174)	£ (1,592)
Charitable			
Bill Pettit Fund	£ (2,528)		£ (4,510)
Bursaries	£ (1,504)		
Sector support	£ -		
		£ (4,032)	£ 4,510
Other			
TOTAL EXPENDITURE		£ (7,583)	£ (7,441)

	2022-23	2021-22
Cash (Deficit) / Surplus for the Year	£ (1,006)	£ 486

Cash Flow Statement			
01.02.2022	Current a/c	£ 48,791	
	Paypal a/c		
			£ 48,791
02.01.2023	Current a/c	£ 47,785	
	Paypal a/c		
			£ 47,785
Balance Including Liabilities			£ 43,685
Adjusted Surplus/(Deficit)			£ (5,106)

OUTSTANDING EXPENDITURE			
2022 Journal			£ 2,000
BP 2022			£ -
BP 2020 - Teeth KCL			£ 2,100
			£ 4,100
EXPECTED INCOME			
			£ -
Adjusted balance estimate 31.01.2023			£ 43,685

Comments on Year End Accounts from Treasurer:

- The reduction in Subscription income is a result of the slight drop in membership numbers.
- The 2022/23 Conference was run with SPNHC so no income and only a small cost recognised.
- In 2023/24 a full conference will run with both online and in person delegates so increases in income and expenditure are expected.
- No new Bill Petit Grants committed to in the 2022/23 year.
- Prior year commitments paid, with exception of Bill Petit - Teeth KCL 2020 - Invoice received March 2023.
- Bursaries offered for the conference, no comparable spend in prior year.
- Running Costs are consistent in total; in person meetings have increased committee travel spend and decreased web provision costs
- Reserves levels are currently healthy, sufficient to cover around 3 years of pre-COVID level expenditure.

Charity Commission report for signing after AGM approval

CHARITY COMMISSION FOR ENGLAND AND WALES

Charity Name:	No:
Natural Sciences Collections Association (NatSCA)	1186918

Receipts and payments accounts — CC16a

For the period from	Period start date	To	Period end date
	1/2/2022		31/1/2023

Section A Receipts and payments

	Unrestricted funds to the nearest £	Restricted funds to the nearest £	Endowment funds to the nearest £	Total funds to the nearest £	Last year to the nearest £
A1 Receipts					
Institutional Subscriptions	1,920	-	-	1,920	2,138
Personal Subscriptions	4,645	-	-	4,645	5,505
Workshops	-	-	-	-	-
Conferences	-	-	-	-	240
Donations	-	-	-	-	44
Publications	12	-	-	12	-
Bank Interest	-	-	-	-	-
	-	-	-	-	-
Sub total (Gross income for AR)	6,577	-	-	6,577	7,927
A2 Asset and investment sales, (see table).					
	-	-	-	-	
	-	-	-	-	-
Sub total	-	-	-	-	-
Total receipts	6,577	-	-	6,577	7,927
A3 Payments					
Running costs	1,324	-	-	1,324	1,335
Workshops	-	-	-	-	-
Conference	53	-	-	53	-
Publications & Information Provision	2,174	-	-	2,174	1,592
Charitable Activities : Bill Petit Grants	2,038	490	-	2,528	4,510
Charitable Activities : Bursaries	1,504	-	-	1,504	-
	-	-	-	-	-
	-	-	-	-	-
	-	-	-	-	-
Sub total	7,093	490	-	7,583	7,441
A4 Asset and investment purchases, (see table)					
	-	-	-	-	
	-	-	-	-	
Sub total	-	-	-	-	
Total payments	7,093	490	-	7,583	7,441
Net of receipts/(payments)	- 516	- 490	-	- 1,006	486
A5 Transfers between funds	-	-	-	-	-
A6 Cash funds last year end	48,301	490	-	48,791	48,305
Cash funds this year end	47,785	-	-	47,785	48,791

Section B Statement of assets and liabilities at the end of the period

Categories	Details	Unrestricted funds to nearest £	Restricted funds to nearest £	Endowment funds to nearest £
B1 Cash funds	Current Account	47,785	-	-
	PayPal	-	-	-
		-	-	-
	Total cash funds	47,785	-	-
	(agree balances with receipts and payments account(s))	OK	OK	OK

	Details	Unrestricted funds to nearest £	Restricted funds to nearest £	Endowment funds to nearest £
B2 Other monetary assets		-	-	-
		-	-	-
		-	-	-
		-	-	-
		-	-	-
		-	-	-

	Details	Fund to which asset belongs	Cost (optional)	Current value (optional)
B3 Investment assets			-	-
			-	-
			-	-
			-	-
			-	-

	Details	Fund to which asset belongs	Cost (optional)	Current value (optional)
B4 Assets retained for the charity's own use			-	-
			-	-
			-	-
			-	-
			-	-
			-	-
			-	-
			-	-
			-	-

	Details	Fund to which liability relates	Amount due (optional)	When due (optional)
B5 Liabilities	Journal 2022	Unrestricted	2,000	
	Bill Petit 2022	Unrestricted	-	
	Bill Petit 2020	Restricted	2,100	
			-	
			-	

Signed by one or two trustees on behalf of all the trustees	Signature	Print Name	Date of approval

Accounts will be signed when agreed at AGM.

Proposer: Laura McCoy **Seconder:** Holly Morgenroth

Membership Secretary's Report: Clare Brown
1st February 2022 - 31st January 2023

For 2022 the membership statistics are as follows:

296 members (55 institutional, 241 personal), this is 38 fewer members than 2021-22.
Around 80% of our membership is UK based, we also have members in 19 other countries.
123 members chose to receive a hardcopy of the journal.
There were 13 free/complimentary mailings of the journal either for legal/copyright reasons or networking (British Library LDO, British Library CRO, GCG, Smithsonian Institute Library Gift and Exchanges, ACE, SPNHC, MA, Zoological Record, plus five copies to Agency for the Legal Deposit Libraries).

Membership numbers have dropped slightly from 2021. This is likely to be linked to NatSCA's reduced post-COVID programme. However, it may also reflect the increasing cost of living problem and the stress on institutional resources. We hope membership numbers will increase again as our programme picks up with an in person NatSCA-led conference in April 2023 and planned training events for the year. We are aware of the need to understand any continued drop in numbers beyond this.

I would like to thank everyone who has supported me with the membership work over the last year, Holly Morgenroth, Glenn Roadley and Justine Aw in particular.

Editor's Report: Jan Freedman
We have had a lot of really interesting articles submitted for Volume 11 of the *Journal of Natural Science Collections*, covering a range of topics from decolonisation, conservation, collections research, and learning and outreach.

Volume 11 is online and available in print for those members who requested the hard copy version (https://www.natsca.org/jonsc-vol-11). The first two articles, Colonial entanglement in extinction narratives: the afterlives of two Saint Lucia giant Rice rats, and Promises of mass digitisation and the colonial realities of natural history collection, are available free for non-members, as part of NatSCA's aim to make all decolonising articles accessible to the wider museum community.

There was a small delay in the completion of Volume 11, unfortunately due to a restructure in a museum, but I'm pleased to say that our colleagues were not affected.

As always, I would like to thank all the authors for their submissions, and all their hard work and time that they put into their original article and subsequent revisions. I would also like to thank all the reviewers who spend time to go through each article and provide positive and constructive feedback to improve the quality of the articles. And finally, a special thanks to our Editorial Board, Bethany Palumbo, Paolo Viscardi and Rob Huxley, who take the time to coordinate finding peer reviewers.

We are looking for two volunteers to join the Editorial Board. Being on the Editorial Board is an important part in the article review process. Members of the board will receive an article that has been submitted, and then reach out to find two reviewers. They are the contact for the reviewers, and return reviewed articles back to the Editor. The process helps by finding a large range of specialist reviewers that one person alone cannot do. The role involves good written communication skills, and is a great way to network with other experts in the sector. If you are interested, please contact me at Editor@natsca.org. The deadline for the next Journal is the end of July 2023, and if you are interested in submitting an article, please feel free to contact me for any information.

Chair's Report: Isla Gladstone

2022 has marked NatSCA's first return to in person activity since the Covid-19 pandemic. We have offered professional development and networking opportunities through a hybrid conference and programme of virtual talks. We have continued our digital and physical publications, with a steady flow of readership and increased diversity of contributors to our blog. The NatSCA trustees have also continued

to review our operating model in the context of low sector resources and increasing cost of living, including a significant increase to our bursary offer. Additional priorities developed during this year for 2023 include trialling new volunteer positions and links to wider networks to help increase our capacity to deliver for, represent and support the NatSCA community.

Conference lead 2022, Glenn Roadley, reports that our first physical conference post-lockdown took place in Edinburgh in June 2022, in partnership with the Society for the Preservation of Natural History Collections (SPNHC) and Biodiversity Heritage Library (BHL). The conference was well attended, with 12 NatSCA members being granted bursaries to support attendance (10 physical and 2 digital). NatSCA hosted two symposia at the conference: One closed ('*Civically engaged natural history museums: transforming public programmes to stay relevant*') and one open ('*Long Time No See*'). NatSCA's AGM was also held as part of the conference.

In January 2023, NatSCA circulated a Call for Papers and Save the Date for the 2023 conference: 'So how do we actually do all this? Hopeful futures and turning theory into practice for big issues in natural history collections', to be hosted by The Potteries Museum & Art Gallery, Stoke-on-Trent. Twenty six papers were received and all were accepted. Due to increased costs, the decision was made to increase registration fees, however the amount made available to cover speaker expenses and bursaries was also increased.

Our **training** leads Laura McCoy and Laura Soul have continued to deliver our regular Lunchtime Chats series, on the last Thursday of each month. These provide an informal opportunity for members to share topics of professional interest with our subject specialist network. Talks this year have ranged from an update on Bill Pettit funded project 'Marvellous Molluscs', to approaches to skeletal preparation and conservation at Natural History Museum of Denmark, to how to mitigate specimen freezer burn. Please do get in touch with training@natsca.org if you have an idea for a future Chat. We are also working towards returning to our pre-pandemic training programme of one skills-based and one seminar-based event per year, now with the added benefit of virtual delivery options.

Blog Editor Jen Gallichan reports steady engagement from across the sector, with an increase in blogs submitted from non-committee sources. This is partly due to blog articles being offered on receipt of bursaries, and partly because of an increased rate of successful submissions from call outs on the NatSCA Jiscmail. The 2023 blog calendar is currently filled until June.

Visits to blog page per month:

Month	Visits	Views
February	1043	1551
March	1452	2047
April	1079	1547
May	1112	1767
June	1197	1679
July	973	1461
August	1067	1644
September	1619	1159
October	1196	1804
November	1254	1873
December	1306	1690
January	4273	3455
February	1239	1685
TOTAL for PERIOD	18810	23362
% Increase vs Feb 2021 - Jan 22	+26%	+8%

The highest number of visitors come from the UK, although we are attracting visitors from our colleagues in the USA, Australia, and parts of Europe. The table below shows a drop in numbers apart from a large spike in January 2023 from the USA and a welcome return of visitors from Italy who had not recorded views on the blog since 2017.

Country	Views	% Change vs 2020
UK	7962	-17
USA	6894	+24
Australia	466	-36
Ireland	461	-17
Germany	423	-1.5
India	386	-15
Canada	372	-18
France	338	-39
Italy	297	+100

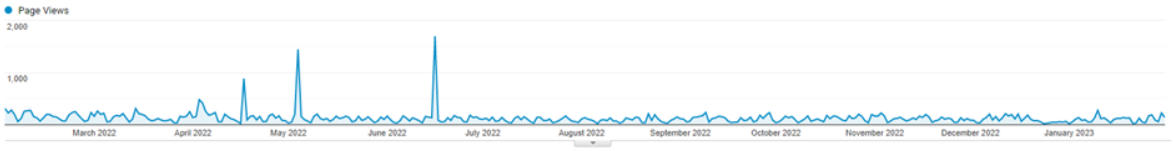
A total of 42 articles were posted. The top, most viewed blogs covered a range of new and old articles, showing that they have longevity and remain relevant to readers for a long period after they are posted.

Post
Private Bone Collections: The Good, The Bad and The Illegal
Giant Sequoia at The Natural History Museum
Telling The Truth About Who Really Collected The 'Hero Collections'
Freezing Specimens and how to Mitigate Freezer Burn
Resurrection 101
The SS Great Britain's 'Final Passenger'
Frequently Asked Questions in Taxidermy
Brendel Plant Model Survey
'Marvellous Molluscs' – Increasing accessibility, improving storage & unlocking research potential at the University of Aberdeen
Collecting with Lao Chao [Zhao Chengzhang]: Decolonising the Collecting Trips of George Forrest

NatSCA **Website** lead Glenn Roadley reports fairly consistent traffic across the period, with generally higher traffic early in the year. There were a few spikes in traffic around April 17th, May 4th and June 16th. Overall figures for the year are down 25-30% on the same period last year, bringing total users in line with 2020-2021 following last year's increases.

Visits to website per month:

Month	Sessions	Users	Page Views
February	2,199	1,690	4,800
March	2,146	1,611	4,409
April	2,545	1,968	5,366
May	2,674	2,097	4,786
June	2,467	1,902	4,846
July	1,454	1,071	2,943
August	1,531	1,162	2,973
September	1,701	1,314	3,568
October	1,863	1,395	3,563
November	1,784	1,317	3,517
December	1,606	1,202	3,096
January	1,754	1,338	3,284
Total for Period: (% change vs 2021-2022)	**23,724** (-29%)	**18,067** (-28%)	**47,115** (-24%)



Top pages:

Rank	Page	Page Views	Unique Page Views	Avg. Time on Page
1 (0)	/home	9159	6679	51.06
2 (+1)	/taxidermy	3592	3278	353.65
3 (+2)	/jobs	3527	3056	89.82
4 (-2)	/importance-of-natural-science-collections	1960	1721	336.71
5 (+1)	/article/2509 (Nature Read in Black and White)	1512	1310	360.13
6 (+1)	/journal	1310	817	33.92
7 (+2)	/care-and-conservation	1187	905	200.44
8 (+2)	/publications	1062	847	43.82
9 (+3)	/events-and-workshops	913	704	38.03
10 (+3)	/membership	714	595	136.54

Website updates have included 22 new journal articles and 66 sector job vacancies. Updates have been made to Awards and Bursaries, Committee Nominations, committee member profiles and Natural Science Collections and Environmental Action pages. Event pages have been created for the NatSCA Lunchtime Chats and the NatSCA 2023 conference.

NatSCA's **Bill Pettit Memorial Award**, which is available to members to apply to for projects that support conservation, access and use of natural science collections, has been paused for the past year. This is to allow for time to recruit new trustees and volunteers to support its running. Our thanks to David Gelsthorpe who has administered this award as well as our bursaries. Tannis Davidson is now taking on this role and plans to re-start the award scheme in 2023.

NatSCA has continued to partner on two **national network projects** in 2022. 'DiSSCo UK' (the Distributed System of Scientific Collections UK) is being coordinated by the Natural History Museum London and funded by the Arts and Humanities Research Council (AHRC). This project is working towards securing major investment for a UK infrastructure for digitising natural science collections – accessible to diverse sizes and locations of heritage organisation. 'People and Plants' is an AHRC networking project exploring the modern relevance of biocultural collections, in conversation with indigenous knowledge holders, researchers and museum professionals. The project has funded NatSCA members to attend workshops and share their content on our blog.

It remains a difficult time financially for many individuals and organisations. NatSCA has increased our bursary offer both in terms of number of bursaries and total amount offered, to support members to attend our events. We are also able to write letters of advocacy for specific **collections at risk**, please contact: chair@natsca.org. Through platforms such as our conference, we will continue to platform best practice that helps to sustain collections, and offer opportunities for connecting with colleagues for mutual support.

4. Election of NatSCA committee:

Trustees form a steering committee with obligations to ensure NatSCA meets our mission, ensure good governance and conform to Charity Commission regulations.

Below are the nominees for NatSCA trustee positions standing for election at this AGM. The Membership Secretary has confirmed that those proposed, those proposing and those seconding are all current personal members of NatSCA. No term will exceed three years without re-election.

Below are the nominated candidates for Co-Chair:

Nominee	**Position**	**Proposed**	**Seconded**
Jen Gallichan (3 year term)	Co-Chair	Yvette Harvey	Laura McCoy
Isla Gladstone (2 year ordinary term)	Co-Chair	David Gelsthorpe	Yvette Harvey

There are two vacancies for Co-Chair and two nominees.

Below is the nominated candidate for Secretary:

Nominee	**Position**	**Proposed**	**Seconded**
Yvette Harvey	Secretary	Jen Gallichan	Rachel Webster

Below are the nominated candidates standing for Ordinary Member positions on the committee:

Nominee	**Position**	**Proposed**	**Seconded**
Jack Ashby	Ordinary Member	Liz Hide	Matthew Lowe
Eimear Ashe	Ordinary Member	Paolo Viscardi	Amy Geraghty
Clare Booth-Downs	Ordinary Member	Jen Gallichan	Isla Gladstone
Laura McCoy	Ordinary Member	Yvette Harvey	Patti Wood Finkle
Emma Murphy	Ordinary Member	Paolo Viscardi	Amy Geraghty
Glenn Roadley	Ordinary Member	Olivia Beavers	Lukas Large

At our AGM in 2022, NatSCA had one vacancy for a Treasurer and no nominees. At that AGM we stated our intention to co-opt to this role. In 2022 we co-opted Belle Buchanan-Smith as our new Treasurer. This is to be ratified at the 2023 AGM.

Proposal 1: we propose one 'en bloc' vote for all nominees (two nominees for Co-Chair, one nominee for Secretary, one position to be ratified for Treasurer, and 6 nominees for ordinary member positions).

Proposer: Paulo Viscardi **Seconder:** Tannis Davidson

Membership vote: Yes / No **Result:** Yes

This will be a hybrid poll, with a greater than 50% vote required to accept the proposal. Please remember that only paid up individual members are able to vote at NatSCA's AGM.

Proposal 2: all nominees are to be accepted as trustees.

Proposer: Donna Young **Seconder:** Maggie Reilly

Membership vote: Yes / No **Result:** Yes

This will be a live digital Zoom poll, with a greater than 50% vote required to accept the proposal. Please remember that only paid up individual members are able to vote at NatSCA's AGM.

5. Any other Business
None

6. Vote of thanks

NatSCA would like to thank everyone who has been involved in delivering our Activities in 2022 for sharing their time, expertise and content.

We would like to thank NatSCA's trustees for their work leading on key activities as well as contributing to the overall running of NatSCA. This includes our new trustees in 2022 - Amy Geraghty, Tannis Davidson and Patti Wood-Finkle, as well as co-opted Treasurer Belle Buchanan-Smith, and former Treasurer Holly Morgenroth. We also thank Justine Aw for highly valued external technical support.

Jen Gallichan and the trustees would like to pass on heartfelt thanks to the great group of volunteers who compile our monthly Digital Digests including Glenn Roadley, Olivia Beavers, Milo Philipps, and Clare Dean (who has now stepped down). Our Editor Jan Freedman has shared thanks to the Editorial Board for their valued support: Bethany Palumbo, Paolo Viscardi and Rob Huxley.

NatSCA would like to extend special thanks to those trustees stepping down from committee this year: David Gelsthorpe, Laura Soul and Lucie Mascord. Their contributions have been highly valued, and they will be very much missed.

NatSCA's strength is in being community-led, and we value your contributions towards this past and future.

7. Next AGM venue: TBC

8. Close: 1.30pm

NatSCA Committee

Honorary Officers

Published by the Natural Sciences Collections Association (2024)
ISSN (print): 2053-1133 ISSN (online): 2053-1141

Index