Perception of Subject Matter Experts (SMEs) on Various Curation and Preservation Techniques for the Development of Natural History Gallery in Malaysia: A Qualitative Study

Z Fatin¹, N Othman¹, H Haris¹, M F Najmuddin¹, M N Indara Rahayu², Z Md Zairi³ and M A B Abdul-Latif¹,4*

¹Faculty of Applied Sciences and Technology, Universiti Tun Hussein Onn Malaysia, KM1 Jalan Panchor, 84600, Muar, Johor, Malaysia
²Ayu Geo Nature Enterprise, No.109a Kampung Kubang Badak, Mukim Ayer Hangat, 07000 Pulau Langkawi, Kedah, Malaysia
³Shaz Resort Pulau Tinggi, Lot 44, Kampung Penaga, Pulau Tinggi, 86800 Mersing, Johor, Malaysia
⁴Oasis Integrated Group (OIG), Institute for Integrated Engineering (I²E), Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Johor, Malaysia

*Corresponding author: latiff@uthm.edu.my

Abstract. Preserving animal’s body or part of the animals have become an important and well-known conservation medium to ensure that the future generations are still able to enjoy the biodiversity and all the incredible species that live within it. This paper aims to present a qualitative study on perception and preference of subject matter experts (SMEs) on various curation and preservation methods that is suitable for certain animals for the development of Natural History Gallery. Interview with the SMEs were done by using semi-structured questionnaire and prior to this, permission were gained from the respondents by signing the Informed Consent Form (ICF). The findings suggest that the preservation methods of specimens ultimately depend on the purpose of specimens collected, either to be preserved as research specimens or exhibition specimens. The information gained form this study will be valuable as directive for the development of natural history gallery in Malaysia.

1. Introduction

Museum that store and exhibit the biological diversity or ‘natural history’ is called Natural History Museum (NHM) and it is particularly well-positioned for contributing in biodiversity research and conservation [1-3]. NHM is an obvious setting to link between conservation and education through specimen collections and is considered as public education platform to wide audience regardless of age, education level and field expertise [4]. Natural History Collection, Gallery or Museum in Malaysia are restricted by the state and national boundaries that cause scientist to work in small geographical group [5]. Besides, Malaysia lack the expertise especially in taxidermy and curation due to the retirement of many experienced staff, lack of training provided, and insufficient funds, hence, becoming a common problem faced in natural history sector in Malaysia [6].

A curator is needed in NHM to perform various preservation techniques on specimens collected as voucher specimens. Based on standard international protocol, there are two main type of preservation techniques comprising of wet (preserved in alcohol) and dry specimens [7, 8]. Dry specimens include
skin, skeleton and mounted specimens. However, as time goes by with modernization and technological advancement, many other preservation techniques besides wet and dry specimen are available [9, 10] such as diaphonization (clearing and staining), plastination, preservation in paraffin wax or resin and many more [11]. The preservation techniques should also be adapted according to the type and the purpose of the specimen preservation [12].

Subject matter experts (SMEs) can be described or defined as an individual who is expected to have greater-than-normal expertise, by their virtue position, education, training, or experience, to a particular technical or operational discipline, system, or process, and has been chosen or appointed to participate in development, verification, validation, accreditation or use of a model or simulation [13].

However, there are no clear directives that should be taken to preserve the specimen, and mostly depend on the researcher to adopt whichever methods. Therefore, this study was carried out to address the questions on which preservation methods should be used to curate certain specimen. This study explores the perspective and preference of subject matter experts (SMEs) on various preservation methods, focusing on the costing, timeline and difficulty level for the development of Natural History Gallery in Malaysia. Five people were selected as SMEs in this study based on their knowledge of discipline especially in museology [14]. We expect that there will be different opinions and answers among SMEs as they have different experiences and backgrounds in this field of museology.

2. Methods

2.1. Study design
This is a qualitative study based on semi-structured interview with SMEs who is expected to have expertise in museology field especially as a curator since they play an important role in organizing, arranging, and managing museums [15]. Qualitative analysis methods were used in this study because it provides new information and uncover dimension such as thought based on experience and provide perception into complex relation [16-18]. One-to-one interview were conducted as we only focused on SMEs with expertise in museology. In particular, straightforward thematic analysis was chosen as the framework approach, which it is a systematic and matrix-based method to classify and organize qualitative data [19]. The interview session took about 30 minutes to an hour either face-to-face or virtually and the conversation was recorded for transcription purposes.

2.2. Selection of participants
The respondents in this study consisted of five SMEs in museology as shown in Table 1. Key informant (KI) 1 and KI 2 were selected as they are knowledgeable and have very extensive experience as they have more than ten years of experience in this field. KI 3 was selected as respondent because of the current position as the head of Zoological Museum in a well-established research university in Malaysia and expected to be an expert in museum and specimen management. As for KI 4 and 5, they were selected based on the recommendations of KI 1 in which they are more knowledgeable in the latest preservation techniques as compared to KI 1. Due to the lack of expertise for museology in Malaysia, this study used purposive, convenience and snowball sampling strategies [20-22]. Participants were recruited if they were: (1) chosen purposively, (2) most accessible, and (3) people who suggested by other participants.

2.3. Ethics
Prior to the interview sessions, participants were briefed on the purposes of this study, emphasising voluntary participation and confidentiality. Then, the transcripts from the interview process were sent to the interviewees for validation purposes.
Table 1. Selection of subject matter experts (SMEs) based on their experiences.

| Respondent | Current position | Previous experience relevant as participants |
|------------|-----------------|---------------------------------------------|
| KI 1       | Chairperson Department of Biological Sciences and Biotechnology, Malaysia / Professor | • Previously served as collector and curator at The Field Museum of Natural History (FMNH) in Chicago  
• Has more than ten years of experience in taxidermy and museology |
| KI 2       | Emeritus Professor | • Pioneer and founder of BORNEENSIS Gallery (Natural History Gallery in Borneo, Malaysia)  
• Has more than ten years of experience in taxidermy and museology  
• Previously appointed as board member in one of the state museums in Malaysia  
• Once made an attachment in Natural History Museum, London |
| KI 3       | The Head of Zoological Museum, Malaysia / Senior Lecturer | • Once made an attachment and had taxidermy training in Louisiana State University (LSU), United States of America  
• Actively involved in managing, restoration, conserving and preserving museum specimens of Zoological Museum in a university in Malaysia |
| KI 4       | Lecturer in a university in Malaysia | • Involved in the development of repository in Langkawi Research Center (Malaysia)  
• Actively involved in the development of Natural History Gallery in one of the universities in Malaysia  
• Involved in the maintenance of Zoological Museum |
| KI 5       | Science Officer in Zoological Museum, Malaysia | • Previously served as curator in one of the state museums in Malaysia  
• Actively involved in the maintenance process of the Zoological Museum in a university in Peninsular Malaysia |

3. Findings

3.1. Overview of preservation methods.
The interview session of KI 1, KI 2 and KI 3 were held face-to-face and took approximately 30 minutes to one hour per session. While the interview session of KI 4 and KI 5 were held virtually. The findings are summarized in Table 2.

The first research question was focusing on the overview of various preservation techniques based on the respondents’ knowledge. The most common answer mentioned by the interviewees were mainly two type of preservation namely wet and dry preservation. Interviewees emphasized more on dry preservation technique and provides more examples as compared to wet preservation technique as it is the easiest method for specimen preservation in 70% ethanol. Dry preservation technique usually referred as taxidermy comprises of different form of preserved specimen such as skin, skeleton and more. One of the interviewees noted that in taxidermy, there are two different objectives for specimen preservation; to preserve as research specimens or as exhibit specimens. This must be decided before the specimens are being curated. The research specimens were used for research purposes, not for
display and will be stored in collection room or repository. While exhibit specimen will be displayed on an exhibition mainly for education and public awareness.

**Table 2. Summary of the interview transcripts with five SMEs.**

| Research question | Answer |
|-------------------|--------|
| RQ1: Overview of preservation methods (type of preservation and example) | Two main preservation techniques:  
➢ Wet preservation  
  ▪ Preservation in 70% ethanol  
➢ Dry preservation  
  ▪ Taxidermy  
  ▪ Skeleton  
  ▪ Paraffin wax  
  ▪ Epoxy resin |
| RQ2: Museum versus gallery (definition, purposes and target demography) | Gallery: To exhibit and display specimens for public awareness, education and dissemination of information.  
Museum: Exhibition for education and awareness for public and at the same time generating income for maintenance and research purposes in the museums. Museum can also serve as repository or research centre. |
| RQ3: Perspective and preference of preservation methods | Perspective of preservation methods considering timeline, cost, and difficulty:  
➢ Wet preservation technique:  
  ▪ Timeline: Short  
  ▪ Cost: Low  
  ▪ Difficulty: Easy  
➢ Dry preservation technique:  
  ▪ Timeline: at least two days until months  
  ▪ Cost: Expensive but high-quality results  
  ▪ Difficulty: Involves many processes and requires expert |
| Preference of preservation methods:  
➢ Mammals: Dry preservation technique using taxidermy method  
➢ Birds: Dry preservation technique using taxidermy method  
➢ Reptiles: Dry preservation technique using taxidermy method or silicon / preserved wet in ethanol  
➢ Amphibians: Dry preservation technique using paraffin wax or resin / wet preservation technique in ethanol  
➢ Fish: Dry preservation technique using taxidermy / mould and cast method/ wet preservation technique in ethanol |
| RQ4: Maintaining the specimen collection (standard room condition, humidity, lighting and temperature to avoid from damage) | Collection room setting for dry specimens:  
➢ Temperature: below 18°C  
➢ Humidity: 40rh  
➢ Lighting: dim (50lux)  
Collection room setting for wet specimens:  
➢ Good ventilation  
➢ Lighting: dim (50lux) |
| RQ5: Coding system for museum/gallery database (opinion and recommendation) | Systematic coding system are essential in a museum to facilitate the management of the specimen |
The second research question was focusing more on the differences between museum and gallery. All interviewees agreed and noted that gallery is referring to an area for exhibit and display the specimens for: (1) public awareness, (2) education, and (3) dissemination of information. According to the interviewees, gallery does not have any repository or collection room to store the specimens and solely developed for exhibition purposes. Furthermore, museum is quite different from gallery where museum plays a bigger role as an exhibition space and at the same time functioning as storage, research, education and awareness centre. Museum also function as an income generator that may be used for museum maintenance and research purposes.

The third research question was focusing on interviewees’ perspective and preference of preservation method in terms of timeline, cost, and difficulty level for each type of animal groups. Based on interviewees’ answers, there was no specific preservation technique for preserving or curating a certain types of animal groups. However, in the selection of appropriate techniques, the purpose for the curation of the animal need to be determined earlier so that the specimen can be temporarily preserved on field as it should be. The perception of all interviewees on dry preservation technique especially in taxidermy were all the same where they all perceived that this technique is the most difficult, costly and take longer time as compared to the other techniques. The most preferred technique by the interviewees is dry preservation method especially for large-sized mammals and birds as it has aesthetical value.

Dry preservation technique is suitable to be used for the animals like mammals and bird because it may reflect their natural habitat in terrestrial as well as presenting their natural state of the fur or feather. This is quite different with scaly animals such as reptiles, amphibians and aquatic animals, in which wet preservation technique is preferable by the interviewees. Besides, preserving them as wet specimen is the easiest method as it requires lower cost in shorter time, while still able to preserve the genetic material. However, for animals like reptiles, amphibians and aquatic animals, they can still be preserved as dry specimens with certain appropriate methods. Some of the interviewees also suggested using methods for dry preservation that may replace wet preservation method, such as using epoxy resin, silicon and paraffin wax. This preservation method is found to be very attractive and fascinating compared to the preservation in ethanol for exhibition.

The fourth research question focusing on the interviewees’ opinion on how to maintain the specimens in collection room. By consensus, all interviewees agreed that all specimens in the collection room or repository need to be well managed so they are not damaged by pest, fungus and others deterioration agents and can be stored for decades. The interviewees noted that for dry specimens, important aspect that needed to be considered are the room temperature and humidity. Wet specimen’s collection room on the other hand, should have a good ventilation, low lighting and stable temperature to ensure that the specimens are in a good condition. One of the interviewees also promoted the fumigation and deep-freezing process to deal with damaged specimens causes by pests and fungus.

The fifth research question focused on interviewees’ opinion on coding system in a museum library or database. All of them agreed that it is important to have a systematic coding system in a museum library or database which will facilitate the search and management of specimens in the collection room or repository.

4. Discussion

Two main techniques in animal specimen preservation namely wet and dry preservation [23, 24] were highlighted in this research. Wet preservation technique is considered to be the easiest, doable, durable and low-cost technique in preservation. But it comes with various disadvantages such as the colour of the specimen may change, difficulties in observing the morphology of the specimens thoroughly and unattractive to be displayed in a natural history gallery. On the other hand, dry preservation method is suitable for most of the animal species as it is durable, can preserve the original colouration of the specimen, appealing to be displayed and can be used as genetic material for ages. But, the disadvantages of the dry specimen collections are costly, difficult to prepare, require expertise and extensive training for beginner curators. Subsequently, through modernization, many new preservation methods were introduced. For example, the specimen of amphibians that are usually kept in glass jars filled with
ethanol, now can be displayed more attractively using paraffin wax or resin. Moreover, in dry preservation technique, there are different techniques that can be applied for different groups of animals based on their suitability. As a result of advancement and modification in preservation techniques in the field of museology, animal bodies became malleable almost at will [25]. Therefore, the preservation techniques are not fixed or restricted to a certain methods. It depends on the purpose of the specimens being collected and curated.

The curated and preserved specimens will be stored in a repository or will be displayed in a museum or gallery. But there is still confusion on the true definition and differences between natural history gallery and museum especially in the context of Malaysia, as each one of it comes in such different shape, size and function along with their own histories, logics and peculiarities [25]. This study validated that the definition of natural history gallery and museum are rely on its function. Apart from that, the stored specimens need to be taken care in order to lengthen the life span of the specimens for further study and future references. In terms of the maintenance of the specimen, we need to emphasise more on the lighting and ventilation for the wet specimen storage rooms [26]. While for the dry specimens, temperature, humidity and lighting should also be considered to ensure the specimen is in good condition for a long-term usage. High exposure to light may bleach the specimens while high humidity and fluctuate temperature may lead to fungus growth. Aside from that, the most important and necessary thing for every specimen collection, but often overlooked is the coding system. All information related to the specimens that were stored in the museum, gallery or collection room must be kept either in the form of documents, catalogue or databases [27]. This is because it will facilitate the search for the specimens and help in monitoring the inventory of the specimens in the collection room by recording the data like exchange of specimens, specimens sharing for research purposes, conservation and also as reference material.

5. Conclusion
There are two main type of preservation techniques and each type of preservation techniques has its own advantages and disadvantages in term of timeline for preparation, attractiveness, costing, and level of difficulties. Proper specimen storage methods and management are important to ensure the specimens will survive for future use. Additionally, we suggest that further research should be explored especially in developing new preservation technique or innovating the current technique which may solve and overcome the existing weaknesses or disadvantages in current techniques especially for Malaysia scenario.

Acknowledgement
The authors acknowledge Universiti Tun Hussein Onn Malaysia, Ministry of Higher Education Malaysia and Shaz Resort for providing the necessary funding, facilities, and assistance. This research was supported by Malaysian Technical University Network Grant (UTHM-MTUN-K121) under the Ministry of Education Malaysia, Industrial Grant, by Shaz Resort Sdn Bhd (UTHM-SHAZ-M004) and GPPS-UTHM-2019-H553 postgraduate grant by Universiti Tun Hussein Onn Malaysia (UTHM). We are deeply indebted to the Department of Wildlife and National Parks Malaysia that provided us with the necessary assistance and permission for this research (JPHL & TN (IP): 600-6/1/4 (03)).

References
[1] Krishtalka L and Humphrey P S 2000 Can natural history museums capture the future? Bioscience 50(7)611–617
[2] Suarez AV and Tsutsui N D 2004 The Value of Museum Collections for Research and Society Bioscience 54 (1) 66–74
[3] Drew J 2011 The Role of Natural History Institutions and Bioinformatics in Conservation Biology Conservation Biology 25(6)1250–1252
[4] Ballard H L, Robinson L D, Young A N, Pauly G B, Higgins L M, Johnson R F, Tweddle J C 2017 Contributions to conservation outcomes by natural history museum-led citizen science:
Examining evidence and next steps *Biological Conservation* 208 (1) 87-97

[5] MONRE Ministry of Natural Resources and Environment 1997 *Assessment of Biological Diversity in Malaysia: Malaysia Country Study on Biological Diversity* Ministry of Science, Technology and the Environment: Kuala Lumpur.

[6] Arney S 2020 *Assessment of Management and Collection of Zoological Specimens at Natural History Museums in Malaysia.* University Tun Hussein Onn Malaysia. PhD Thesis

[7] Grantz G J 1980 *Home Book of Taxidermy and Tanning* StackPole Book: Pennsylvania, USA p 164

[8] Carter D J and Walker A K 1999 Collection environment. In Carter D and Walker A (eds.) Chapter 7 *Care and Conservation of Natural History Collections* Oxford: Butterworth, Heinemann 139-151

[9] Reid G 1994 The preparation and preservation of collections. In. Stansfield G, Mathias J and Reid G (Eds.) *Manual of Natural History Curatorship* HMSO:United Kingdom 28-69

[10] Simmons J E 1995 Storage in fluid preservatives. In Rose C L, Hawks C A and Genoways H H (eds) *Storage of Natural History Collections: A Preventative Conservation Approach* Society for the Preservation of Natural History Collections 161-186

[11] von Horst C, von Hagens R, Sora C-M and Henry R W 2019 History and development of plastination techniques *Anatomia Histologia Embryologia* 48 512–517

[12] NPS National Park Service 2018 *Museum Handbook: Part 1* NPS Museum Management Program: Washington D C 16-24

[13] Pace D K and Sheehan J 2002 Subject matter expert (SME) / peer use in M&S V&V. In *Foundations for the V&V in the 21st Century workshop* (Foundations 2002), John Hopkins University.

[14] Kasper C E 1995 Going through the motions: the ethics of process *The Journal of cardiovascular nursing* 9 3 p 62-67

[15] Davis A B 1980 A museum curator *The Public Historian* 2 (4) 97-99

[16] Malterud K 2001 The art and science of clinical knowledge: evidence beyond measures and numbers *The Lancet* 358 9279 397-400

[17] Patton M Q 2014 *Qualitative research & evaluation methods: Integrating theory and practice.* Sage publications

[18] Mason J 2017 *Qualitative researching* Sage Publication

[19] Gale N K, Heath G, Cameron E, Rashid S and Redwood S 2013 Using the framework method for the analysis of qualitative data in multi-disciplinary health research *BMC medical research methodology* 13 1 1-8

[20] Devers K and Frankel R 2000 Study design in qualitative research-2: Sampling and data collection strategies *Education for health* 13 2 263-271

[21] Etikan I, Musa S A and Alkassim R S 2016 Comparison of convenience sampling and purposive sampling *American journal of theoretical and applied statistics* 5 1 1-4

[22] Noy C 2008 Sampling Knowledge: The Hermeneutics of Snowball Sampling in Qualitative Research *International Journal of Social Research Methodology* 11 4 327–344

[23] Farber P L 1977 The development of taxidermy and the history of ornithology *Isis* 68 4 550-566

[24] Ross A S 2019 Introduction: Preserving the Animal Body-Cultures of Scholarship and Display, 1660–1914 *Journal of Social History* 52 4 1027–1032

[25] Mason R, Robinson A and Coffield E 2017 Museum and gallery studies: the basics *Routledge*

[26] Maniatis N and Panagiaris G 2015 From Macro to Micro and from Micro to Nano: The Evolution of the Information Content Preservation of Biological Wet Specimen Collections *Jornal of Integrated Information Management* 268-271

[27] deWaard J R, Ratnasingham S, Zakharov E V, Borisenko A V, Steinke D, Telfer A C, Sobel C N 2019 A reference library for Canadian invertebrates with 1.5 million barcodes, voucher specimens, and DNA samples *Scientific data* 6 1 1-12