2014 Posters Associated with the Preparators' Symposium

THE DEVELOPMENT OF THE ELGIN MUSEUM AS A PUBLIC AND SCIENTIFIC RESOURCE

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The Elgin Museum, the oldest independently run museum in Scotland, houses a 'Recognised' Collection of Devonian (Old Red Sandstone), Permian, and Triassic vertebrate fossils from the surrounding Moray area. This material was collected in the early–mid 19th Century attracting the interest of geologists and palaeontologists of the time who either personally visited the area or were sent material relating to their own studies. Subsequently, material has contributed to important discussions on tetrapod evolution, in a revision of the phylogeny of dicynodonts (Synapsida, Therapsida) and the affinities of *Saltopus* relative to the earliest dinosaurs, among other topics. Sadly, the majority, if not all, of the quarries sourcing these unique and diverse fossils have now closed or are inaccessible, meaning new examples are not likely to be recovered. In view of this, the entire geology collection at Elgin Museum, which includes the Recognised Collection, rocks and minerals from the local area, and a further range of non-Recognised fossils, is in the process of being re-organised to fully and better use the limited space available. The first step has been a thorough re-examination of the condition and potential use of specimens, for example, in displays, and school and public handling, leading to some unavoidable rationalisation of the rocks and minerals. The catalogue system has similarly been scrutinised to ensure all specimens are properly documented, particularly regarding their current location and the status of loans. Improvements to the building include the simple addition of new lighting in the West (geology) Store, to be followed eventually by strengthening of the floor in the larger North Store where rolling stacks will be installed to house more permanently the geology collection. The ultimate aim is to increase access to the geology collection for museum staff, volunteers, the interested public and academic community alike, and promote the collection as a valuable and versatile learning resource. Herein, the difficulties and successes of the developments are described so that other museums undergoing similar changes, now or in the future, can benefit from our experience.

3-D SCANNING AND PRODUCTION OF ACCURATE FORM-FITTING SUPPORT CRADLES FOR FOSSILS USING CNC MILLING TECHNOLOGY (COMPUTERIZED NUMERICAL CONTROL TECHNIQUE): A PROJECT WITH THE GEISELTAL COLLECTION

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Supporting cradles are needed for long-term preservation and storage of fragile Cenozoic fossils, such as those housed at the Geiseltal collections. These cradles are traditionally produced by molding techniques, using materials such as plaster, epoxy resin, and silicone. These materials are relatively easily made by hand, but they degrade over time. Additionally, the fossils are affected both chemically and mechanically during the cradle's manufacture. Furthermore, it is not always possible to establish a perfectly fitting supporting structure. If the base does not fit exactly, the fragile fossils can become damaged during long-term storage.

Until recently, age-resistant materials such as polyethylene plates (e.g., Neopolen and Ethafoam) were rarely used to create support cradles because they are produced only by hand cutting the material to fit the object, which is very time-consuming.

The use of mobile 3D scanners offers the possibility to digitize detailed surface structures of fossils on all sides. From this scan, computer software can provide an accurate negative counterpart. CNC milling technology (Computerized Numerical Control Technique) is a form of 3D printing that can carve out detailed surfaces from age-resistant plastics such as Neopolen. This method can produce a support cradle to exactly fit a fossil of nearly any shape or size.

The procedure of scanning and printing cradles is non-invasive and non-destructive. This method is advantageous over traditional molding methods in that it does not require plaster, epoxy resin, or silicone, which can damage the fossil chemically and/or mechanically. This method has been successfully applied to the Geiseltal collection with large and fragile material including a synsacrum of the large flightless bird Gastornis and skulls of the large crocodile-relative *Asiatosuchus*. As costs of the methodology continue to reduce, it is our hope that it will be used as a standard for safe long-term storage of delicate fossil material.

REPURPOSING THE PURPOSEFUL: RE-TRAINING FOSSIL PREPARATORS IN VERTEBRATE MOUNT DISMANTLING AND CONSERVATION

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The Smithsonian Institution National Museum of Natural History (NMNH) is undergoing the renovation and redesign of its nearly 31,000 square foot paleontology exhibit halls. In addition to many Smithsonian staff and contractors, museum volunteers serve an essential role in the dismantling and conservation of hundreds of mounted and bracketed fossil specimens previously on exhibit. Specimens allotted for volunteer work are not slated to return to public display. These specimens must be removed from their armature, repaired and conserved, and reincorporated into research collections both physically and in digital documentation.

NMNH Paleobiology volunteers have been educated and trained in many aspects of general paleontology, fossil preparation, and collections work through the NMNH Paleontology Training Program and/or a specialized 11-day preparation training course. Most volunteers perform fossil preparation activities in the publicly-viewable preparation lab called the FossiLab. A group of approximately 20 FossiLab volunteers have shifted from research-driven preparation projects to assist with the fossil hall renovation. The adjustment from their former tasks to their current ones was facilitated through a series of training sessions led by staff from the NMNH Paleobiology department and Vertebrate Paleontology Preparation Laboratory. This training incorporates hands-on specimen work with demonstrations in personal safety and protective equipment, documenting processes and materials used, and ways to resolve unique specimen issues through critical thinking. Volunteers work in a temporary FossiLab facility located in an interim NMNH paleontology exhibition, providing excellent opportunities to communicate with and educate public museum visitors. Overall content of training sessions was developed using professional fossil preparator core competencies as developed in 2012 through the Society of Vertebrate Paleontology Preparators Grant, as well as input and feedback from the participating volunteers. The materials and demonstrative setups produced for this training can be useful to other institutions training volunteers for similar tasks.

Training activities have resulted in the expansion of volunteer skill sets and competencies, allowing them to assist NMNH staff in the ongoing care of paleobiology collections and the fossil hall renovation project.

ADHESIVES USED IN 2014 BY THE VERTEBRATE PALEONTOLOGY PREPARATION LABORATORY, AMERICAN MUSEUM OF NATURAL HISTORY: AN ILLUSTRATED WALL CHART

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The decision to apply adhesives to fossil vertebrate specimens should be guided by an ability to assess the specimen and the task at hand, determine the desired end product, and choose the most appropriate adhesive. At the American Museum of Natural History, while some specimens are not treated (to avoid chemical contamination), most specimens require one or more of the following: (1) consolidants during excavation and/or preparation; (2) adhesives for joining; and (3) coatings for molding.

This chart illustrates the most widely used adhesives at the AMNH with details as to why preparators choose specific adhesives for specific tasks, based on their different properties. Some of these important properties are long-term stability, solubility, removability, penetration, strength, set-time, and glossiness. Included are seven adhesives: Aron Alpha 201 (ethyl-2-cyanoacrylate), Butvar B-76 and Butvar B-98 (both terpolymers of vinyl butyral, vinyl alcohol and vinyl acetate monomers), Devcon 2 Ton epoxy (polyoxypropylenediamine hardener), Epo-Tek 301-2 epoxy (aliphatic amine hardener), Paraloid B-72 (acrylic copolymer), and Primal/Rhoplex WS-24 (acrylic copolymer dispersion).

HOW TO PACK FOSSILS FOR LOANS

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It is not possible for every researcher to visit every museum to see every specimen, so vertebrate paleontology collections regularly loan material to researchers in other institutions. This means that delicate, irreplaceable fossil specimens are shipped all over the world. It is easy to imagine a multitude of ways in which damage can occur; however, with a few simple steps most damage can be avoided. We describe a basic packing procedure, consisting of three main components: plastic bag, inner box, and outer box, with appropriate padding added between the plastic bag and inner box, and between the inner and outer boxes to cushion the specimen and minimize movement and breakage.

The plastic bag prevents contact of the specimen with packing materials, and if any breakage occurs, keeps all fragments together. We discuss selection criteria for packing materials. Some preferable materials include Ethafoam, polyester fiberfill, and stretch wrap, while materials to be avoided include cotton batting and inadequate boxes. We also include steps that should be taken before the specimen is packed, such as archival labelling and photography, which provides documentation of the specimen and its current condition. Examples are provided of checklists that can be used to standardize and streamline the packing and unpacking process for both the lending and receiving institutions. Checklists help to ensure that the same set of procedures is followed regardless of the person processing the loan. In addition to a packing list, specimen loan forms, and other documentation, a separate sheet should also be included that contains information to help the researcher return the loan safely. This sheet includes a brief outline of the appropriate packing procedure, as well as the address and contact information of the person to whom the loan should be returned. These simple steps help to maintain the level of access required for research and yet greatly reduce the loss of information inherent in any specimen breakage.

SCOTTISH MAMMOTH TUSKS AT NATIONAL MUSEUMS SCOTLAND

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Conservation treatment was undertaken on one complete pair of tusks (possibly from the same animal), and two separate fragments from two specimens of mammoth tusk from the National Museums Scotland, Edinburgh, in preparation for a travelling exhibition, Mammoths of the Ice Age, originating from the Field Museum in Chicago.

The specimens were registered in the museum in the early 19th Century and the early 20^{th} Century respectively. One of these was the first mammoth discovered in Scotland. Both were suffering from the results of degrading historic treatments, including an epoxy based coating which is now insoluble in conventional organic solvents. No written records of previous storage or treatment exist for these tusks; however the problematic nature of past conditions were clear, given the physical state of the tusks when they came into the lab.

C-14 dating was carried out to establish whether the specimen was mammoth or modern elephant based on aging. Further investigations, using ultraviolet light and Fourier transform infrared spectroscopy, were carried out in order to determine the chemistry of surface dirt, paint residues, and coatings prior to developing a treatment proposal for reversing historical treatments and stabilising the tusks.

Cleaning proved problematic due to the aging of these early treatments. Experimentation was therefore carried out with pineapple juice, a technique used in ceramic conservation and the boat industry, in order to attempt the breakdown of the cross-linked epoxy, and this treatment proved very successful.

Ethyl methacrylate co-polymer of varying concentrations in acetone was used as an adhesive and consolidant. Large voids created by the warped and delaminated layers had led to diminished contact points, requiring a bulked adhesive to effectively join the two surfaces together. Pulled threads of Kozo Japanese tissue paper were used in an ethyl methacrylate co-polymer 10% in acetone mixture to create a strong but flexible backing for the top layer.

The successful conservation treatment of the mammoth tusks means that they can be used in an upcoming lecture series about the history of the discovery and study of mammoths in Scotland and they are currently featured on the National Museums Scotland website.

MULTIPLE ISSUES WHEN PREPARING AND PRESERVING LATE MIOCENE BEAKED WHALE (GRAM FM) FOR RESEARCH AND EXHIBITION: THE DIFFICULT TASK OF DOING AS LITTLE AS POSSIBLE

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A fossil whale discovered in the Gram Clay Pit in 1986 was the first fossil of a beaked whale (Ziphiidae) to be found in Denmark. Initial taphonomic processes resulted in a very disarticulated specimen with only the cranium and a few postcranial elements left. Compaction and movements within the sediment have led to severe fragmentation and shifting of especially cranium elements making it highly vulnerable to damage during excavation, preparation, and other handling. The specimen also had serious pyrite oxidation issues.

In combination, this made the fossil, particularly the cranium, unsuitable for exhibition and difficult to study. Because of this fragile, crumbling state, all treatment and handling degraded it slightly more. This was the motivation to "do as little as possible" by using the least invasive treatments possible.

From 1988-1994, the best preserved parts were prepared, treated for pyrite oxidation, and consolidated. In 2005, mandibles and 50 teeth were exhibited. Funds made it possible to start the preparation and conservation of the cranium itself. Subsequently, research on the whale specimen could begin.

Preparation was needed to ensure visibility, but also to remove degraded pyrite in the sediment. This was done carefully with solvents, brushes, and scalpel. Local cementation within the brain cavity was removed with a pneumatic chisel and scalpel. Usually carbonate concretions offers support, strength, and buffer capacity to the fossil, but in this case pyrite oxidation went on unnoticed in a thin layer of soft sediment between concretion and fossil, damaging the latter. It proved difficult to make good, strong adhesions due to crumbling and worn down fracture surfaces. Occasionally epoxy putty was carefully and sparsely applied on a barrier between the fossil and putty of a reversible adhesive acrylate copolymer (Paraloid B-72).

Degradation products of pyrite oxidation were mechanically removed and the fossil was neutralized in ammonia vapour. Controlling the relative humidity, visual inspection, and pH spot tests above and below fossil surfaces are part of the careful monitoring to follow. Oxidized fossils waiting for treatment were stored in a dry and oxygen free microenvironment. Immersion in ethanolamine thioglycollate solution was a last resort to reduce pyrite oxidation.

Custom-made cradles are necessary to support the fossil in all situations. Every time a new cradle was made new damage was inflicted. Manufacturing re-usable cradles is problematic, especially for very fragile and complex shapes such as the cranium.

THE SAUROPOD THAT STOPPED THE TRAIN

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Lo Hueco quarry (Upper Cretaceous; Cuenca, Spain) was found in 2007 during the installation of the tracks of the Madrid-Valencia high-speed rail line. The Konzentrat-Lagerstätten of Lo Hueco constitutes a singular accumulation of fossils, especially representing titanosaur sauropods. The site has provided partial skeletons in anatomical connection or with a low dispersion, producing a unique record in Europe. Fieldwork and preparation of the first partial titanosaur skeleton from Lo Hueco (EC1), which is currently regarded as the holotype of a new species, is here reported.

In the field, EC1 was exposed to distinct weather conditions affecting its state of preservation, and resulting in changes of the conservation protocols. More than one hundred bone elements where profiled and consolidated before its extraction. Three large jackets with connected bones were built including sacrum and proximal part of the tail, middle-to-posterior dorsal vertebrae and cervical remains. The jackets were built with bandages drenched in Paraloid B-72 solved in acetone. A coat of expanded polyurethane was used to ensure cohesion of the blocks, and an outer metal frame was made for removal. A detailed documentation from distinct sedimentary levels, geo-referenced data, draws, maps, photos and videos was recompiled.

Phases of preparation include: 1) removing extraction structures (metal frame, polyurethane, and bandages) using different techniques; 2) elimination of matrix (mainly clays) using mechanical techniques, both manual and with tools; 3) use of paraloid resin with microspheres to fill the present cracks in order to stabilize them and prevent the propagation of the vibration caused by airscribe, avoiding damage on the bone surface; 4) use of a kind of epoxy resin on problematic fractures using its high stability and machining characteristics (used in restoration of wood sculptures), avoiding dissolution processes in the posterior consolidation of the bone; and 5) when gypsum produced irreversible damage to the bone, it was decided not to withdraw it.

RESOLUTION AND ACCURACY OF 3-DIMENSIONAL MODELS OF SPECIMENS USING PHOTOGRAMMETRY AND IMAGE STACKING SOFTWARE

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Photogrammetry is a relatively inexpensive and more portable method of digitizing the three-dimensional surface morphology of specimens through the use of digital images from a camera instead of a laser surface scanner. However, when photographing specimens that have considerable depth it can be difficult or impossible to keep the entire specimen in focus in each image, which has the potential to influence how photogrammetry software pieces together the images to build the 3D model. This is particularly challenging in the case of very small specimens, because in order to capture more detail, the specimen must fill the frame of the camera, which requires the camera to be relatively close to the specimen and the closer an object is to the camera, the more narrow the region in focus will be.

Image stacking is a technique whereby multiple images in the same field of view, but at different focal distances, are digitally combined to create a single image with most or all of the object of interest in focus. This technique in conjunction with traditional photogrammetry has the potential to generate three-dimensional models with high levels of detail without sacrificing accuracy or requiring large numbers of photographs taken at slightly different angles. However, there is also potential for details to be lost or image misalignments to occur and be amplified when processing images through these additional steps.

To determine how combining image stacking with photogrammetry influences precision and accuracy, models of several objects of known dimensions and varying surface complexity were generated using the same sets of images from the same camera. Two models were created of each object, the first with photogrammetry software alone and the second by processing the original images with image stacking software before imputing the files into the photogrammetry software. The dimensions of these models were then compared to each other and to the dimensions of the original objects. The effects of incorporating image stacking on the precision and accuracy of these models will be discussed for each object and recommendations made for which types of specimens should be digitally modeled in this way.

IMPROVING COLLABORATION BETWEEN PALEONTOLOGISTS AND PALEOARTISTS: A CASE STUDY, FOCUSED ON THE CERATOPSID DINOSAUR *STYRACOSAURUS*

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Since the origin of the science of paleontology, illustrators and sculptors have cooperated with paleontologists in reconstructing and interpreting fossil organisms. Our aim is to promote and

facilitate this scientist-artist cooperation, providing both categories with a technical literature aimed at the comprehensive analysis of the reconstructions.

This literature supports the paleontologists in giving reliable references to the paleoartists, which, in turn, can make artwork that is more appropriate for supporting research and for enhancing educational effectiveness for the general public. Therefore, both popularization and academic studies can take advantage of the improved accuracy of their iconographic apparatus.

The tools proposed are: a study able to collect and summarize the data dealing with a topic, from the paleobiological and historical-iconographic points of view; and the use of three-dimensional fossil scans and digital models, accessible to a wide audience, that can be easily updated and modified in case of new discoveries and/or revised interpretations.

The example presented here focuses on *Styracosaurus*, a ceratopsid dinosaur from the Upper Cretaceous of the Dinosaur Provincial Park, Alberta, Canada. New, updated skeletal and muscular reconstructions are proposed. The restoration of the skin is based on fossil evidences in strictly related taxa. Biomechanical, paleoethological, and paleoecological hypotheses are also summarized and reviewed. The application of the extant phylogenetic bracketing (EPB) permits the analysis of some of the most speculative aspects (e.g., soft tissues, behavior) that are fundamental for the 'in vivo' restorations. A three-dimensional digital model is proposed based on the data analyzed. A summary of the paleoenvironmental data is also given, with remarks on paleofaunal and paleofloral assemblages, to make the framework as complete as possible.

In the end, in order to show the practical utility of our research, we present some illustrations and a life-sized flesh model by several Italian artists, made by applying different levels of depth of our research.

A FOUNDATION FOR BEST PRACTICES IN MITIGATION PALEONTOLOGY

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Mitigation paleontology focuses on the recovery and preservation of paleontological resources (fossils) that are threatened by ground disturbance associated with land and energy development projects. Mitigation includes the assessment of potential impacts and the development of measures to reduce or eliminate adverse impacts to scientifically important fossils, as well as the implementation of those measures. Despite several decades of steady progress with the development of standard procedures and regulatory guidelines for the assessment and mitigation of impacts, neither mitigation paleontologists nor the regulatory agencies that oversee their activities have been successful in developing industry-wide standard operating procedures. Best practices are methods and techniques that have consistently shown results superior to those achieved by other means, and are used as a benchmark for judging the adequacy of mitigation.

They are a standard way of doing things that multiple organizations can adhere to, although they evolve and improve over time. In this paper we propose comprehensive and detailed best practices for the mitigation paleontology industry that fall into ten categories: (1) qualifications and permitting; (2) analyses of existing data; (3) research models and scientific context; (4) field data collection; (5) field surveys; (6) construction monitoring; (7) fossil salvage; (8) data management and reporting; (9) curation facilities; and (10) business ethics and scientific rigor. Our purpose, with input from the mitigation community, is to establish procedures that are successful in maintaining a rigorous scientific standard while promoting integrity in the industry in order to accomplish the common goal of paleontological resource preservation via impact mitigation.