2018 Preparators' Session Abstracts

THE LATE PENNSYLVANIAN BIRTHDAY BONEBED FROM THE HALGAITO FORMATION OF VALLEY OF THE GODS, SOUTHEASTERN UTAH: COLLECTION, PREPARATION, AND PHOTO DOCUMENTATION.

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Field crews led by David S Berman collected 20 blocks from the Upper Pennsylvanian Halgaito Formation, southeastern Utah, intermittently from 1989 to 2015. The blocks contain a diverse fauna represented by chondrichthyan teeth; dipnoan tooth plates and skull bones; partial skeletons of a temnospondyl amphibian and three genera of synapsids; and scattered skeletons of a new araeoscelidian reptile. The blocks, the largest of which measures 137 x 94 cm, were collected using the standard technique of encasing them in a plaster-burlap jacket. A north arrow was marked on the top surface of each block for bone orientation analysis.

The fossils are mostly preserved on a horizontal bedding plane in a friable-to-blocky siltstone penetrated by modern plant roots. A very dilute white glue was used to consolidate the bones and matrix before jacketing. Acetone or alcohol-based glues were not used, because they react with moisture in the rock and turn white. In the lab, Butvar-98 diluted in isopropyl alcohol was used frequently to further consolidate the blocks. Because the matrix is very friable, air scribes could not be used for preparation, so the bones were exposed using pin vices with several sizes of carbide bits and tips modified for different tasks. A microscope was necessary for preparation of the smaller bones. It was mounted on an articulated boom arm held by a post attached by a clamp to the preparationtable. Several methods were tried for photo documenting the specimens for curation and research. A DSLR camera was initially mounted on a standard tripod positioned adjacent to a block with poor results. Then the tripod was taped in a horizontal position onto a rolling step ladder so that the camera could be positioned over a block. It proved difficult to reach the camera to focus and shoot images. A larger tripod and better DSLR camera were obtained so that the tripod with mounted camera could be positioned over the block, and the camera operated via a laptop. This worked well for the blocks and larger specimens. In order to obtain publication quality photographs of the small araeoscelid bones, the camera with a 100 mm macro lens was mounted on a tripod with the center column oriented horizontally and positioned over the block, which sat on a table whose base was derived from a dental chair, allowing the table with block to be moved up or down relative to the camera to obtain appropriate shooting distance. A ring-light flash mounted on the camera lens proved to be the best light source. The images were subsequently processed using photo stacking and blending techniques in Adobe Photoshop.

Grant Information
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FISHING WITH SILICON CARBIDE: PREPARING DIVERSE MARINE VERTEBRATES FROM THE LATE DEVONIAN (FAMENNIAN) CLEVELAND MEMBER OF THE OHIO SHALE, OHIO, U.S.A.

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Since its incorporation in 1920, the Cleveland Museum of Natural History's (CMNH) Department of Vertebrate Paleontology has amassed a substantial collection (~8,000) of Late Devonian (Famennian) marine vertebrates from the Cleveland Member of the Ohio Shale. The collection consists largely of arthrodire placoderms, including numerous specimens of the iconic apex predator *Dunkleosteus terrelli*, paleoniscoid fish (e.g., *Kentuckia hlavini*), and among the oldest complete chondrichthyans in the world (e.g., *Cladoselache fyleri*).

Arthrodire skulls (cartilaginous postcrania are rarely preserved) are found in blocky shale, cone-in-cone limestone or shale concretions, and may often contain mushroom-like pyrite nodules growing from the cancellous bone tissue and across the bone surface. Chondrichthyans are almost exclusively found as complete specimens within shale concretions (likely a reflection of historical collecting bias), and preserve threedimensional soft tissue structures (e.g., ceratotrichia, gill arches, stomach contents). These varying preservational circumstances necessitate the utilization of specific preparation techniques and tools to properly extract the massive, bony placodermskulls and the delicate features of shark soft tissues.

Experimentation by CMNH staff and volunteers has established protocols for the preparation challenges of each unique Cleveland Member taxon. Shale overburden is worked down in layers using a flex-shaft hand grinder fit with a silicon carbide abrasion disk in a ventilated blasting cabinet with the aid of a microscope. For placoderm bone, once the first sign of black bone appears in the dark gray matrix, air abrasion using dolomite abrasive media is used to remove the remaining fine layer of shale. Masses of pyrite or barite can be removed down to the bone surface using an air scribe with a dull carbide steel tip. Grinding is not recommended on pyrite due to excess heating and wheel wear. For sharks, layered matrix removal is done exclusively with grinding wheels and air scribes. Air abrasion is not recommended as it tends to easily obliterate or mar soft tissue and tooth enamel.

Employing these basic methods, delicate/fragile fossils can be safely extracted from their hard shale matrix. In addition to revealing the Konservat-Lagerstätten preservation of soft tissue and gut contents in sharks, this procedure has recently led to the discovery and description of the first definitive cartilaginous postcrania from the Late Devonian apex predator *Dunkleosteus terrelli*.

THE PREPARATION PROJECT: A GLOBAL PARTNERSHIP BETWEEN THE MIFUNE DINOSAUR MUSEUM, KUMAMOTO, JAPAN, AND THE MUSEUM OF THE ROCKIES, MONTANA, U.S.A.

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In 2011, the Mifune Dinosaur Museum (MDM) proposed a unique collaborative partnership to the Museum of the Rockies, Montana State University (MOR) . This partnership, known as the Preparation Project, has allowed MDM staff to receive extensive training by MOR in curatorial techniques and the preparation of large dinosaur fossils. Fossils are prepared in the MDM viewing lab so that visitors can observe the process. The paleontology department at MOR benefits from this project as more than 700 fossils have been prepared over the course of the last 6 years, and are now available for research and exhibition purposes.

The first phase of this project began in 2012 when a large field jacket collected from the Morrison Formation of southern Montana in the early 1990s by MOR was shipped to the MDM. Believed to contain sauropod vertebrae, it was only upon preparation at MDM that the jacket was found to contain a rare nearly complete diplodocid skull. With wide spread media coverage, phase one of the Preparation Project attracted considerable attention throughout Japan, and visitation at the MDM increased significantly. Phase one was completed in the spring of 2013, and the project's success story was used by the MDM when they applied for a federal grant to fund the construction of a new museum which was completed in April, 2014.

The second phase of the project began in April 2014 and was completed over a two-year period. Field jackets containing *Daspletosaurus horneri* cranial and postcranial material were sent to the viewing lab at the MDM. The densely concreted sandstone encasing the fossils was a challenge for the MDM staff, but with additional training they skillfully prepared more than 150 specimens.

The third phase was also a two-year project and the MDM staff prepared additional sauropod specimens which were used in MOR's *Dinosaur Dynasties* exhibition at the MDM in 2017. Although the project was interrupted when a massive earthquake struck Kumamoto in 2016, preparation was completed in early 2018. There are few museums in Japan that hire fossil preparators, but the Preparation Project has attracted the attention of many natural history museums. It is our hope that this partnership will foster new relationships and be a model for future global collaborations.

Grant Information
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CRACKS, GREEN FOSSILS, AND MELTED BONE: CHARACTERIZATION OF PREPARATION DAMAGE USING SEM AND TOF-SIMS

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Mechanical and acid preparation have been the most common methods for preparing fossil bones since the 19th century. They have been very successful, and have shaped how fossils are interpreted and stored. The consequences of their use have only been analyzed after issues have occurred, forcing changes in the methodologies. For example, the coating of fossils before an acid bath began as a recommendation if there was doubt that the acid would affect them. In the present, coating is a required step that must be followed. In addition to these techniques, preparators have been developing their own innovative approaches, sometimes using practices from other disciplines like conservation. The goal of this work was to understand the

consequences of using three techniques: mechanical preparation, acid preparation, and laser treatment.

The samples used were small, unidentified bone fragments from the Cloverly Formation, Wyoming. The mechanical preparation was done using an air scribe, and one of the bones was intentionally damaged with three markings invisible to the naked eye. Acid preparation was performed using a 5% V/V acetic acid solution in water. Samples were coated with a thin solution of Paraloid B67, acetone and methyl-ethyl ketone, except for one of them, to evaluate the effect of the acid on it. Finally, a Nd:YAG (neodymium-doped yttrium aluminum garnet) 1064 nm laser system was employed for treatment. Samples were analyzed with a Scanning Electron Microscope (SEM), and one of them was further analyzed using an SEM with energy-dispersive X-ray spectroscopy capabilities (SEMEDS). Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS), operated in static mode, was employed to study the chemical composition of the surface of the samples.

SEM analysis determined that the area damaged with the air scribe contains micro cracks that can become future areas of damage if the specimen is not housed in proper environmental conditions. The uncoated sample treated with acetic acid shows severe cracking that is not observed with the naked eye. Laser-treated samples show variations in color with the naked eye, and under the SEM, the bone surface appears damaged. TOFSIMS analysis reveals chemical localization in the samples treated with the laser, but not in the others. These results indicate that fossil preparation can be a damaging agent to specimens if not done correctly. For this reason, it is important that institutions recognize the value in this profession, for both the long-term stability of their collections, as well as for future scientific analyses.

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ULTRA-THIN SMALL MAMMAL CRANIAL RECONSTRUCTION IN THE 0.5– 0.7 MILLIMETER RANGE USING BUTVAR B-76

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The Gray Fossil Site in east Tennessee represents a diverse assemblage of earliest Pliocene fossils, including many new species. Preservation at the site is often exquisite, but due to the small size of many animals and the enormous weight of the overlying clay small articulated specimens are often crushed flat. Bone directly adjacent to the folded breaks can sometimes be irreparably damaged by the taphonomic processes. Specimens can be fully prepared but the missing bone left from crushing does create zones of weakness. Curators desired the specimens to be stabilized by replacing the missing bone with filler. Candidates for filler were required to be archival, reversible, strong, and lightweight. It was also required that the filler be thinner than a millimeter, readily distinguishable from the actual bone, and not interfere with MRI and CT scanning. To meet all these requirements we developed a new technique that used Butvar B-76 as filler.

We first used this technique in 2008 on a nearly complete skeleton of a fossil red panda, *Pristinailurus bristoli*, particularly in reconstructing the crania. Once the majority of preparation had been completed, the exposed broken margin left by missing bone was coated in a fine bead of Butvar B-76. We then attached beads to points projecting into the void and pulled them into extremely fine threads, attaching to points across the void on a corresponding surface. This created a structure similar in appearance and curvature to a wire-frame. The threads where then stretched and contoured with a dental explorer while still in a semi-plastic state to match the curvature of the missing bone and allowed to set. Once the frame was hardened, a new higher volume bead was started and with a side to side motion of the glue tube pulled into a very thin sheet over the threads. The original threads were partially dissolved and incorporated into the freshly applied Butvar B-76, forming a 0.5 millimeter thick transparent sheet that matched the thickness and contour of the original missing bone. The final product is quite stable and allows the specimen to be handled with confidence. No degradation or changes have been observed over the last 10 years. The specimen has been scanned and the Butvar B-76 does not show up in scans due to its low density. We have successfully prepared a number of small specimens over the last 10 years using this technique, including eggshell.

MAINTAINING DATA LABEL INTEGRITY: A REVIEW OF MATERIALS AND TECHNIQUES FOR AFFIXING LABELS TO VERTEBRATE FOSSILS, HOUSINGS, AND COLLECTION STORAGE AREAS

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In order to track the identification and disposition of vertebrate fossils, specimens are often assigned catalog or locality numbers before being organized into a systematic or geochronostratigraphic arrangement. Assigning numbers and placing objects within a standard system is a common practice in paleontology. Yet many of us have experienced the frustration of data loss due to poor labeling materials or techniques. Paper deterioration can occur due to absorption of pollutants, insect damage, fluctuations in relative humidity and temperature, as well as UV and fluorescent light. Custodial neglect can result in equivocal association of data labels with the specimen. While digital methods for tracking specimen data may continue to advance, the need to manually label specimens and their storage containers will remain. Each specimen has a labeling history involving a suite of labeling materials and techniques from the time it is discovered in the field to its preparation in the lab to its curation for research or public display. During these stages, people of various expertise may handle or move the specimen to different physical locations. Every person entrusted with handling a specimen should take care to maintain the physical association of any data labels with the specimen. Developing a consistent method of labeling and a tool kit of materials and techniques is important. Selecting durable, long-lasting materials will help maintain the longevity of the information, but consideration should also be given to how labels are attached to the object, as well as the storage environment in which the specimen and label will reside. Examples of durable materials include the use of archival pens with light fast India ink, acid free Bristol cardstock, Tyvek, titanium white acrylic paint, and metal tags affixed with engraved or stamped numbers. Examples of methods for associating labels with specimens include, inserting labels directing into cavity mounts, using solution adhesives to affix labels to various surfaces, placing extra labels inside field jackets, using wire rivets, writing numbers on nested containers, encapsulating paper labels in mylar or polyethylene zip bags, and the use of plastic label sleeves with magnetic or adhesive backing for metal cabinets and oversize storage racks. Awareness of the physical properties of materials and how they behave in different storage environments over time is essential to maintaining data label integrity.

THE CURATION, CONSERVATION, AND DIGITIZATION OF A PLEISTOCENE FAUNA FROM GYPSUM CAVE, NEVADA, U.S.A.

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The relationship between early humans in North America with Ice Age megafauna has been an ongoing debate for many decades. Excavations at Gypsum Cave, Nevada in the early 1930s sparked the interest of archaeologists and paleontologists alike, as both artifacts and vertebrate fossils were found immaculately preserved in situ. The xeric conditions within the cave yielded exceptional preservation of soft tissue remains, such as ground sloth hair, skin, and horny claw sheaths, as well as plant material from ground sloth dung. Despite the intriguing aspects of the fauna, not much research has been done on the collection in the last 80 years.

In order to increase accessibility and thereby use of the collection for research, a federal grant was obtained to complete the curation, conservation, and digitization of this significant vertebrate fossil collection. An emerging professional was hired to work on the project and learn how to implement best practices concerning the curation of a historical collection. An initial condition assessment was conducted of an estimated 700 specimens housed in 31 drawers and 30 cubic feet of ground sloth dung housed in wooden crates. As a result, the following priorities were identified: creating space in the collection to accommodate expansion of the cataloged material, sorting and identification of elements and taxonomic groups, cataloging and archival labeling, taxonomic organization, specimen cleaning and repairs, archival housings, and digital photography. An inventory of accessory data showed that correspondence, cave maps, and photographs could be digitally scanned to supplement the contextual information about the site.

Applying modern conservation principles to the collection resulted in less crowded drawers and proper labeling of the material for easier access. Potential data loss was minimized due to improved specimen housings to mitigate the effects of abrasion, poor handling, and breakage of delicate specimens. Trays were lined with inert, non-abrasive materials, such as closed-cell polyethylene foam and polyester spun olefin. Deteriorated labels were digitally photographed and encapsulated in polyester mylar. The sloth dung previously stored in wooden crates was cleaned using a variable controlled vacuum and re-housed in Coroplast boxes so that the material would be protected from ambient pollutants. A public outreach component of the project will feature a blog about the curation process, historical significance of the site, and 3D photogrammetry models for public viewing on the museum web page.

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EVALUATION OF NOVEL VISUALIZATION SOFTWARE FOR VIRTUAL PALEONTOLOGY

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In early 2017, the Denver Museum of Nature & Science (DMNS) established a Digital Imaging Laboratory to perform paleontological research through the visualization of anatomical details as 3-dimensional models extracted from CT data. As a new, grantfunded lab, we had a small list of requirements that visualization software platforms needed to meet. First, we needed a powerful program capable of handling very large µCT datasets with ease and efficiency. Second, we wanted to employ a platform that was relatively userfriendly, as we utilize a volunteer corps to perform digital segmentation. The third limitation was cost; we hoped to utilize a platform that would absorb minimal grant funds. After a brief review of available options, Dragonfly (Object Research Systems, Montreal, Canada), a new visualization and image-processing platform, was selected as the primary platform pending an assessment period. Over the course of one year and several software updates, the DMNS Digital Imaging Lab exclusively uses Dragonfly for our virtual paleontology projects. Here we present our observations of the advantages and disadvantages encountered during the evaluation period. Several advantages of the Dragonfly platform were immediately apparent: an ability to handle large datasets up to 21GB; an intuitive interface that allowed users of all backgrounds to quickly learn the protocols for segmentation and meshing; and the free-of-charge non-commercial license to academic institutions. At the same time, some disadvantages became clear: mesh processing was almost non-existent; there was no communication with other common visualization programs (e.g., Avizo); and our license did not provide support help. Some issues required creative problem solving. Collaboration with external researchers and facilities required the development of a crossover protocol for sharing content between Dragonfly and Avizo. As the software evolved, more of our issues were resolved within the platform, whether fixing a particular software bug or creating a new application for mesh processing. Despite the issues encountered, the ease of teaching the program to new users and the powerful, yet straightforward segmentation capabilities allowed us to train a dozen volunteers and three interns in the first 10 months. As our work expands and evolves, we will continue to push the limits of the Dragonfly platform as a useful tool in paleontological research.

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OPTIMIZING THE SUB-OPTIMAL: USING POINT-AND-SHOOT DIGITAL CAMERAS, GREEN PAPER, AN IMAGE PROCESSING ALGORITHM, AND A KITCHEN TIMER TO BUILD AN INEXPENSIVE SEMI-AUTOMATED 3D SCANNER
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Many assume an expensive DSLR camera is a prerequisite to achieving high-quality results when using photogrammetry to build 3D digital models. I maintain the axiom that “the best camera is the one you have” applies as much in photogrammetry as in fine-art photography. Here I describe the improvised, semi-automated scanner and associated workflow I use to scan skulls and other objects between 5–30 cm long. At its heart my scanner consists of a backdrop of neon green cardstock, a pair of Nikon Coolpix P90 digital cameras, and what is essentially a

mechanical kitchen timer serving as the turntable. Any point-and-shoot (PAS) camera with decent macro capabilities and a built-in intervalometer should be appropriate for this purpose. When compared to PAS cameras, the main perceived advantages of DSLR cameras are higher megapixel (MP) counts and the ability to tightly control aperture and ISO settings. Many PAS cameras also have high MP ratings and decent ISO control. The main limitation of PAS cameras is the inability to set the aperture to hi f-stop values, which can result in photos with limited depth-of-field and out-of-focus areas. Without masking each photo, photogrammetry software struggles to align poorly-focused images and significant time and system resources are spent searching for structure in out-of-focus regions. I use automated actions in Adobe Photoshop to select and delete the green background and outof-focus areas in each image and replace them with a uniform green color. While this yields fragmentary images, they are optimized for use in model building in that only high- quality information is retained, significantly improving the signal-to-noise ratio of each image. Since the low information portions of each image have been replaced with a uniform color, it is possible to easily generate masks using the "mask by background" option in Agisoft Photoscan. When compared to using an equal number of unprocessed PAS photos, I have found that point cloud generation time in Photoscan is reduced by approximately 60%, and the time required to manually clean-up the final clouds is reduced to almost nothing. In practice, I use the decreased per image system demands to increase the number of images used in model building. Whereas 200–300 unprocessed images may have represented a strain on my system previously, I now commonly use between 400–700 images in model building, generate point clouds ofsignificantly greater densities with higher-quality points, and often still enjoy significant time savings.

DEVELOPING BEST PRACTICES TO IMPROVE FOSSIL DATA QUALITY AND ACCESSIBILITY

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As the paleontological community pursues greater data mobilization, paleontologists and collections professionals need to evaluate data management practices to determine the best course forward as we share an increasing volume of data. We have a responsibility to maintain high quality collections information and to enable the sharing of that information to stakeholders and communities to promote research, education, and preservation. In order to accomplish this goal we must develop and implement data capture workflows that utilize well documented best practices for recording specimen information in an interoperable, digital format.

The Smithsonian National Museum of Natural History Department of Paleobiology recently completed a two year effort to catalog all terrestrial mammal fossils in our collections to improve data quality. This project allowed us to refine our workflows to capture more detailed specimen data and assess our data management practices. We established controlled vocabularies and guidelines for recording data in specific fields, such as new best practices for morphological data. As part of this we reviewed how our data are structured, identified what data are required, and determined what standards existed or were lacking.

When the cataloging project ended in 2017, we had created over 13,000 new records and enhanced 15,000 existing records. We refined our cataloging workflows and developed best practices for capturing data that can now be applied to other vertebrate fossil collections in the department. By ensuring that the data are standardized according to best practices, we're promoting data quality and accessibility for scientific research.