WHEN *GLYPTOTHERIUM* FLIES: RELOCATION OF A MOUNTED SPECIMEN TO A NEW BASE

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The Smithsonian Institution National Museum of Natural History renovated the Fossil Hall and wanted to include the *Glyptotherium arizonae* specimen that was in the old hall on display. The specimen was mounted many years ago on a robust joist deck with mahogany trim. This deck was too large for the new space and did not match the new aesthetic. The base could not be trimmed down to fit in the smaller space because of the joist construction. The specimen has numerous bolts though the carapace and complete disassembly of the mount was deemed too risky for the health of the specimen. The mount consists of two pipes bolted to the base and a rainbow-shaped band of steel with supports on the inner side of the carapace. These two supports are independent, and we were concerned that torque on the pipes could damage the carapace. The selected option was to fabricate a new base and transfer the mounted carapace onto it.

To keep the pipes from moving during the transfer, 2x4boards were bolted on either side of the pipes to create a clamp. Grooves for the pipes were cut into the boards to increase the clamping strength. Additional 2x4 boards were attached to the pipes below and perpendicular to the previous clamped boards to create stable lifting points outside of the carapace. The specimen was unbolted from the base and lifted into the air with two chain hoists and lifting straps. A spreader bar was used to prevent the straps from rubbing on the carapace. Once the pipes were lifted clear, the old base was wheeled away, and the new base pushed into place. The specimen was lowered on to the new base and secured in place.

Although, this is not to recommend that anyone rush out and lift mounted specimens, if done slowly, and all of the contact points with the base are locked in place, it should be possible to create a new base for any specimen.

SKELETONS IN THE CLOSET: A CURATORIAL CASE STUDY OF THE MACE BROWN MUSEUM OF NATURAL HISTORY, AND OTHER UNIVERSITY NATURAL HISTORY MUSEUMS

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The Mace Brown Museum of Natural History (CCNHM) is a small paleontologically focused university museum in the Department of Geology and Environmental Geosciences at the College of Charleston. CCNHM is home to a unique and world-class collection of Oligocene age (30-million-year-old) cetacean (whale and dolphin) fossils, as well as home to the second largest collection of fossils from the Lee Creek Mine of North Carolina outside of the Smithsonian Institution. However, while the collection is unique in being one of the only institutions with such a large amount of these Oligocene cetacean fossils on display and in collections, it is not unique in some of the challenges it faces. University museums face many issues, such as poor or limited funding, unreliable climate control, limited security, and understaffing with high turnover, and many staff members have responsibilities split between museum work and academic work; while not all universities face all of these challenges, all face at least one of these problems. This curatorial case study of CCNHM compares other university museums to it and each other and analyzes these different areas where there is overlap between institutions to see any patterns in similar issues faced by different institutions.

Curatorial quality was assessed for CCNHM collections though a thorough internal audit, and a Google survey was sent to other university natural history museums to assess their collections; while museums all reported differing methods of security, collections sizes, and budgets, no strong correlation was found between higher budgets and curatorial assessments; it may be that museums scoring higher in individual curatorial assessments have larger staff sizes, or staff members who do not split duties with teaching, and instead can focus solely on museum work.

A TEST OF THE STATE OF THE ART IN 3D COLOR PRINTING

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Replicating fossils for a variety of reasons is almost as old as collecting and preparing fossils. Silicone molds havebeen the norm, but in the past decade or so, 3D printing has started to replace actual casts. 3D printing comes in many forms and uses digital models to guide the printing. The digital models can be created from a variety of technologies including laser and structured-light scanners, photogrammetry, and CT scanning. Common concerns with printing copies of fossils with 3D printers are visible 'topo lines', scars left by support struts, and the lack of realistic color. New advances are bringing high resolution color 3D printing to the public that also deals with these concerns.

The University of Wyoming's Engineering Makerspace recently added a full color Stratasys J750 polyjet 3D printer capable of printing over 360,000 color combinations at a 14 micron (0.00055 in.) resolution scale. The J750 is capable of producing full color, high resolution copies without the use of breakaway supports, instead using a removable water-soluble support. The UW program is free and available to the public to use with appropriate training, a short 90-minute course.

Staff and volunteers from the Tate Geological Museum recently spent time at UW to attend the training and print a 'fossil'. The Tate Geological Museum borrowed the University of Wyoming's type specimen of *Corosaurus alcovensis* (UW-5485) in hopes of creating an affordable replica for display. Using photogrammetry, a digital model of the specimen was made without actually threatening the delicate teeth. This digital model was used to make a full color 3D copy at UW on the J750 printer. The final product has none of the of low-resolution 'topo lines' on the model, no strut scars, and is in full color. Digital models of UW-5485 were also generated using two structured-light scanners (*Creaform2*0 and *HP 3D Scan*); however, these scanning technologies generated pixelated texture overlays and were unsuitable for printing on the J750. Model comparisons suggest that digital models generated with high resolution texture overlays, like photogrammetry, are better suited for color 3D printing. With the introduction of these new polyjet 3D printers, and the recent announcement of a new, affordable Stratasys J55 for museums and educators, replicating full-color, high resolution, accurate fossil specimens through 3D printing may be within the realm of possibility.

THE USE OF THE TEAS TRIANGLE TO REMOVE AGED MATERIALS APPLIED TO FOSSILS: AGED HYDROGENATED POLYMER (BLUE-TACK®) ON *HYPSILOPHODON FOXII* IN IGEA (LA RIOJA,SPAIN).

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Igea, a locality of La Rioja (Spain), contains fossil remains attributed to *Hypsilophodon foxii*. These remains were found, prepared, and put on display in 1994. The specimen was adhered to methacrylate sheets using a hydrogenated polymer (synthetic rubber) commonly known as Blue-Tack and displayed in a glass case.

Due to the need for further studies on the fossils, it was necessary to extract the specimen from the showcase and remove the aged Blue-Tack. Blue-Tack is composed of a hydrogenated polymer (synthetic rubber), which contains a particulate-shaped mineral filler, mixed with a blue pigment and a mineral oil, which is not specified, but presumably a paraffin, naphthenes, or aromatic hydrocarbons. The product also indicates that under optimal conditions of preservation (temperature, humidity, and low light incidence), it can last up to 4 years. Knowing the physical-chemical characteristics, we can place the Blue-Tack inside the Teas Triangle. In this way, we can superimpose two Teas Triangles (solvents and product) with the information of the organic solvents, and thus be able to determine which mixture of organic solvents is better and safer for the removal of the material. The organic solvents selected for the solubility tests are acetone and white spirit, given the nonpolar nature of the material we want to dissolve.

Finally, solubility tests are carried out by different applications of the solvents separately and together in the selected quantity, by swab in three methods: applied, rolled, and rubbed. Thanks to these tests and the comparison between the swabs, we can determine how solvents work on the material. With this comparison, we can see how the removal of both solvents works without having to use the rolled and rubbed swab, and the fossil suffers less mechanical stress. Therefore, the use of the Teas Triangle for the removal of applied materials can determine the necessary quantity of solvent and mode of removal to safely restore fossils for research.

ULTRAVIOLET INDUCED FLUORESCENCE DIGITAL PHOTOGRAPHY AS A DIAGNOSTIC TOOL FOR DISCOVERY, DIGITAL DOCUMENTATION, ANALYSIS AND CURATION OF PALEONTOLOGICAL SPECIMENS

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The use of ultraviolet lights to generate Ultraviolet Induced Fluorescence (UVIF) in fossil specimens is well known, but not widely utilized among paleontologists. Unlike many other diagnostic options, UVIF Digital Photography is a non-destructive, cost effective and easy to use tool using standard equipment. It can be performed by anyone to obtain immediate UVIF Digital Photographic images for documentation and analysis of fossil specimens and their enclosing matrix.

UVIF Digital Photography is particularly well suited for use on German Lithographic Limestone fossils which make up most of the Lauer Foundation collection. It helps to reveal rarely seen features such as the soft tissue preservation of muscle and skin. It provides clarity and definition of morphological details such as fine structures, teeth and bones.

UVIF can be used to identify areas where repair has been made and to reveal man-made artifacts of restoration or embellishment. Information obtained utilizing this technique has influenced and improved our fossil preparation practices. It has become part of our standard curation procedure and provides researchers with an additional diagnostic tool with which to more accurately analyze and measure specimens.

Our preferred UVIF digital photographic system utilizes standard DSLR or mirrorless cameras, without sensor modification, to photograph in the visible spectrum. We developed customized settings and techniques to efficiently capture images which are consistent and reproducible. A lamp equipped with 95-watt ultraviolet UV-A, B and C wavelength bulbs, which are used individually and together, provide the only light source in a darkened room. The UVIF response to specific wavelengths varies from specimen to specimen, therefore each is subjected to the full range of UV frequencies and photographed. A linear polarizing filter and an orange color lens filter provide enhanced clarity and resolution while reducing glare. Safety procedures require protective clothing and UV goggles must be worn to avoid skin and retinal damage.

Refinements include a custom-built light stand, camera stand, motorized table and a tethered 4K monitor. These provide consistent and reproducible results and can be easily modified to accommodate variable sizes and types of fossils.

REMOVING PAINT FROM A MASTODON THAT WAS ON EXHIBIT FOR 90 YEARS
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In 1904 a partial mastodon (*Mammut americanum*)skeleton was discovered in Moorland, Michigan and purchased by the Grand Rapids Public Museum (GRPM) for $300. The bones were almost immediately put on exhibit in an articulated, standing position and stayed on exhibit almost continuously until 1994, when the skeleton was partially dismantled and moved into storage. In 2019, work began on completely disassembling and repairing the skeleton for better long-term preservation and returning it to a state more similar to when it was found. Here we report on the methodology used to remove multiple layers of water- and oil-based paints from non-permineralized bone without the use of an air abrasion unit.

A bone was placed on a pedestal in a sealed container with 0.5-1 inch of acetone and left in the vapors for 24 hours. The bone was then scrubbed for 15-30 minutes with a moderately stiff nylon brush dipped in 70% isopropyl alcohol to remove any peeled paint. The bone was then rinsed with water and placed back into a sealed container with acetone for another 24 hours. This process was repeated two to four times, depending on paint thickness and the bone's surface roughness. Wax sculpting tools were used to remove paint from problematic cracks and crevasses, after the second acetone vapor bath. The paint was easier to remove using multiple, shorter vapor treatments opposed to trying to remove all the paint after one longer treatment (>48 hrs). A thin, black layer composed of an unknown, man-made coating makes up the fourth layer on the bone, but a methodology for its complete removal has not yet been identified. This black layer will sometimes flake off the smoother bone surfaces after the second or third vapor bath, but is largely unchanged even after being completely exposed and sitting in acetone vapors for a week.

Acetone, water, 2% hydrogen peroxide, 70% isopropyl alcohol, and paint thinner were all tested for removing the paint, by directly brushing the liquid onto the bone and placing the bone in a vapor bath for various lengths of time (1-144 hrs). Acetone vapors and brushing with isopropyl alcohol has proven to be the most efficient method for removing the paint without degrading or damaging the non-permineralized bone.

RESTORING OUTREACH, DISPLAY, AND RESEARCH VALUE TO A SPECIMEN OF *TRICERATOPS* FROM THE UPPERMOST CRETACEOUS HELL CREEK FORMATION OF NORTH DAKOTA THROUGH INSTRUCTION IN PREPARATION AND CONSERVATION

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In 1975 an Appalachian State University (ASU) crew recovered an incomplete *Triceratops* skeleton from badlands near Marmath, North Dakota. After initial retrieval and preparation, several *Triceratops* bones have been on display, but most remained undisturbed in storage. Recently, ASU paleontology classes have used these fossils to teach paleontological preparation, conservation, and research methods, while enhancing the specimen's scientific value by inventorying and preparing it for accession into a recognized repository. The *Triceratops* includes at least one incomplete postorbital horn core, much of the left and right squamosals, dozens of frill and other skull fragments, an incomplete right lower jaw, one complete and several fragmentary vertebrae, several complete ribs, hundreds of rib fragments, an incomplete scapula, many femur fragments, and several small unopened jackets. A small tyrannosaurid(?) tooth and incomplete turtle carapace were also collected from the site. Preparation work included cleaning and removal of sediment and non-archival adhesives using pin vises and acetone as well as reconstructing fractured bones, initially with PaleoBond® products, but increasingly with more archival paraloid (B-72) and/or polyvinyl acetate (Butvar B-76). Conservation work also included removing old jackets, building support cradles, and archiving related collections data, while replication was carried out by molding and casting with platinum silicone rubber molds and urethane resins. We are now using photogrammetry to generate 3-D models of various bones (right lower jaw, both squamosals, the postorbital horn core and dorsal vertebra) with Agisoft PhotoScan.

A histologic study was also performed on a rib fragment to evaluate the microstructure preservation in this specimen The rib was embedded in resin and mounted to slides using a curing epoxy. The microstructure, including numerous secondary osteons, was very well preserved, suggesting that the femur or other rarer elements could provide more histologic data.

As a result of this project, students learned a variety of paleontological preparation, conservation, and research methods while removing the specimen from storage and placing it on exhibit in support cradles on archival materials. Replication methods allow for a greater use of this specimen for outreach events, continuing its use as a teaching specimen while preparing for its accession to a recognized repository.