THE USE OF SODIUM POLYTUNGSTATE TO ACCELERATE THE PICKING OF VERTEBRATE MICROFOSSILS: A CASE STUDY FROM THE ELLISDALE FOSSIL SITE

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Sodium Polytungstate (SPT) is a non-toxic salt combined with distilled water to create dense aqueous solutions (up to 3.1 g/ml) that can be used to in a sink-float process to separate materials of different densities. Materials that are less dense than the solution float to the surface and denser materials sink to the bottom. The less dense material is removed from the surface. The denser material retrieved from the bottom. It is used extensively in paleontology to separate microfossils from the surrounding mineral grains and clasts.

The Ellisdale Fossil Site in New Jersey is significant for the diverse collection of Late Cretaceous vertebrate microfossils from eastern North America. In addition to the vertebrates, the site also contains significant quantities of charcoal that obscure microfossils when picking. The initial purpose for the SPT treatment of this site was to float the charcoal and sink the fossil remains to make it easier and quicker to find the fossils. After some testing, the fossils were determined to be denser than 2.75 g/ml. For reference, quartz is 2.65 g/ml.

The vertebrate microfossil material was initially wet screened with 1 mm and 0.425 mm nested sieves. After each sample dried, about 50ml of screened material were added to a 250 ml beaker filled with 100 ml SPT adjusted to 2.75 g/ml. The solution was gently stirred, filled the rest of the way with SPT, and left alone for ten minutes to let the contents settle. A small stream of SPT was then added to coax the less dense material to flow off into a collecting tray. Once the surface was clear, the contents of the beaker were poured through a 0.1 mm sieve and allowed the drain. The same was done with the fluid in the tray in another 0.1 mm sieve. Both sieves were rinsed three times with distilled water to recover the SPT. The rinsed solution was filtered to remove particles and left to evaporate. The density of the solution was checked as the water evaporated until it was at 2.75 g/ml and then poured into a storage bottle to be used again.

This process took about 4 man-hours over the course of two days to complete. It separated about 80 percent of the sample as float, leaving the last 20 percent as sink. The sink contained largely iron oxides, pyrite, glauconite, and clay aggregates. The fossils stand out among these minerals and were easily picked.

3D PRINTING POP-TOGETHER OSTEOLOGICAL MODELS: A DESIGN AND FABRICATION WORKFLOW

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Inspired by the work of Mr. Ramón Gonzalez, we set out to make 3D pop-together models of fossil vertebrate skulls where the individual bones are held in place by embedded magnets. While it is possible to simply drill small holes and insert magnets into the contact surfaces of the 3D-printed elements, that method presents several limitations. Small or fragmentary joint surfaces will not provide the contact area necessary to form a stable link. Additionally, if multiple copies are desired, each must be drilled and filled by hand. We developed a workflow where all of the modifications necessary to bridge gaps between elements and create magnetic housings are done digitally before 3D printing. While initially more labor intensive, working digitally gives us the ability to produce models that display a wider range of morphologies, make multiple copies with little additional effort, replace damaged parts, and easily redistribute the 3D printable files. To create several demonstration models, we used Avizo Lite (ThermoFisher Scientific) to segment the individual bones of the mandible of an adult *Alligator mississippiensis*; and obtained mesh files of other specimens available through digital repositories (e.g. MorphoSource and Sketchfab). We used the free program Meshmixer (Autodesk) to edit and modify the surface meshes.

The process of turning the mesh files into a magnetic pop- together model consists of eight major steps: Initial Print Optimization – removing unnecessary geometries and bridging of small gaps; Scaling – since the size of the magnets is fixed the final scale of the printed model must be set before further modifications can be made; Enforcing Edge Congruence – modifying the contact surfaces of each element to assure proper fits; Joining – adding the infrastructure needed to hold the magnets; Final Print Optimization; 3D Printing; Assessment and Modification – final fit tests and mesh revisions; and Final Assembly.

For the end user, assembling the model demonstrates the articulations between different bones and how they contribute to the structure of the skeleton. Disassembling a model allows for inspection of individual elements and reveals features that are not normally visible. Beyond simply illustrating relationships and concepts, the final printed models are a huge amount of fun to take apart and put back together, making them well suited for use in education and outreach.

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EXAMINING DATA COLLECTION, ARCHIVING PROTOCOLS, AND DATA ACCESSIBILITY IN FOSSIL PREPARATION LABS

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Through a systematic program of paleontological resource inventory and monitoring, the National Park Service (NPS) has been at the forefront of paleontological resource management on public lands. The Utah Geological Survey has partnered with the NPS for the past twenty years to inventory and monitor paleontological resources in the national parks of Utah that contain significant vertebrate fossils. These inventories have focused on Mesozoic rocks, especially the Triassic Chinle and Moenkopi Formations, because of the extensive outcrop exposure in the parks and high potential for scientifically significant vertebrate fossils. Although many parks have completed baseline paleontological resource inventories and more targeted follow-up fossil surveys, the fossil resources of Canyonlands National Park (CANY) have remained virtually unknown. In 2020, we began a survey of paleontological resources in CANY, focusing our efforts on the Early Triassic Moenkopi and Late Triassic Chinle Formations in the Island in the Sky District. A second phase was completed in the spring of 2022. Based on this fieldwork we have documented over 100 new fossil localities. We found that the Torrey Member of the Moenkopi contains numerous vertebrate tracksites. Many of these sites preserve Chirotheriid-type swim tracks. Several localities contain small terrestrial tracks tentatively assigned to the ichnogenera *Chelonipus*, *Procolophonichnium, Protochirotherium, Rotodactylus*, *Synaptichnium*, and others. We directed most of our field efforts to the Chinle Formation because of the high potential for finding significant vertebrate fossils. Northern CANY lies in the Paradox Basin, and Chinle deposition in the region was influenced by salt tectonism. Consequently, Chinle strata in the region are difficult to correlate with Chinle strata elsewhere in southeastern Utah. Workers have recognized the Kane Springs strata that likely correlate to all or parts of the Moss Back, Petrified Forest, and Owl Rock Members. The upper Chinle strata are assigned to the Church Rock Member. One of the goals of our survey was to find taxonomically identifiable vertebrate fossils that can be used for biostratigraphy. Numerous vertebrate localities that include the remains of aetosaurs, metoposaurs, phytosaurs, and fishes from the Chinle Formation were documented and placed in stratigraphic context.

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BASIC FIELD JACKETING TECHNIQUES - A CASE STUDY OF METHODS USED IN THE NIOBRARA FORMATION OF KANSAS

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Field jackets are a critical component to the work of paleontologists and preparators. They ensure safe transport of fossil material from the field to the lab, and safe storage once there. Triebold Paleontology Inc. (TPI) has completed fieldwork for over three decades and has honed an effective set of methods for field jacketing that will be used to discuss basic techniques and safety. Topics include materials, personal protective equipment, overall plan for jacket size, shape, structure, flip, and safe extraction. The aim of testing different field jacketing methods is to provide anyone doing fieldwork with a basic set of guidelines to recover specimens in the safest way possible. Standardizing field collection techniques has the potential to improve the science of paleontology as a whole.

The authors investigated how jacket strength may be affected by different fabrication methods. Strength tests were performed on strips made using three layers of 45 cm x 15 cm burlap and USG Hydrocal White Gypsum Cement. Four different methods were tested: 1) Hydrocal was mixed normally (control); 2) the strip was sprayed with water after the Hydrocal had set but not fully cured; 3) Hydrocal was allowed to partially set and thicken, then water added to thin it to working consistency; 4) burlap was soaked in water before use. Each strip was placed on a scale and tested to failure. The control and the strips sprayed with water failed at approximately the same amount of weight whereas the strips made with reconstituted plaster and wet burlap failed earlier. These results indicate that constructing field jackets using water-soaked burlap or reconstituted plaster are inferior techniques.

Additional tests examined whether burlap cut on the bias or parallel to the weave (straight-cut) affects overall jacket strength. Three layers of bias-cut burlap laid in alternate orientations to create a woven square were mixed with Hydrocal and then tested to failure against squares with straight-cut burlap. Results show that squares made with straight-cut strips failed at approximately half the weight as the bias-cut squares. The authors also tested this idea using simulated standardized jackets, tested after 3 days (short-term cure to simulate field conditions) and after 30 days (long-term cure to approximate storage). These results show that straight- cut jackets failed under less weight as well as more catastrophically than bias-cut jackets.

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STABILIZATION AND CRATING FOR TRANSPORT OF A LOANED HOLOTYPE *TRICERATOPS* SKULL

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USNM V4928 is the holotype of *Triceratops calicornis* (=*Triceratops horridus*), in the National Museum of Natural History (NMNH) collections. The cranium and lower jaws of the specimen were loaned to the University of Colorado Museum of Natural History (CUMNH) in 1981, where the frill was reconstructed in the museum exhibit space. A wooden base displays the cranium and jaws in articulation, with the specimen supported by external and internal steel armature.

To return the loaned specimen, two advance trips were made by NMNH to CUMNH to assess and measure the specimen and surrounding spaces. As the reconstructed frill was now wider than museum doorways, the challenge was how to crate and remove the specimen with minimal alteration. Preparations included creating technical drawings for crates, mapping reconstructed materials in the specimen, and advance shipment of supplies. A daily schedule of work determined the person-hours required. Arrangements were finalized with campus staff also providing much-needed resources.

To retrieve the specimen, a team of four NMNH staff worked with CUMNH staff over a period of five days. Work was conducted within the museum's Paleo Hall exhibit space. The process to prepare, pack, and crate the specimen included first protecting the surrounding floor and exhibits. Specimen cracks were consolidated, and gaps filled using solutions of Butvar B-76 in acetone. The lower jaws were removed from the mount and packaged individually. The display base became the crate base by adding wood supports and replacing caster wheels. The right side of the frill was cut off through reconstructed materials using an oscillating saw. All specimen parts were padded with Ethafoam, then wrapped in plastic cling wrap and bubble wrap. Specimen pieces were secured to the deck of the display base for transport. Open space under the ventral surface of the cranium was infilled with wooden supports and expanding foam. Wood studs, diagonal braces, and plywood formed the crate walls and top. Campus Facilities staff used a forklift to take the crate off the museum's front steps, and transport it to a dedicated freight truck. All work processes were documented to aid in future work with the specimen at NMNH. Collaboration with CUMNH and Facilities staff minimized the project's impact to the museum and campus. Although onsite conditions required slight deviations from the original plans, advance planning proved essential to a successful project.

VIRTUAL RECONSTRUCTION OF THE PARANASAL SINUS AND NASAL AIRWAYS OF THE GIBRALTAR- 1 *HOMO NEANDERTHALENSIS* SKULL.

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This work exposes new methods of virtual reconstruction, which in combination, provide an emerging potential for solving fossil record problems, in this case study, the skull of the Gibraltar-1 specimen, *Homo neanderthalensis.* Fossil remains of Neanderthals rarely preserve details of internal anatomy such as the endocranial base or internal facial structures. Gibraltar 1 lacks a considerable part of the neurocranium, yet the internal part of the nasal region is comparatively well preserved. Thus, in the context of paleophysiologically related research there is a great need for improved virtual reconstruction methods. Such methods must be non-invasive given the importance of the material; therefore, we start from image acquisition techniques such as computed tomography. Once these image data are obtained, a virtual reconstruction processes can be carried out. First, by using various specialized image enhancement programs, we improve image quality and eliminate artifacts due to taphonomic materials of the fossil. Then, based on comparative material of morphologically, phylogenetically, or otherwise related specimens and human cranial material, we proceeded to the virtual generation of missing anatomical regions of the fossil. For this purpose, we used techniques of anatomical repositioning, mirroring, and positional calibration. For a better control of the thickness, shape and position of the generated bone elements, topological deviation techniques and distance analysis thickness were applied. The result of this virtual reconstruction provides great anatomical detail and information. Particularly, our reconstruction offers a highly detailed and complex endocast of the paranasal sinus and more information on internal anatomical elements of the nasal region and airways. Based on this newly reconstructed bone information, further improvement was achieved using 3D (semi-)landmarks for quantitative, geometric morphometric tissue reconstruction by missing landmarks estimations. This new reconstruction of the soft-tissue airways suggests a relatively high nasopharynx, narrow air passages and vertically oriented choanae These new mesh configurations gave us new results in the CFD simulations in Flowgy, giving an improvement in the middle and final part of the nasopharyngeal path in air acclimatization and a lower nasopharyngeal pressure. These data indicate that further high-precision reconstruction is needed to decipher fossil physiology using modern technology.

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PLASTER FIELD JACKETS USING AIR FILTER MEDIA: AN ALTERNATIVE TO TRADITIONAL BURLAP AND PLASTER JACKETS

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Traditional plaster field jackets using plaster and burlap were developed by paleontologists in the late 19th century, and the same technique is still widely used today. Occasionally the plastering process fails due to improper measuring and/or mixing and often wastes plaster. Poor distribution of burlap across the specimen increases the risk of failure as well.

In the early 2000's, an air filter media made of polyester, which is used in HVAC systems and sold in bulk rolls of varying sizes, was proposed as an alternative material to burlap on the preparators' listserv. After nearly 20 years of experiments and field use, the Field Museum team has achieved a quick and effective method of making plaster field jackets using 1" thick filter media. In this method, one square foot of filter media requires plaster mixed with 1 qt of water. Five steps are required to make a successful filter media plaster jacket; 1) prepare a block containing fossils by isolating and undercutting the block, filling large gaps and cracks with mud or paper, and covering it with a separator such as wet paper towel, 2) overlay uncut filter media with the tacky side facing down, mark a line for cutting and orienting the filter media, then cut it with a pair of scissors, 3) measure water according to the size of the filter media, disperse the plaster evenly onto water, and let soak undisturbed for 3 minutes, then mix continuously for 3 minutes, 4) saturate the filter media with the plaster mixture, and 5) place it on the block when the plaster mixture is viscous, rub and squeeze the surface to remove air pockets, and add remaining plaster to smoothen the surface.

The compression strength of the casting plaster is up to 1200 psi after one hour of setting and 2400 psi after complete drying, and a single layer of filter media with casting plaster is equivalent to 3 to 4 layers of burlap with plaster, but it is uniform in thickness. In order to achieve the maximum strength, the proper ratio of water-to-plaster and the timed soaking and mixing technique described above should be used. Minimal plaster is wasted with this method because all the components, the filter media, water, and plaster, are measured. The filter media plaster jacket is a quick one-piece wrapping technique that is an excellent alternative to the traditional plaster and burlap method.