A technique for cutting and preparing a section of Cretaceous/Paleogene boundary for exhibition

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We developed a method for cutting and polishing soft sedimentary rocks for exhibition, featuring a Cretaceous/Paleogene (K/Pg) boundary section collected from the uppermost Maastrichtian Lance Formation (Powder River Basin) of Central Wyoming. This field sample highlights the iconic moment of extinction and evolutionary transition caused by the Chicxulub impact, highlighting the boundary clay and spherules resulting from the impact. Sections of boundary rock were collected using plaster field jackets, capturing 18 centimeters of rock above and 27 centimeters below the boundary. The field jacket was left open on one side and later consolidated with epoxy to stabilize the layers of rock. Clear epoxy resin and hardener were mixed completely, then diluted 20% by mass with denatured alcohol to lower viscosity for improved absorption. Epoxy was poured into the open block of sediment in several rounds until saturated. After curing, the block was placed into a bin and leveled with bedding tilted vertically. The block of sediment was wrapped in plastic, and plaster was poured into the bin to hold it in place for cutting. At the Lyons Sandstone quarry (Colorado), the block was cut with an industrial diamond wire saw. The two halves were each embedded in plaster individually and saturated again with diluted epoxy. A second round of cuts was completed at the Lyons quarry, creating two 1.5 cm thick slices of sediment and two thicker end caps resulting in four total display pieces. The wire saw was oriented parallel with bedding to help hide cutting imperfections. Two of these pieces were consolidated again, one with diluted epoxy, and the other with Tenax Tiger Agar Sealant. Both pieces were polished down from 40 to 2000 grit, the epoxy sample with diamond studded buffing pads on an angle grinder and the Tiger Agar sample with aluminum oxide sandpaper on an electric hand sander. The final step to create a smooth surface required polishing the slabs with a cotton buffing wheel and jeweler's rouge. Epoxy consolidation resulted in a more solid display piece with more color distortion, while Tiger Agar consolidation gave truer colors, but filled holes less effectively. Both polishing methods display layers of the rock and spherules clearly and create a more robust finished product than an unfinished surface. The two polished specimens are currently featured in temporary exhibits at the Denver Museum of Nature & Science and Betty Ford Alpine Gardens (Aspen, Colorado).

Funding Sources Denver Museum of Nature & Science, National Science Foundation (Frontier Research in Earth Sciences grant EAR-2317666).

New methods for complex morphologies: quantifying three-dimensional complexity in mammalian cranial sutures

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Cranial sutures are a network of fibrous joints that connect and form boundaries between skull bones. These joints are growth sites of skull bones during development, and act as absorbers of biomechanical stresses the skull is subjected to. Suture outlines form interdigitations whose frequency and amplitude correlate with both growth and stress absorption patterns, and thus represent important developmental, biomechanical and ecological markers for extant and fossil taxa. Efforts to quantify and compare suture morphology have been hindered by their large intra- and interspecific variability, the lack of strict homology, and by challenges in extracting them from CT scans. Traditional methods were limited to assessments of suture outlines in two dimensions without considering underlying three-dimensional morphologies. Thanks to recent advancements in parcellation techniques, it has now become possible to quantify and compare their 3D morphology. Here, we showcase the first-ever methodological steps for extraction and visualisation of detailed three-dimensional suture outlines in mammalian taxa. We then apply three dimensional complexity metrics to quantify and compare their morphologies. We introduce the use of alpha complexity as an effective means to capture the functional and developmental aspects of suture morphology, such as interdigitation. Due to the elevated variability introduced by complex geometrical structures, these aspects are not clearly captured by other quantification methods such as 3D geometric morphometrics. We applied this new approach to a sample of fifteen mammals to quantify variation in suture complexity and assess its relationship to skull function, including feeding and brain protection. We find that across mammals, facial sutures are generally characterised by higher complexity compared to the sutures of the cranial vault, indicating that biomechanical stress from mastication is a dominant influence on suture morphology. Herbivores generally show more complex sutures than taxa with diets that require less oral processing. Going forward, we are expanding our dataset to include non-mammalian synapsids to reconstruct changes in cranial sutures associated with the evolution of complex mastication along the lineage leading to mammals.

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A method for conservation of waterlogged material: A case study using fossil tusk

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Waterlogged subfossil and poorly mineralized fossil vertebrate material is notably difficult to conserve due to its susceptibility to damage during the drying process. Techniques have been developed to conserve waterlogged subfossil material; however, each method presents its own problems and no cohesive solution resulting in minimal damage currently exists. Tusks present a unique problem due to their density and layered growth and are more likely to crack or delaminate while drying, highlighting the need for a reliable conservation method. In 2020, a 1.3m-long section of mammoth tusk was discovered at a local gravel pit and brought to the Science Museum of Minnesota for conservation. The tusk was approximately 12m below the water table, and the tusk itself was waterlogged, requiring immediate treatment to prevent uneven drying and subsequent damage. Current guidance on conservation of waterlogged materials suggests various methods of air-drying, unless the specimen has experienced loss or degradation of the original organic material; however, the condition of the material may be hard to determine initially and degradation may not be obvious until warping or cracking occurs. In an attempt to minimize the damage caused during the vulnerable drying process, consolidation, dewatering, and drying were combined into a single multi-step process. Typical adhesives used in fossil preparation react poorly with water, plasticizing and preventing penetration, so a water-based adhesive was chosen for initial consolidation. The tusk was placed in an initial bath (10% water-based adhesive to water) and left loosely covered for a month, after which the adhesive was emptied, properly disposed of, and a new batch mixed. The adhesive to water ratio was increased by 10% monthly, up to 50:50. Once consolidation was complete, the dewatering process began and the tusk was placed in a bath of 10% isopropyl alcohol to water. The alcohol was also chosen to assist in further dilution and penetration of the adhesive. The alcohol to water solution was also increased 10% monthly and the final bath of 100% isopropyl alcohol was allowed to evaporate naturally, as a final proxy for the necessary slow-dry. Once evaporated, the tusk was able to be further consolidated with Butvar B-76 and has been stable for approximately 2 years.'

Results of an extensive surface-scanning project of Idaho's Cretaceous fossil record

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The Albian-Cenomanian Wayan Formation, predominantly exposed in eastern Idaho (USA) preserves a unique upland assemblage, including: dinosaurs, crocodilians, turtles, mammals, and fishes, as well as gymnosperm and angiosperm remains. The Wayan Formation has been understudied compared to broadly contemporaneous units in surrounding states (i.e. Cloverly and Cedar Mountain formations). In 2024 the Idaho Museum of Natural History (IMNH) completed an ambitious program to digitize via surface laser scanning the Wayan Formation vertebrate record in order to provide digital specimen security during exhibit creation, create a comprehensive and accessible digital public collection, and create new education and outreach materials. The IMNH achieved these goals, and this project provides a roadmap for other institutions. There are two main steps for digitization; scanning the specimens, and processing the scans into 3D files for use. Specimens take between 5 minutes and an hour to scan, depending on their complexity. Each object received a minimum of 18 scan passes, with more complicated shapes requiring additional passes. A medium-sized, geometrically-simple specimen would take approximately an hour and a half to fully scan and process: processing the raw scans includes trimming background data and aligning all the scan passes. This takes a minimum of 15 minutes; specimen alignment time varies by size (with large pieces usually aligning overnight). Processing a specimen into a manifold 3D object requires another minimum of 15 minutes. In total, approximately 500 individual fossils were surface scanned between 2023 and early 2024. This represents all specimens suitable for surface scanning, >80% of Idaho's Cretaceous fossils at the IMNH, with >120 hours spent on scanning and postprocessing. 25% of scanned specimens have been partially post-processed in alignment software, and 14% have been fully processed into manifold 3D objects suitable for upload to a database or 3D printing. 2% have been printed for use in education and outreach, with this number expected to reach over 10% by the start of 2025. As of May 2024, over 2,000 K-12 students in Idaho have interacted with these 3D prints, across 9 counties. Additionally, nearly 6,000 visitors have interacted with touchable Wayan 3D prints in the IMNH's gallery.

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Sticking up for Cuvier: osteological correlates of performance and ecology from big morphological data

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Highly-dimensional, densely-landmarked morphology datasets seem to over an unparalleled chance to test for relationships between morphology and function, but many recent analyses of morphological covariance in big morphology data have only recovered allometric and phylogenetic signal. This has been surprising, as many of the systems assessed (e.g., bird beaks) have long been viewed as textbook examples of adaptive morphology. Many current forms of analysis, inherited from linear and low-dimensional geometric morphometrics, do not allow full exploration of densely-sampled morphology—or if they do, they couple morphological complexity with ambiguous, low-fidelity ecological data. This results in bias that inflates evolutionary allometric signal and filters out ecological relationships. While the prevalence of evolutionary allometry is a noteworthy result, it does not need to be mutually exclusive of ecological signal. This study uses simulations alongside Partial Least Squares (PLS) analyses of handwing morphology and qualitative ecological information in extant coraciimorph birds to assess two analytical strategies for recovering ecological relationships. The first strategy addresses the shape of 'unpreserved attribute' data, and is assessed by comparing guild-like ecological categories (e.g., aquatic, semi-aquatic, and terrestrial), principal coordinate analyses on binary performance related characters, and direct inclusion of binary or proportional performance-related characters by a modified Hellinger transform. Preliminary results of this assessment show that both data reduction approaches restrict inferences to patterns of covariance seen in the 'training' taxon set, preventing an inference of novel performance combinations with novel morphology. The second strategy addresses the treatment of landmark data, and is assessed by comparing morphological data reduction by Principal Components Analysis, landmark decimation based on morphological covariance, and a novel decimation approach informed by estimated morphology-performance relationships across the tree. Preliminary results from this assessment show that strict morphology based data reduction may not be desirable for PLS analyses of ecology. Taken together, these strategies offer a means to look past expected allometric signal and test for subtle, evolutionarily stable relationships that can serve as quantitative osteological correlates.

Funding Sources Northeast Ohio Medical University

Opening the digital door at MOR: reconfiguring the Paleontology Collections to increase accessibility

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Since the founding of the Paleontology Department at Museum of the Rockies (MOR) in 1982, the museum's paleontology collections have grown to an extensive representation of dinosaurs and other vertebrates (currently over 13,000 numbered specimens) from the northern Rocky Mountain region. MOR is a repository for fossils found on state of Montana and federal lands and the collection continues to grow with ongoing fieldwork. To facilitate tracking of specimens and related data, the collections are being reorganized into a hierarchy of geological formation, land management agency, locality, taxonomy, and anatomy. This organizational structure prioritizes the preservation of paleoecological data and is attuned

to the needs of land management agency inventories. Over the years, specimen tracking at MOR has evolved from the use of a card catalogue, to digital spreadsheets, to the recent implementation of the browser-based relational database system: Specify. This software has been customized to record individual elements preserved from each specimen, as well as depositional and taphonomic information. The database system permits the importation and tracking of specimen and locality images, as well as photomicrographs from the museum's archive of paleohistological specimens (n >2400). In 2024, MOR's paleontology collection will be made available to the public via a web portal, with certain data embargoed per federal and state regulations. Updating the organizational system in the paleontology collections at MOR and improving digital access to this library of information will greatly expand its use for paleontology research and education during both onsite and virtual visits to the collections.

Funding Sources Funding for the MOR Paleontology Collections reorganization provided in part by Department of Interior, Bureau of Land Management, and United States Forest Service.

Animal, environmental, and health safety challenges facing paleontological collections in southern Arizona inform climate-calibrated roadmaps for fossil repositories

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With regard to secure long-term housing of fossils in the United States, Arizona provides greater geological stability and insulation from natural disasters compared to the tectonically unstable Pacific, tornado afflicted Great Plains and Midwest, and hurricane-threatened Eastern Seaboard and Gulf regions. Year-round low humidity inhibits corrosive decay of fossils (i.e., pyrite disease) without the need for indoor moisture control. In the latter half of the 20th century, southern Arizona was home to a robust paleontological program centered on the University of Arizona's Laboratory of Paleontology (UALP). Their activities resulted in the collection of 23,730 specimens across 9,000+ localities. Collection degradation resulted from the shuttering of UALP in 1996; reduction in access to public fossil collections also negatively impacted localized research and student training opportunities. Continued restoration of historical collections and opening of new collections is necessary for revitalizing paleontology in Arizona. However, collections management in the desert Southwest is not without its challenges, chief among them being inadequate funding and staffing. Non-administrative challenges to fossil collections and their stewards include animals, such as the termite *Heterotermes aureus* and the rodent *Neotoma* sp.; environmental hazards, including wildfires and floods; and finally, hazards to worker health, such as radioactivity from fossils themselves. Significant vertebrate material remaining in the region includes the "Empire Mountain Dinosaur" (UALP 4638), numerous mammals from the Miocene, Pliocene, and Pleistocene of Arizona (particularly camelids and proboscideans), as well as the early Cretaceous brachiosaurid and Arizona state dinosaur *Sonorasaurus thompsoni* from the Turney Ranch Formation, represented solely by ASDM 500. Initial radiological evaluation of ASDM 500 reveals emissions averaging ~3 μSv/hr1 or roughly 10 times typical background radiation levels. This assessment was founded on experience with multiple regional collections and enhanced with midand end-century climate change projections for Arizona in the literature to create a roadmap for successful long-term housing strategies.

Exceptionally large jackets required: Collection of an adult gomphothere skeleton from a sandy bone bed in northcentral Florida

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The Montbrook Fossil Site is a latest Miocene (~5.5Ma) fluvial deposit in Levy County, Florida with sediments consisting of alternating layers of unconsolidated sand and clay. The most common mammal recovered is the gomphothere *Rhynchotherium* sp. represented by over 38 individuals, mostly juvenile to subadult. In April 2022, the first articulated adult skeleton was exposed, initially by the right forelimb. Further excavation revealed a nearly complete skull with in-situ left tusk and mandible, the left forelimb, paired scapulae, numerous thoracic vertebrae and ribs, the pelvis, and both femora; all articulated or nearly so. This individual was likely a young adult male based on tooth eruption (heavily worn M2/m2; fully erupted and lightly worn M3/m3), the large size of major limb bones, and circumference of the tusk. The progress of the skeleton's year-long excavation was documented with photogrammetry providing taphonomic information otherwise lost. Using the 3D models as a map, individual elements were tracked after removal. Collection of the skeleton required numerous plaster jackets, including one of extraordinary size (~4.09m3). Prior to jacketing, the fossils were heavily consolidated with a solution of acetone and Paraloid B-72. Two inches of surrounding sandy matrix was applied as a buffer between the fossils and jacket. Perimeters of the pedestaled fossils were vertically undercut by up to 12 inches at a 45-degree angle along a clay layer to avoid collapse of the sand. Jackets were constructed using up to 12 layers of burlap strips soaked in Hydrocal gypsum cement and 2" x 4" wood struts were incorporated for structural support. A telephone cable attached to an excavator bucket was used to detach the base of each jacket, much like a wire cheese slicer; a method devised by one of our volunteers. The jackets were flipped onto ratchet straps with the excavator bucket, using underlying, relatively non-fossiliferous sediments as a buffer between the bucket and jackets. Once flipped, jackets were lightened in the field by removing matrix and cutting down the burlap walls, and then lifted out of the 3m deep pit with the ratchet straps and excavator. Despite excess removal, the largest jacket still weighed 1,211kg, making it the largest jacket successfully removed from unconsolidated sediments in Florida and perhaps more broadly. Following preparation, the complete skeleton will be light scanned, resulting in the first virtual 3D model of a gomphothere.

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Supplementing modern 3-D data with historical records of serially sectioned specimens

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X-ray and neutron microtomography (μCT) have become commonplace in paleontology, particularly to study internal structures of both body fossils (e.g., inner ear, maxillary canal, etc.) and trace fossils (e.g., coprolites). These techniques are generally accepted as being non-destructive. Prior to μCT scanning, researchers relied on low-tech solutions— either inducing cracks using a hammer and chisel, or cutting specimens into a series of sections with a circular saw. The latter technique of serial sectioning usually results in a series of slices ~1–2 cm thick, with a space of ~5 mm lost between each slice. This technique was refined, becoming serial grinding, and allowed for sections to be made at fractions of a millimeter. Despite completely destroying the original specimen, serial grinding was used extensively to study therapsids from the Karoo Basin. This has resulted in the permanent loss of over 60 specimens. The only record(s) of these specimens are those created before the grinding process (e.g., casts and photographs), or those created during the grinding process (e.g., pencil drawings, nitrocellulose peels, photographs, etc.). Records of a specimen prior to grinding provide limited information of the internal anatomy. Similarly, the amount of internal detail recorded during the grinding process is restricted by the thickness of section intervals and the amount of time taken to record the sections. For example, pencil drawings and tracings might only preserve the most prominent features (i.e., teeth, sutures, bony canals, etc.), whereas photographs and peels may preserve additional details such as trabecular structure. Fortunately, records of the sectioning process have been preserved for a majority of these 60 specimens. By digitizing the various records of serially sectioned and ground specimens, we have been able to produce three-dimensional visualizations of specimens for restudy. This has facilitated the re-identification of a specimen of anomodont as *Brachyprosopus*, the description of the maxillary canals in the dinocephalian *Jonkeria,* and a description of the replacement teeth in the basal cynodont '*Scalopocynodon*.' These data have allowed us to supplement existing samples of μCT data, in some cases expanding the diversity of species for which internal anatomy is known. Furthermore, by digitizing the physical records of serially ground and sectioned specimens, these data can be preserved, archived and curated as objects in a data repository.

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Paleontology's heaviest airlift: The collection and transportation of a complete opisthotonic Judithian tyrannosaur in a calcite-cemented sandstone concretion

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In 2017 an articulated opisthotonic skeleton of a tyrannosaur was discovered in exposures of the Campanian Judith River Formation on BLM public lands near Hinsdale, Montana. The skeleton was mostly preserved in a large iron-rich calcite-cemented sandstone concretion ~ 3 m by 2 m by 1 m located ~2 km from the nearest road, and surrounded by a number of narrow ravines which blocked overland travel in most directions. It would therefore have to be removed by helicopter. Density and volume calculations led to an estimate of 9000-13000 lb (4000-6000 kg), a substantial payload only liftable by a CH-47 Chinook, or an Erickson S-64 aircrane. Fitting the block through the doors into our preparation laboratory was an additional challenge. A novel total strategy was devised and fabricated by museum board members whereby the skeleton block would be suspended beneath a 1000 lb (450 kg) steel lifting frame and delivered by helicopter onto a receiving frame on a heavy-duty flatbed trailer. The lifting frame was constructed from five welded 3.2 m long beams and two 2.2 m end beams each of which were carried by hand over the difficult terrain by the field crew then bolted together over the fossil block. The lifting frame was necessarily wider and longer than the fossil block as this would prevent lateral compressive forces potentially snapping the block during the lift, instead the block was effectively suspended below the lifting frame like a hammock using heavy 12 m chains with ratchet straps for steadying. Four V-shaped feet were welded "nose-down" to the main frame, which corresponded with four V-shaped channels welded on to the receiving frame. The v-shape of the feet would be self-guided into the receiving channels, making lowering of the frame quicker and more precise. Four ropes hung down from the corners of the lifting frame. These would be grasped by the receiving crew and used to guide the lifting frame onto the receiving frame. The lift was completed in October 2021 by a privately operated CH-47 Chinook, then driven to Dickinson on a heavy-duty flatbed. In November 2021 the block was flipped over by a privately operated crane. One long beam was removed from the lifting frame (making it narrower, but wide enough to support the block), and wheels were welded on. The frame was then placed underneath the block and wheeled through the preparation lab doors. The block is currently undergoing preparation and can be viewed by the public through the lab window.

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Locate, assess, support, move, repeat: planning considerations when moving collections of specimens and archives time after time

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The Yale Peabody Museum embarked on a four-year renovation project, which necessitated a complete building evacuation and re-installation of all exhibits, collections, libraries, archives, laboratories, and offices. Planning the workflow, staffing, and resources for collection moves of any scope can be a challenge to align with administrative timelines and budget constraints. Yet, as collection stewards our goal is to make a series of choices that advocates for the long-term preservation of the objects and associated data we hold in public trust. To accomplish this, we are deeply interested and invested in the materials, tools, and methods we use to handle, support, transport, track, and label collections, as well as consideration of the environment in which collections are stored, including climate, integrative pest management, ease of access, and security. In review, three aspects contributed to an efficient and safe relocation of all objects during recent moves: 1) use of a physical location field in our EMu database to inventory and track object level movement, 2) use of condition assessments to improve the archival housing and stability of specimens prior to movement, and 3) imparting operational procedures to team members and ensuring access to move equipment resources. Cataloged specimens were assigned a four-part physical storage location string in our database and printed barcodes were placed in specimen trays and affixed to storage units to allow for the rapid relocation of groups of objects. Assessing the condition of mounted skeletons and isolate elements allowed for improvements to specimen housings, such as use of closed-cell polyethylene foam liners and wedges for immobilization, as well as fabrication of custom support bases, pallets, and A-frame carts for larger specimens. Lastly, directing and motivating move team personnel was achieved by reviewing the sequence of move phase objectives, imparting a daily workflow pull list, providing maps of building unit locations, and availing use of mechanical and electrical lifts, pallet jacks, drawer carts, rolling shelving units, and supplies. Daily digital and physical documentation of collection move progress informed weekly check-in meetings, which facilitated procedure debriefs, reporting, and milestone celebrations. In the end, meticulous space mapping, logistical planning, and resource allocation were paramount to the success of multiple specimen and archive collection moves time after time.

The first glimpse into the trabecular bone of a stem primate: use of the Regularized Deep Network (RDN) for segmentation of a 55 Ma femur (*Microsyops latidens*; Wasatchian NALMA, Southern Bighorn Basin, Wyoming)

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Over the last two decades the use of microCT scanning has revolutionized researchers' ability to identify functionally informative patterns in fossil trabecular bone. This work has demonstrated meaningful differences related to reconstructing locomotion. However, there have been challenges associated with segmenting fossil material including poor quality due to taphonomic processes, sediment infill, and bias in manual segmentation. Here we present the first trabecular observations for a stem primate from a well preserved femoral head of a 55 Ma fossil (*Microsyops latidens*), part of the first dentally associated partial skeleton for Microsyopidae. Using the new machine learning based domain enriched regularized deep network (RDN) model, we segmented high resolution microCT scans (resolution of 15.5 - 20 μm) of the femoral heads of M. latidens, as well as 2 extant primates (*Galago senegalensis*, *Callithrix argentata*). Employing the unique relearning capabilities of RDN and training data from 5 slices of manually segmented data from the *Microsyops* fossil per plane, we fine tuned the segmentation to overcome the challenges of segmenting trabecular bone as old, small, and complex as that of a plesiadapiform. In doing so we are able to make preliminary qualitative comparisons of the M. latidens femoral head internal morphology to that of two diverse comparative extant taxa (*G. senegalensis* and *C. argentata*), demonstrating the validity of this method to produce a segmentation comparable to that for modern specimens. We conclude that the use of RDN will allow for the most accurate functional comparisons of trabecular variables when applied to both ancient fossil and extant materials. This study is the first to use microCT segmentation methods to explore plesiadapiform trabecular anatomy and therefore is key to the continuing studies of the earliest members of the primate clade. Using RDN's advanced segmentation capabilities opens the doors to a wealth of trabecular data to be explored within ancient fossil materials in the future.

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Love's labor's lost: Texas type, figured and forgotten specimens lost to neglect. Notes on keeping your research associates close and their data closer

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Recent specimen losses suffered by the Texas Vertebrate Paleontology Collections (TMM) have occurred through the most insidious agent of deterioration - neglect. The classic definition of curatorial neglect includes dissociation of objects and documentation, or deterioration through lack of conservation effort. However, our recent experience with curatorial neglect was through poor management of researcher relationships. Despite strong personal relationships with recently departed researchers (possibly because of it), the quality of professional relationships to their collections deteriorated over time, ultimately resulting in lost collection objects. Had these missteps followed a pattern, more recent losses might have been prevented, but each collection, collector, and curatorial relationship is different. The intention of this abstract and presentation is to provide examples of pitfalls with these associations, provide guidelines to remedy them, and plea for assistance in recovering the lost fossils. Most fossil repositories build collections through affiliated researchers through donations and agreements such as MOUs and repository agreements. The researchers usually retain the specimens for a period of time so that they can complete research projects. These relationships can last decades, and the flow of specimens and related documentation is typically episodic. Recently, the Texas collections lost a handful of research associates who died before their collections could be transferred. Despite permit reports and publications listing TMM as repository, when researchers perish, so too can the knowledge of the whereabouts of those collections. Even when an understanding between researcher and repository is firm, if plans for retrieving collections do not include family and institutional administration, those plans can be thwarted. Close review of collection transfers over the past 40 years - notably Lamar University (Stevens and Westgate), Midwestern State University (Dalquest and Stangl), the Texas A&M system (Baskin, Echols, Francis, Hesse), and individual collectors, revealed successes and pitfalls. Lessons learned from those experiences informed our development of research associate policies and protocols that include loss prevention. This includes: (1) designating personal and professional contacts to help manage transfers, (2) managing third-party loans, (3) including documentation with transfers, (4) reviewing research associate agreements.

Digitizing collections in small museums: a case study at Pioneer Trails Regional Museum

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Analysis of the fossil record requires aggregation of paleontological data from individual fossil localities. Prior to computers, these datasets were compiled by hand, a painstaking undertaking that took years of effort and forced paleontologists to make difficult choices about what types of data to consider. Digitization has greatly increased the amount of data available, but there is still a wide amount of ‘dark data’ unaccounted for. With the second digital revolution of paleontology and digitization efforts in museums, the amount of ‘dark data’ has been greatly reduced. However, there are still highly underutilized collections in small museums, leaving many specimens unknown. These collections have not been fully digitized due to the constraints placed on them due to budgets, staff, and/or location. Looking at a case study of Pioneer Trails Regional Museum (PTRM) in Bowman, ND, we aim to shed light on the importance of collection access through digitization and how this can be done under the constraint of a small museum. We will outline the processes used to complete the Bureau of Land Management Hell Creek Formation specimens housed at the museum. This project was completed with funding from the Institute of Museum and Library Services (IMLS). With the IMLS grant, we were able

to hire an intern to assist with digitizing written records on fossil specimens and localities dating from 1984 to 2013. These specimens and localities were documented from sites in Hell Creek Formation strata in Slope and Bowman Counties, North Dakota; Harding County, South Dakota; and Fallon County, Montana. We used Specify7 to compile and store various information on fossil specimens, including age, taxon, element, locality information, and collection date. Taxa ranged from aquatic vertebrates (e.g., *Lepisosteus*, *Melvius*, *Champsosaurus*) to terrestrial vertebrates (e.g., *Richardoestesia*, *Tyrannosaurus*, *Triceratops*) of varying completeness and condition. Several thousand fossil specimens and over 800 localities have been digitized to date, with work ongoing to add more information (associated publications, photographs of specimens, etc.) to the PTRM's digital database.

Funding Sources This project was completed with funding from the Institute of Museum and Library Services (IMLS).

Collaborative collections management of the Cretaceous vertebrates of the Mahajanga Basin, Madagascar: from the physical to the digital

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The Late Cretaceous Madagascar Collection at the Denver Museum of Nature & Science (DMNS) represents over 30 years of collaborative work from the Mahajanga Basin of Madagascar, involving Malagasy scientists working alongside an international group of researchers from multiple institutions. In an effort to create a more equitable research relationship, the project aims to: 1) physically transfer half of the specimens currently housed at DMNS to the University of Antananarivo (UA) in Madagascar; 2) establish a shared specimen database to maintain digital unity across dispersed collections; and 3) empower UA to continue to manage its specimens and their data in a secure and sustainable repository into the future. Since 2023, DMNS has accelerated the preparation of these collections for transfer to UA. This process has involved the development and refinement of digitization workflows, the preparation of >1,800 specimens, the division and curation of specimens, and the training of early career paleontologists and collections professionals. This includes the intensive and immersive training of a doctoral candidate from UA in both preparation practices and collections management. A central component of this project has been the establishment of a new Symbiota portal to facilitate collaboration between DMNS and UA. Symbiota is an open-source data management software that can be accessed by users at both institutions. Over the past year, >2,500 specimen records (including all vertebrate holotypes) have been added to the portal and are linked to a curated taxonomic backbone. Importantly, the portal has demonstrated the potential of Extended Specimen data through external linkages, including to 3D data maintained in MorphoSource. The portal has also enabled the publication of specimen records to larger data aggregators (GBIF and iDigBio), in turn allowing for the integration of Madagascar Project-generated data with records published by other institutions. In this presentation, we will provide an overview of what has been accomplished to date, including how the new data portal has been integrated into workflows developed for this project; how, moving forward, DMNS and UA will use the portal to further the goals of the

Madagascar Project; and how opportunities have arisen as a result of this novel use of Symbiota. Likewise, we will consider what challenges have been overcome, and we will forecast next steps for the project.

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A class of its own: Paleontology lab techniques at Montana State University and the necessity for more courses like it

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Several North American universities and colleges offer paleontology curricula featuring research and field collecting collaborations with museums. By contrast, very few have a college-level course in paleontological conservation techniques. For nearly two decades Montana State University (MSU) has offered a semi-annual 3-credit course (GEO 330 - Paleontology Lab Techniques) as part of its Earth Sciences - Paleontology bachelor's degree. The class was first taught by paleontology graduate students with varying fossil preparation experience. In 2019 MSU began to standardize and strengthen the course by hiring Museum of the Rockies (MOR) Paleontology staff as co-instructors. Coincidentally, increased demand overloaded the roster to over twenty students. GEO 330 was held Wednesday evenings with a one-hour lecture and two hour lab session in the Varricchio Family Paleontology Laboratory on MSU's campus. The syllabus focused on technical aspects of fossil preparation skills including discerning fossil material from matrix, proper use of hand tools/pin vises, pneumatic tool operation and maintenance, air abrasion, microscope use, consolidant and adhesive use, basic molding and casting, and fabrication of conservation cradles. Fossils came from MOR's backlog of material collected from the Upper Cretaceous Two Medicine and Judith River formations, and the Upper Jurassic Morrison Formation. Students were grouped into teams of three to four due to lab space constraints and the element assigned. Groups prepared their specimens over fourteen weeks, finishing with conservation cradles by semester's end. Other major grade components included a mid-term quiz, a class presentation, and a final paper detailing the preparation of their specimen. In 2023 registration remained overcapacity and both instructors were now from MOR's Paleontology staff. The curriculum evolved to focus on paleontological conservation, the importance of archival materials and reversibility, and added guest presenters with expertise in taphonomy, 3D scanning, photogrammetry, figure creation, and curation and collections management. In 2024 demand has compelled MSU to offer GEO 330 annually and relocate it to MOR's larger, newly renovated fossil preparation lab. The success of this course demonstrates both the growing need for course options featuring paleontological conservation and provides other universities a template for additions to their geology/paleontology curricula.