A METHOD FOR SEPARATING THE RHAMPHOTHECA FROM THE SKULL IN TURTLES THAT KEEPS BOTH BONE AND KERATIN INTACT.

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Tooth loss has evolved convergently in many disparate taxa, and it is often accompanied by the development of a keratinous beak or rhamphotheca. Though this structure informs a great deal about an animal's diet and ecology, keratin is rarely preserved in the fossil record. Consequently, we must ground-truth our understanding of beak morphology using extant species. Ideally, specimens involved in groundtruthing would have the skull and rhamphotheca separated and intact so that the relationship between these structures can be analyzed, but the rhamphotheca is often left attached to the skull during the preparation of osteological specimens.

As part of a study on turtle beak triturating surface morphology, we established a protocol for the removal of keratin from bone, thus allowing us to compare the morphology of a turtle's rhamphotheca with that of its underlying maxilla and premaxilla. A protocol for separating turtle rhamphotheca from skull material in a manner that keeps both intact has not been made readily available. We, therefore, present our method for preparing the bone and rhamphotheca of 13 turtle specimens from the Idaho Museum of Natural History. We first soaked specimens in distilled water for 12 hours, then transferred them to 70% ethanol for several days. Next, specimens were placed in solutions of three parts 70% ethanol to one part glacial acetic acid for one hour, then rinsed in distilled water. Finally, we transferred specimens to a solution of one part porcine trypsin, one part sodium borate, and one-hundred parts distilled water for 24 hours. All steps were performed at room temperature. At the end of the 24- hour trypsin soak, intact keratin could be removed from bone with little effort.

The preparation of these specimens provided valuable data for upcoming publications. This method allows for better conservation of edentulous taxa and thus a more robust understanding of the relationship between bone and rhamphotheca. The data gathered can be used to make predictions about keratin-bearing organisms where keratin is not preserved.

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DUAL OSTEOLOGY GUIDE/WORKFLOWS AS AN ANSWER TO SEVERAL MUSEUM COLLECTION PROBLEMS

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Museum collections have or aspire to have object inventories. Inventories of elements present within each object are less common, and typically imprecise when they exist. Vertebrate specimens are often incomplete; therefore the lack of element inventories strongly affects our field. Collections managers are often unable to provide researchers with a full description of their collections' holdings, which can result in more time and funding allotted for visits than necessary. Museum workers may have issues such as not knowing if, which, or how many elements have gone missing. Inventorying is a time-intensive undertaking. Museums are often short-staffed, and many workers are not guaranteed to have the expertise needed to properly identify every element in all their specimens. To address this, I created the first of many dual osteology guide/workflows for a collection I manage, while updating previous element inventory sheets to more precisely capture anatomy. I used turtles as my first venture since their fused skulls and shells make bone identification easier for beginners. The guide/workflow is sectioned by anatomical region and part type in step with the inventory sheet. Sections contain: images to aid identification; number of elements expected, noting when particular subclades vary from the norm; ways inventorying may differ from other clades; common variances that should be captured in the Notes section of the inventory sheet; and common mistakes to avoid. Numbers are bolded to reinforce them as the information to be recorded. A short introduction includes an authoritative source to reference when species-specific information is needed, as well as a missive to alert the Collections Manager if differing information is found therein so the guide can be updated. A glossary of potentially unfamiliar terms is included. This format should result in more accurate and consistent inventories than have been done in the past. The inventory sheet contains additional helpful fields such as: circling Yes or No for presence of parts the worker was unable to identify; the date and name of the worker doing the inventory; and the ontological age category of the specimen. Eventually, these physical sheets will be incorporated into the digital database, then made available and searchable online so researchers can more easily estimate the time they need to spend visiting the collection, and museum workers can have a better grasp of their holdings.

VIRTUAL REALITY AIDED RECONSTRUCTION AND IMMERSIVE INTERNAL ANATOMICAL VISUALIZATION OF VERTEBRATE FOSSILS

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Virtual reality (VR) is a technology that has been used in visualization of deposits in resource geology, surgical training and in the creation of many commercial gaming-centric experiences. Recently, applications have arisen that allow the user to accomplish computer aided design (CAD) tasks in virtual spaces and with virtual manipulation. We outline the potential that integrated VR and CAD methods carry for digitized fossil specimens and their use with digital rearticulation of fossil remains,1:1 scale visualization, and immersive examination of microanatomy.

Methods - VR Equipment and protocols: We utilize the Oculus (now Meta) Quest II headset and peripherals in conjunction with Gravity Sketch, a VR CAD application, and their Landing pad service and file directory import to deliver mesh data to the headset in the form of a wavefront.OBJ mesh. In initial attempts to use VR in this manner, a digitized false gharial skull (Tomistoma schlegelii, published via digimorph.org), was cut into three segments in order to attempt simple rearticulation. Surface models of theropod dinosaur bone vasculature were constructed and exported from Avizo into our system to test interactive visualization of canal systems.

Results: Re-articulation is rapid when using separated elements, but placing elements in exact positions in VR can prove difficult and time consuming. Placing elements in close proximity and saving the data in this way can prove useful in creating an "exploded" model or in preparation for more detailed desktop-based work.

We interactively present VR results comparing bone vascular systems in tyrannosaur and ornithomimid metatarsals. The adult ornithomimid elements illustrate a vascular network that is far more sparse when compared to that of perinate tyrannosaurs, reflecting slower growth. These anatomical features are visible to the operator in a virtual environment without an exaggerated modification of the source data. This investigation serves as an assessment of the techniques described and their efficiency when compared to traditional methods of digital manipulation where three dimensional imagery is concerned.

A COMPARATIVE INVESTIGATION OF ASPHALTIC FOSSIL PREPARATION FROM THREE BREA LOCALITIES: CALIFORNIA, ECUADOR & TRINIDAD

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Through the BREAS Project (Bridging Research and Education at Asphaltic Sites), Rancho La Brea (RLB) aims to develop collaborations and share knowledge with paleontological contemporaries. Asphaltic fossil preparation is specialized, with <15 asphaltic paleontological deposits (breas) known worldwide. Several breas occur in South America and the Caribbean, such as Ecuador and Trinidad.

Quaternary ground sloth specimens (n=6) from RLB Project 23 Deposit 9 (P23-9), Ecuador's Tanque Loma (TL) and Trindad's Forest Reserve (FR) locality were investigated to develop a comparative understanding of how

different breas sediment types and preservational context impact fossil preparation. Studies at TL and FR suggest that asphalt was likely a secondary (post-depositional), rather than primary (RLB-style entrapment), taphonomic agent for these fossils, and matrix at these two localities have significantly higher clay content than RLB deposits.

Asphaltic fossil preparation requires targeted application of degreasing solvents to the adherent matrix, in order to soften and loosen the material for easy mechanical separation from the bone. We used Novec 73DE as the primary preparation solvent. Acetone was included as a solvent effective in removing high clay content matrix. We evaluated the effectiveness of these preparation materials and methods based on 1) the degree of surface removal of asphalt and matrix; 2) internal asphalt retention; 3) total preparation time; and 4) fossil integrity, which was monitored by tracking fossil conditions such as visible dehydration and cracking. Manual preparation with Novec 73DE proved effective for external asphalt removal from fossils associated with the three brea localities studied. Acetone worked well in liberating the high clay matrix from TL and FR material. Internal asphalt retention remains unaffected in all specimens. TL and FR specimens required more time and manual effort due to the clay content in the matrix. The quantities of solvent and tools used appeared comparable between the sites. Fossil integrity remained stable throughout preparation with no visible dehydration or additional cracking.

Based on results of this preliminary investigation, Novec 73DE and manual techniques can be adopted as best practices for asphalt removal from RLB, TL and FR osteological specimens. Due to the secondary infiltration of asphalt at TL and FR, acetone is recommended as an additional step in removing the high clay residue.

A CALL FOR STANDARDIZATION OF DESTRUCTIVE ANALYSIS POLICIES

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As technology advances, there are a growing number of analytical techniques that require complete or partial consumptive sampling of fossil material. While these analyses can elucidate paleontological patterns and processes undetectable from traditional observations and measurements, consumptive sampling poses a risk to non-renewable fossil resources. This risk must be considered when creating destructive analysis polices, which are currently inconsistent or nonexistent in institutions throughout the United States (US). A survey was sent to 47 institutions with fossil collections in summer 2021 to determine what destructive analysis policies were in place in the US; 24 responses (51%) were received. The responses indicated destructive analysis policies were variable if existent. Three institutions indicated they do not have a written policy (two have informal guidelines requiring a proposal for destructive analyses), and one indicated a destructive analysis policy is not part of their collections management plan because they do not allow destructive analyses of their collections. 22 institutions indicated a form and/or formal proposal must be completed and submitted to museum personnel for consideration, and only eight institutions required archival documentation of fossil shape data (e.g., photography, 3D scanning, molding/casting). Based on these responses, three core guidelines are proposed for institutions with fossil collections. First, a consumptive sampling request form should be created by the institution and required for all destructive research requests. Forms should be structured so the merit and risk of each request can be objectively quantified to standardize approval decisions. Second, retention of fossil shape data should be required for all approved requests before consumptive sampling is done. Third, statistical evidence should be utilized to ensure 1) that collections are not over sampled and 2) that the number of specimens consumptively sampled is appropriate for project-specific objectives. These general guidelines are designed for institutions to incorporate into their collections management plan and modify as needed. Adaptation of these guidelines may improve the objectivity and reproducibility of request evaluations and facilitate responsible collections conservation practices so fossil data remains accessible for future research.

BE PREPARED: ADVANTAGES OF IMPLEMENTATION OF SEVERAL FOSSIL PREPARATION TECHNIQUES IN THE PIPESTONE CREEK BONEBED, A CRETACEOUS WAPITI FORMATION LOCALITY

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The innumerable varieties of fossil preservation types across temporal ranges and cladal groups has necessitated a similar diversity of methods required to prepare and preserve the specimens. Preparation and preservation methods vary according to fossil type (i.e., vertebrate vs.plant), geological age (e.g., Cretaceous vs. Pliocene) and lithology. Every fossil locality, and every species within the locality, varies in how it must be prepared and preserved. Even in a monospecific fossil locality such as a bonebed, preservation varies, and specimens may require unique treatment.

The Pipestone Creek Bonebed (PCB) near Wembley, Alberta, Canada, is a prime example of the variety of preparation techniques that must be employed in the preparation of fossils from a single species and locality. The PCB is a monospecific bonebed of the Late Campanian ceratopsian species, *Pachyrhinosaurus lakustai.* The bonebed deposit extends for an estimated 5000 m^2 in a nearly flat layer 10 m above its namesake, Pipestone Creek. To date, an approximate 4,000 fossils have been collected from a 50 m^2 area, and *Pachyrhinosaurus lakustai* makes up approximately 95% of the vertebrate skeletal material identified.

Despite the incredible density of this bonebed and its monospecific nature, preservation and subsequent preparation of fossils are not comparable across all specimens collected. Preservation can vary between adjacent bones and even across a single bone, and the preparation of the specimen must vary accordingly. The fossils from the PCB are most often prepared using a variety of manual techniques involving small hand tools (i.e., carbine pins, scalpels, dental picks, wire brushes) and pneumatic air scribes. The use of a variety of tools and the associated skills required to employ them has highlighted the advantages of preparators of PCB material being trained and practiced in a variety of preparation methods. Case studies of these fossil preparations from the PCB demonstrate the importance of preparators being knowledgeable in a variety of tools and techniques and to be flexible and adaptable in how and when they are implemented.