EFFECTS OF CONSOLIDANTS (PVAC, PARALOID, BUTVAR, CELLULOSE NITRATE, CYCLODODECANE) ON BONE COLLAGEN AND BIOAPATITE COMPOSITION – CONSIDERATIONS FOR FUTURE CHEMICAL ANALYSES

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Consolidation is a critical step in preserving valuable specimens in museum collections. Common consolidants such as polyvinyl acetate (PVAc), polyvinyl butyral resins (Butvar), methyl methacrylate resins (Acryloid/Paraloid), and cellulose nitrate resins (Ambroid, Celluloid, Duco Cement) have been used for decades to stabilize fragile bone material. Temporary consolidants that readily sublimate also have been explored, such as cyclododecane (CDD). However, advances in chemical analyses of paleontological bone require pristine specimens unaltered by addition of secondary consolidants. We examined the effects of PVAc, Butvar B-98, Paraloid B-72, Duco 145 cement, and CDD on the chemical composition of a modern whale rib and modern seal femur. Various solvents and drying methods were examined to determine the efficacy of different removal processes. Stable isotopes of carbon, nitrogen, and oxygen were used to monitor changes in the collagen and bioapatite. Results show that all consolidants can be successfully removed using appropriate solvents (acetone, ethanol, or Cyclosol C-53) and low heat (≤80°C). Collagen carbon and nitrogen isotope values, bioapatite phosphate oxygen isotope values, and bioapatite carbonate carbon isotope values were unaltered by application and removal of all consolidants. Bioapatite carbonate oxygen isotope values were altered during application of PVAc, Butvar B-98, Paraloid B-72, and cellulose nitrate in an unpredictable manner. The CDD had no effect on bioapatite carbonate oxygen isotope values. These results bode well for chemical analyses involving the organic protein in the bone, such as stable isotopes, C-14 dating, and proteomics. However, the labile ionic groups in bone mineral apparently are susceptible to alteration and exchange during consolidant treatment. This study highlights the need for limited exposure to consolidants, as well as as thorough treatment documentation, for bone specimens where future chemical analyses of the bioapatite mineral may be desired. Furthermore, the results support the use of non-polar sublimating consolidants like CDD as a viable alternative for temporary consolidation to avoid chemical alteration.

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PREPARATION AND RECONSTRUCTION OF THE TEETH OF *ADALATHERIUM HUI*, A GONDWANATHERIAN MAMMAL FROM THE UPPER CRETACEOUS MAEVARANO FORMATION OF MADAGASCAR

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We describe details of the mechanical and digital preparation of the dentition of the holotype of *Adalatherium hui* (UA 9030), a virtually complete skeleton of a gondwanatherian mammal from

the Upper Cretaceous Maevarano Formation of Madagascar. While remarkably complete, taphonomic processes (likely including infiltration of modern roots and swelling clay minerals at at and just below the erosional surface) resulted in the destruction of most of the braincase and degradation of other posterior portions of the skull. Mechanical preparation with insect pins and carbide needles revealed that distal aspects of the postcanine dentition in particular were affected, with shattered enamel fragments displaced to varying degrees from their condition prior to death and burial. Because most fragments (sub-mm in size) were realistically too challenging to mechanically repair, and out of concern that disarticulation of fragments would result in important loss of information related to in-situ positions, we digitally separated and reconstructed these fragments. Segmentations of individual teeth were first performed, followed by sub-segmentation into between 2 and 220 fragments depending on the condition of the tooth. These fragments were then reconstructed digitally, with an intermediary step of rapid prototyping at enlarged scale to inform the second round of changes. All fragment position changes from in-situ to idealized, as-in-life reconstructions were recorded for repeatability. Changes between in-situ and in-life position were animated in a 'rocker' style to qualitatively depict patterns of displacement relative to an 'anchor' fragment. Challenges that arose were due to degrees of freedom for fragments capable of passing through one another, number of fragments, scale of fragments, and displacement. To ground-truth results, we scaled up and rapid prototyped fragments critical to the digital reconstructions, and used fragment maps and animations to create physical reconstructions with the help of researchers and volunteers. These models will be used in ongoing research into the occlusion and function of these extraordinary teeth, which are unlike those of any mammaliaform yet known.

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RECENT EFFORTS TO DIGITIZE IMAGES IN THE SECTION OF VERTEBRATE PALEONTOLOGY CARNEGIE MUSEUM OF NATURAL HISTORY USING THE VAUGHN PROJECT AS AN EXAMPLE

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The Section of Vertebrate Paleontology at Carnegie Museum of Natural History (CM) has over 90,000 cataloged specimens and a wealth of associated data, including correspondence, field images, and field notes. A series of grants over the past 44 years has provided funding to improve fossil storage and climate in the collection rooms. Efforts to organize and preserve paper archives and images during this time were initiated by the former Collection Manager. She did so by organizing them, housing them in archival materials, cataloging a large portion of the image collection (some of which dates to 1898), and having copy negatives and prints made from glass plates. More recent efforts to preserve images and associated data include digitizing cataloged images, cataloging and digitizing images that were not previously cataloged, and storing the physical images, such as slides, negative film, and prints, in appropriate archival holders. With the recent migration of the Section's database to Axiell Emu, scanned images can now be linked to their respective image catalog record and, as appropriate, specimen or site records.

The Vaughn project involves the recent acquisition of field-books and 35 mm slides related to a collection of late Paleozoic vertebrate fossils donated to the Section in 1988 by the late Peter P. Vaughn, formerly a professor at the University of California Los Angeles. These images record fossil sites, field camps, and the American Southwest between 1960–1973, a time before or during incorporation of some of the sites into national parks, monuments, recreation areas, and state parks. The slides were cataloged, scanned, uploaded to the Emu database, and stored in archival sleeves. Information used to catalog the slides came from various sources. Some slides had locality information written on them, whereas others bore slide numbers to link them to descriptions in Vaughn's fieldbooks, while still others lacked notation. This information was augmented by David S Berman (Curator Emeritus at CM), a former Vaughn student who helped collect many of the fossils, and one of us (ACH), who has been to many of the fossil sites, as well as the use of Internet mapping tools. The digitization of this important archival collection will help to ensure that it remains available to researchers in perpetuity.

CURATION OF THE MEHRTEN FORMATION

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Collecting efforts throughout the past 50 years by Mr. Dennis Garber yielded a diverse Neogene vertebrate fossil assemblage from the Mehrten Formation in Stanislaus County, California, U.S.A.

The collection consisting of well-preserved fish, birds, amphibians, reptiles, mammals, and plant material were donated to both the Natural History Museum of Los Angeles County and the University of California Museum of Paleontology. After limited publication on the material, resurgence in studies of the Hemphillian fossils reveal major insights into the paleoecology of the time. The collection holds the only known Californian occurrence of the *Hesperotestudo orthopygia* tortoise. This species presence supports previous paleobotanical evidence of a warmer Pliocene climate in the region compared to today. Most notably, the collection also includes the first and only fossilized coprolites from Borophagine canids exhibiting the bonecrushing behavior of the hypercarnivore's diet.

Supported by an anonymous donation, the Natural History Museum of Los Angeles County is facilitating future use and availability of this unique assemblage by completing the curation and digitization of newly acquired fossils discovered by Mr. Garber. Additional georeference data supplied by researchers at California State University Stanislaus provide missing contextual information of the Mehrten Formation localities. In order to process the collection, the following goals were established: inventory the material, sort and identify elements and taxonomic groups, catalog and archivally label elements, digitally photograph material, integrate the newly acquired fossils within the existing locality drawers, and supplement locality records.

The project resulted in the identification of over 400 elements from the 49 existing localities which were consequently labeled, stored in archival housing, cataloged, and photographed. Database locality records were updated to reflect accurate and extensive georeference data such as site photographs, GPS coordinates, lithologic descriptions, and collector interviews pertaining to the existing localities. Overall, the collection and its corresponding data are now housed and organized according to current best practices. The completion of the project provides for greater access to specimens and preservation of locality data from the Mehrten Formation so that a deeper understanding of the paleoecology of Stanislaus County throughout the Neogene period can continue to develop.

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IF A SPECIMEN IS ON EXHIBIT DOES IT REALLY EXIST?

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In June 2019, the Smithsonian National Museum of Natural History opened the "David H. Koch Hall of Fossils - Deep Time" after an extensive five-year renovation. Deep Time includes over 250 vertebrate specimens, more than one-third of all fossils in the exhibit. Historically, the Department of Paleobiology has tracked specimen exhibit data inconsistently using a combination of hand-written and digital inventories as well as various notations in current and legacy databases. As data was generated for exhibit specimens we determined that there was an increasing need for updating specimen records and creating new records in our collections information system (CIS). We also realized that we needed better guidelines for recording exhibit data for our objects.

Our main objective was to develop ways of recording data that could be used consistently within our CIS as well as providing information that could be useful to the public and external researchers. This effort involved reviewing how we document that a specimen is on exhibit and noting inconsistencies and use of multiple fields. In addition to the needs that we identified from the outset, many more complex data issues developed throughout the exhibit planning process. Some of these complexities included vertebrate composite mounts made from multiple individuals, noting that only part of a specimen was on exhibit, or that we created a replica of a specimen for exhibit. Beyond exhibit information, there were additional challenges associated with updating specimen data. During the planning and script writing stages, researchers updated taxonomic identifications, stratigraphic data, and sometimes discovered more specific locality data.

However, the way this was recorded for exhibit planning wasn't always interoperable with our CIS, so we had to develop new ways of documenting these updates. Updating exhibit data for our specimen records is an ongoing process. We are still reviewing exhibit documentation and parsing out specimen data to incorporate into our CIS. Although challenging, this process has helped us establish much needed guidelines for a variety of data points and enables better access to and management of exhibit specimens.

SCREENWASHING, MICROPREPARATION, AND MICRO CT: A CASE STUDY OF HOW PREPARATION WORKFLOW FACILITATES RESEARCH ON MICROFOSSIL LOCALITIES AT PETRIFIED FOREST NATIONAL PARK

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Microvertebrate bonebeds are important proxies for diversity and ecological structure in the fossil record, but how microvertebrate field collection and preparation methods bias our interpretation of the fossil record remain largely unevaluated. This is largely due to a lack of published preparation techniques in the scientific literature which leaves no way to adequately evaluate past and current biases in the field and laboratory. Recent work at several new and well-known sites in Petrified Forest National Park, Arizona (PEFO) suggest that collection and preparation technique can have a significant effect on interpretation of species diversity.

Recently we developed a methodological protocol that we believe maximizes recovery of small, delicate, diagnostic skeletal elements from Late Triassic microvertebrate bonebeds in PEFO. Paleoecological data loss is minimized, resulting in recovery of unparalleled levels of lissamphibian and lepidosaur diversity for the Triassic. Therefore, we have adopted this protocol in house as a best practice.

The workflow involves two sub-paths. 1) Bones visible to the naked eye while quarrying are collected as hand samples and mechanically prepared in the round, often only exposing one diagnostic surface if the fossil is overly fragile. 2) All fossiliferous matrix without visible fossils is mapped, collected as blocks, and then systematically screen-washed with a minimum screen size of 0.446 mm in separate 2.25 kg batches. Batches of concentrate are individually sorted, and elements which fragmented into pieces during screen washing including jaws and limbs are re-associated and reassembled using a novel inexpensive jig similar to a jeweler's ball vise. Resulting bones from both sub-paths are μ-CT scanned and 3D printed at a large scale to reduce handling of specimens.

The re-assembly of associated skeletal elements from screen washing has yielded many scientifically important specimens, producing a more accurate picture of total diversity and ecology for sampled sites compared to past studies at similar localities within PEFO. Implications of this new methodology allow reconstruction of past ecosystems with less bias allowing for robust studies of how and why they change through time; and recovery of bones from scientifically important clades with poor fossil records due to their minute and fragile bones.

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