2017 Preparators' Session Abstracts

AT THE CUTTING EDGE OF PALEONTOLOGY: THE DIAMOND TIPPED CHAINSAW – ADVANTAGES AND DISADVANTAGES COMPARED TO THE CONCRETE CUT-OFF SAW

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Tools are often adopted from their intended application to be used in paleontological fieldwork. Concrete saws are often used for cutting away sterile rock, making large specimens manageable for collection. The Royal Tyrrell Museum of Palaeontology (RTMP) frequently uses a 4.8kW cut-off concrete saw fitted with a diamond blade for this purpose. The circular blade of this saw imposes some limitations on the directionality and depth of cuts. The maximum blade diameter is 35cm, which restricts the maximum cut depth to 12.5cm. The saw is relatively heavy (9.7kg) and is used most safely while oriented vertically, which limits the type of cut it can perform, and usually requires a hammer and chisel to complete rock removal. In addition to the cut-off saw, the RTMP has recently started using a 4.3kW diamond tipped concrete-cutting chainsaw to trim excess rock from stabilized blocks during preparation. The chainsaw's guide bar is 40cm long and is capable of cutting while completely submerged in the rock up to the rubber housing. This enables cutting to more than three times the depth of the cut-off saw, and the full length can be used to cut in many different orientations. The use of a multidirectional tool has many applications for fieldwork including making transverse cuts to facilitate extracting fossils from bedrock, and shedding excess weight from large blocks so they can be removed safely. The chainsaw can perform plunge cuts directly into the rock face, without the resistance or kickback of a wood-cutting chainsaw. The comparatively lighter weight (7.6kg) and the broad range of cutting angles allow this tool to make precise cuts closer to the specimen than the cut-off saw. The chainsaw's maneuverability makes it more comfortable and safer to operate since kickback is less likely, and also circular blade failure can be more hazardous than chain failure. The water-cooled chain cuts through rock faster than the cut-off saw blade, however the short lifespan and cost of the chain are liabilities. A new chain can range from $500 to $700 and must be replaced every 12-24 linear metres of cutting. The saw requires water at a minimum pressure of 22psi during operation; pumps can supply this, but field localities are not always located near water sources. The purchase and operation costs are greater for the chainsaw but can be partially offset by the time saved. If cost and location are not limiting factors, the diamond tipped chainsaw is a more effective and safer tool for paleontological applications.

RETRODEFORMATION AND RECONSTRUCTION OF A CERVICAL SERIES OF GALEAMOPUS (SAUROPODA: DIPLODOCIDAE)

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Diplodocid necks are peculiar in their extreme elongation, in terms of element number and vertebrae elongation, as well as pneumatization. Due to their light-weight structure, these vertebrae are also easily deformed diagenetically, often hindering a reasonable interpretation of shape changes along the neck, and even influencing taxonomic identifications. We applied digital

reconstruction and retrodeformation to the cervical vertebrae of a new specimen of *Galeamopus*. The cervical series was found partially articulated and consists of 13 vertebrae; atlas to cervical vertebra 10, and the three posterior-most elements, all heavily deformed. The anterior and posterior cervical vertebrae are compressed transversely, the mid-cervical elements dorsoventrally. The neural arches in the mid-cervical vertebrae were not fused to their centra and disarticulated during burial. In addition to the vertical compression, these mid-cervical neural arches are strongly sheared. Due to instability, the five posterior-most cervicals were not fully prepared and remain partially embedded in the original matrix, which caused additional problems in the reconstruction process. We digitized the vertebrae using photogrammetry and created 3D-models for further processing. The vertebrae models were then simplified and minor taphonomic alterations such as cracks and smaller holes were removed. The broken pieces were placed at their supposed original position and missing or hidden elements (in the partly embedded vertebrae) were mirrored from the opposite side. The vertebrae were then imported into Landmark for general retrodeformation. Problematic elements, which could not be resolved through Landmark's symmetricalization, e.g. uniaxially compressed vertebrae, were further retrodeformed using the lattice tool in Maya and through manual sculpting in zBrush, based on betterpreserved material of related taxa. Finally, the missing cervical vertebra 11 was interpolated based on the adjacent vertebrae and was adjusted in comparison with known material of related taxa to obtain the complete cervical series of *Galeamopus*. The reconstructed vertebrae were then compared with the original scan data to obtain a visual representation of the deformation. Our approach allows a more precise characterisation of the morphology and builds a new base for future research and comparison between different taxa. The reconstructed cervical series was 3D-printed at full scale and presented as part of the bachelor exhibition at the Zurich University of the Arts.

A TECHNICAL ANALYSIS OF METHODS OF DEFLESHING SMALL MAMMAL MODERN COMPARATIVE SPECIMENS

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Modern skeletal collections are integral in modern taxonomic studies and are essential for comparative specimens for fossil collections. The need for efficient, high quality defleshing methods is essential to the further modern biological taxonomic studies, as well as being a vital comparative resource for morphology and taxonomy studies in the paleontological field. Small mammals (mass 500 grams or less) present a problem in the defleshing process because their small bones are fragile and easily lost or damaged, and existing published literature focuses mainly on large mammals. This study investigates seven methods of defleshing to determine the most efficient method, given a preparator’s constraints: bleach and hydrogen peroxide soaks, maceration, dermestid beetles, cooking, horse manure, burial, and flies in open air. We also compare efficiency within two size groupings, 0-25 grams and 25-500 grams. Dermestid beetles and maceration are common procedures utilized to deflesh specimens; however, their efficiency and quality of bone production has yet to be analyzed compared to other known methods of defleshing in small mammals. We compare each method on the time it takes to fully deflesh and the texture and completeness of the bones. We also take into account the effort of each method, whether skinning and gutting is required, and whether required materials and location of defleshing make the method less effective. Our preliminary results reveal that the most appropriate method of small mammal defleshing for the average academic or scientific institution is bleach and hydrogen peroxide soaking, as it produces high quality bones, with minimal degradation or damage to bones, in a timely, cost efficient, and obtainable method. When we compare bleach and hydrogen peroxide soaking to maceration, though similar quality bones are produced, the time required to completely deflesh is exceptionally long. Further investigation into more small-mammal defleshing methods is necessary, and individual circumstances must be taken into account in order to encompass preference, time, and materials available to preparators.

THE MANY BENEFITS OF 3D XRAY IMAGING IN PALEONTOLOGY: PREPARATION OF A DELICATE FOSSIL CONTAINED INSIDE A PLASTER JACKET

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Traditionally the preparation of a fossil contained in a plaster jacket requires a great deal of guess, because often its detailed content is unknown. Therefore, the preparation can be greatly improved by the use of Xray imaging, such as Computed Tomography (CT), since it makes possible a preliminary observation.

Here we present our results on the preparation of three plaster jackets which contained bones of *Caraguatypotherium munozi*, a Mesotheriinae (Nothoungulate mammal, late Miocene) found in Northern Chile. The bedrock consisted on a semi consolidated fine grained sandstone with abundant diaclases. Also plant roots are usually squeezed into the fractures. All of these factors makes difficult the extraction. Thus, a plaster jacket was applied with minimal superficial preparation. At this stage, sediment removal was performed only to know the fossil boundaries. Hence, its precise content was left unexplored.

Once at the Laboratory of Paleontology, Universidad Austral de Chile (UACh), a CT scan was performed in a medical equipment (UACh), and images analyzed with Osirix® free software. Image treatment included the search for the appropriated density range (Houndfield units) to distinguish the fossil and then perform a 3D reconstruction. The 3D reconstruction permitted to: 1) identify bones, their position, size and preservation status. 2) to prioritize the sediment removal on areas of interest, such as the area comprising the occipital, an unknown skull bone in previously collected materials of the species including the holotype. 3) to choose and adjust extraction and consolidation techniques, such as the use of dentistry wax for filling cracks, and Paraloid (B-72) at various concentrations.

The use of CT scan allowed the successful extraction of two complete skulls with their corresponding mandibles, a series of 5 cervical vertebrae, a semi articulated arm and a few other isolated bones in just 20 days.

It is important to note that fossils were extremely fragmented within the sediment matrix, being often cut through by numerous one-centimenter wide cracks disposed in different directions. Hence, if the fossils were collected by *in-situ* picking, there would have literally resulted in a bunch of little unidentifiable pieces. Similarly, if the laboratory preparation would have not used CT scan, it would have been a difficult task to identify the puzzle, multiplying its preparation time. In conclusion, as 3D reconstruction technology becomes more accessible, it is possible to use it to facilitate, speed up and improve the preparation results.

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COMBINING ALL DIMENSIONS: INTEGRATED 3D MODELS OF DINOSAUR BONEBEDS

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Digital three-dimensional (3D) models are widely used in museology and vertebrate paleontology. However, these models are almost exclusively used for visualizing and archiving the surface of specific bone elements or single specimens. Here, we propose to apply sophisticated 3D techniques from archaeology and geodesy to create integrated and georeferenced 3D models of entire dinosaur excavation sites. These 3D models serve as a solid framework to combine all existing paleontological, geochemical and geological data from the field and the lab to solve questions regarding sedimentology, taphonomy and paleobiology.

Since 2013, the National Natural History Museum of the Netherlands, Naturalis Biodiversity Center in Leiden, is actively involved in the excavation and study of a new *Tyrannosaurus* specimen from Montana and multiple *Triceratops* skeletons from Wyoming, USA. Both fossil sites are visualized as a 30m x 30m x 10m large digital elevation model, derived from high resolution LiDAR imaging. The ongoing *Triceratops* excavation is also recorded by aerial photogrammetry allowing daily reports of the progress and stratigraphic correlation with nearby exposures. A (robotic) total station and GPS rover are used to accurately document the x, y and z position of every bone element and lithostratigraphic section. This replaces the traditional 2D grid mapping of bonebeds. Finally, prepared bones are scanned with a handheld 3D scanner to place them volumetrically correct in their original burial position.

By integrating all these techniques, it is possible to develop an interactive, multi-layered 3D model which is coupled to a GIS (spatial) database that aids research, bone preparation in the lab, online collection registration, and educational and outreach purposes. Recording the elevation of every element is fundamental for taphonomic reconstructions, especially when dealing with complex bonebed structures with stacks of multiple disarticulated skeletons, as is the case for the Naturalis’ *Triceratops* site. New components within this 3D model are high resolution quantitative sedimentological and geochemical records, e.g. laser diffraction grain-size, bulk organic content and µXRF data. Mapping the lateral and vertical variability of these components sheds light on distinct taphonomic, diagenetic and paleoenvironmental patterns throughout the bonebed. Together with paleohistological data, this can be employed to match specific bone elements to specific individuals and to unravel the taphonomic history of this dinosaur graveyard.

EIGHTY PERCENT FASTER AND GOOD ENOUGH? A MORE PRACTICAL PROCESS TO PRODUCE PHOTOGRAMMETRIC MODELS OF VERTEBRATE MICROFOSSILS IN THE 0.5-2 MM SIZE RANGE

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I have previously presented a protocol to produce research-quality photogrammetric 3D models of vertebrate microfossils using inexpensive equipment and readily available software. That process uses focus-stacked images to enhance depth of field at high magnification. While the method yields research-quality models, image capture is a laborious manual process that often requires 8 to 9 hours to adequately photograph a single rodent tooth. This makes it impractical for the digitization of large datasets. Alternatively, high depth-of-field can be achieved using a "pinhole" aperture. The downside of pinhole apertures is that they can produce significant diffraction effects that tend reduce overall image quality. When used in photogrammetric reconstruction this leads to reduced model quality relative to those produced with focus-stacked images.

Here I explore the addition of a pinhole aperture to my equipment and the results of several experiments designed to test whether the expected decrease in model quality is small enough to be a reasonable price to pay for the savings in image capture and processing time. I used the same upper second molar of a shrew (*Sorex sp*.) I used previously to test the quality of models generated using focus-stacked images. As in the earlier study, I developed rarefaction curves by plotting the number of photos randomly drawn from sets of 220 photographs against the Dirichlet Normal Energy (DNE) of the best surface model generated for that subset. For each photoset, I retained models with DNE values greater than the lower 95% confidence bound for the asymptote of its curve for further analysis. On average DNE values of the pinhole models are 45% lower than those of the focus-stacked models. 3D geometric morphometric analysis revealed clear differences between the focus-stacked and pinhole models. While the differences are clear, the overall magnitude appears to fall within the range of what would be expected within a single population, and not so large as to be interpreted as separate species. This suggests that with a little more development the pinhole method could provide a practical inexpensive means to generate large 3D datasets of very small specimens.

ASSESSING AND REHOUSING THE DEPARTMENT OF VERTEBRATE PALEONTOLOGY'S TEACHING COLLECTION AT THE MUSEUM OF COMPARATIVE ZOOLOGY (MCZ), HARVARD UNIVERSITY: A CASE STUDY INTO THE IMPORTANCE OF PREPARATION RECORDS IN REMEDIAL CONSERVATION

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Housekeeping is considered a well-known and important part of museum best practices. As new materials and methods evolve with the field, museums must keep up with curating specimens to the highest possible standards to slow the inevitable deterioration over time. This is particularly important to museums with older collections, where many specimens were prepared over 50 years ago and have remained relatively untouched.

One particular specimen in the MCZ's Vertebrate Paleontology teaching collection, a partial articulated *Archeria* vertebral column, is an excellent and unfortunate example of 'curatorial stasis'. Based on the label, the specimen was mounted in its current state in 1939, and has undergone several reparations since then. The specimen was sunk into a type of hard putty to add stability to the individual bones, causing several to become firmly fixed to the putty and difficult to remove. This has resulted in several fractures occurring during conservation efforts. The putty also caused discolouration of the fossil bone in contact with its surface.

In addition to the physical housing causing specimen damage, poor handling and recordkeeping was evident. The specimen had several pleurocentra and intercentra missing as there were empty spaces in the putty where they would have resided. To make matters more difficult, the individual bones were labelled in an ineffective way, causing greater confusion when trying to mitigate the issue. The lack of photographic and written records with the specimen made the preparator unaware of the previous condition and what fragments were present/absent throughout the specimen's history, making conservation more difficult and time-consuming.

To mitigate this issue, all preparation and remedial conservation are photographed to document the conservation process. Preparation record sheets were created to track all work done on a specimen, documenting the materials and methods used to get the specimen to its current state. This information is archived to allow members of the curatorial staff to review the history of the specimen and properly assess and execute conservation measures. The next step in this project will be to design a template to store preparation/conservation records in our database, MCZbase, to increase access of information for each specimen to current and future curatorial staff.

LEVERAGING GIS AS A COLLABORATIVE PLATFORM: ESTABLISHING A PALEONTOLOGY RESOURCE DATABASE FOR PUBLIC LANDS

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Anticipating the Paleontological Resources Preservation Act, the U.S. Forest Service initiated the creation of a GIS based application to track fossils located on lands managed by the agency. To obtain a broad view of the subject matter and to establish a common environment for all US land management agencies, several agencies were included in the development. The process included a year-long program working closely with USFS Paleontologists considering agency, regional, and field-level requirements with additional input from paleontologists at the Bureau of Land Management, US Geological Survey, and other agencies.

PaleoEx (short for Paleontology Extension for ArcGIS) includes a purpose-built geodatabase with a map-based interface designed to ease the data entry, editing, and tracking of fossil resources for historical, current and future activities within a paleontological area of interest. This includes key activities such as tracking individual fossil specimens; removal authorizations and accompanying curatorial agreements; National Environmental Policy Act clearance and reclamation monitoring data; and history of theft, vandalism, and site impacts. As an added benefit, PaleoEx provides a seamless link to detailed mapping, analysis, and reporting.

PaleoEx currently contains greater than 700 fossil localities and nearly 650 individual specimens in the US. The application will be demonstrated highlighting current uses including the automated fossil potential estimate; data mapping / reporting; and manual vs automated data entry of fossil locals, specimen locations, field images, field preparation notes, and reference materials.

THE NULLARBOR SWAT TEAM PROJECT: ADDRESSING COLLECTIONS BACKLOGS

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Over the past five years Field Museum's vertebrate paleontology staff has focused on addressing persistent backlogs, particularly in the fossil mammal collection. The most recent effort involves a strategy we call the "Swat Team" approach to work on collections whose specimens we cannot easily identify with in house expertise. This concept was used on a small scale in the extant mammal collections, and we have completed the first large scale application of this method at Field Museum. The tactic has two components; an outside expert to provide identifications, and a short term team of collections staff to process the newly identified fossils. The target of this project was a collection of thousands of small mammals from Quaternary owl pellet deposits in a series of caves of the Nullarbor Plain in southern Australia. In 1955, and 1964-65 Ernie Lundelius and Bill Turnbull made collections in the Nullarbor Plain caves, but published a series of papers only on the Madura Cave. Most specimens from the other caves were still in bulk storage, taking up room, but no use to science in that state. We found our expert in Matt Macdowell of Flinders University who came to Chicago for six months from March to November, 2016 and identified approximately 20,000 rodents and small marsupial specimens including mostly unprocessed specimens. A team of five paid summer interns created 11,098 new catalogue records. This processing included electronic cataloguing, numbering specimens, printing specimen labels, packaging specimens in gelcaps and vials, arranging in drawers, and creating drawer labels. One intern took high resolution photos of all specimens, but this aspect took another three months to finish. These specimens document the pre-European small mammal fauna of the Nullarbor, and are now available for studies including "paleo-conservation" work to restore these faunas to the extent possible.

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HOW TO STRUCTURE AN EFFECTIVE VOLUNTEER TASK FORCE IN THE LAB AND COLLECTIONS: A CASE STUDY ON ESTABLISHING CRITERIA FOR RECRUITMENT, SELECTION, AND TRAINING

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Over the decades, various volunteer programs have been in place at the Natural History Museum of Los Angeles County. Yet, until recently, there was no formal approach to evaluating the fittingness of potential volunteers for work in our Vertebrate Paleontology department. Since 2012, over 50 individuals of various ages, backgrounds, and interests have participated in our volunteer program. Initially, potential candidates were brought on if they had the availability to serve and a willingness to learn new skill sets. While this approach garnered enthusiastic individuals, it did not successfully retain trained volunteers and often left projects pending for some length of time.

Changes were made to how we informed potential volunteers of behind-the-scenes opportunities, the amount of information we queried from them, and how we conducted candidate interviews. Prospective volunteers perused informational flyers on our collections scope and program requirements. If their interest was piqued, specific project advertisements provided detailed descriptions of the work to be performed, the desired skill sets, and the expected time commitment. The written application was expanded to survey their motives for

volunteering, their character, previous work experience, physical aptitude, technical skills, and aspirations. Conducting group interviews and conveying a sense of limited space availability allowed for some individuals to stand out from among other promising applicants. Task training involved a variety of approaches from one-onone verbal and visual instruction to written guidelines and assigned reading to group workshops and practicums. Creating forums for volunteer feedback and appreciation were crucial for improving workflows and fostering a collegiate environment. As a result, we have seen a return on the investment of our staff time and expertise, which has not only proved efficient and effective, but has also benefited the museum community at large by preparing future professionals in related careers.