ASSOCIATION FOR MATERIALS AND METHODS IN PALEONTOLOGY

AMMP

MAY 7-11

2024

MORDEN, MANITOBA

CANADIAN FOSSIL DISCOVERY CENTRE

Association for Materials & Methods in Paleontology

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Land Acknowledgement:

We acknowledge that the City of Morden is located on Treaty No. 1 territory, the traditional lands of the Anishinaabe, Cree, Oji-Cree, and Dakota Nations. We also acknowledge the historical and ongoing presence of the Métis Nation, including the Red River Métis, and honour their contributions to the past, present, and future.

#AMMP2024

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YouTube Link, or search for Association for Materials and Methods in Paleontology

Our website: www.paleomethods.org

Purchase 2024 apparel, drinkware, and other products from our AMMP Store. All proceeds will help fund the McCarty Student Travel Grant.

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Dear Colleagues,

Welcome to Morden, Manitoba and the Canadian Fossil Discovery Centre (CFDC)! The Host Committee and the AMMP Annual Meeting Committee have worked very hard to provide a welcoming venue and pleasant educational experience for our members and guests. We hope you will take an opportunity to greet and thank them for their efforts.

Surprisingly, Morden is Manitoba's 8th largest city with a population of about 10,000 and is located just 80 miles from Winnipeg, the province's capital and largest city (population about 750,000). While large cities are fascinating, some of my most memorable AMMP meetings have been held in more rural settings…a bit closer to those open spaces that we all love during field seasons. This year, we will have the best of both worlds with visits scheduled for some of CFDC's research field localities around Morden as well as visits to the University of Manitoba paleo lab and to the Manitoba Museum paleo collections and labs in Winnipeg.

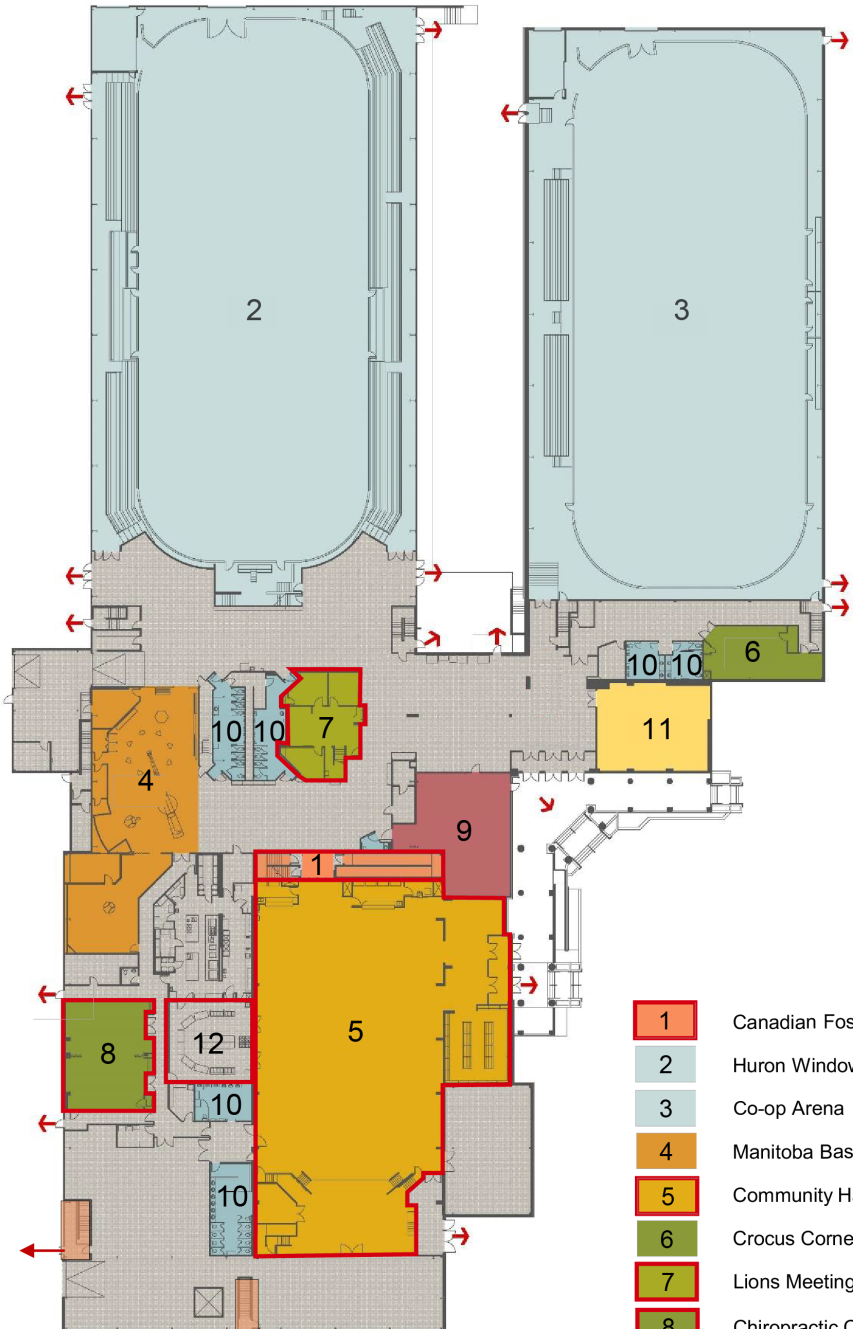
Fossils are the fundamental data upon which the entire science of paleontology is based. As preparators and collections-care practitioners, we all have the need to constantly improve upon the materials and methods we employ to ensure that the specimens in our care preserve the maximum data and research potential they contain and that they remain stable for all time…or as close to it as humanly and technologically possible!

We gather here to learn, not just through passively viewing presentations or posters or even through the brief interactions we have with workshop instructors, but through in-person collaboration with our colleagues. None of us is perfect, regardless of our experience level, but we can all contribute. Our profession is not one of blindly following recipes passed down from our grey-haired brethren, but rather one of creativity and critical thinking based upon sound knowledge and underlying principles. We must always strive to understand the "why" behind the "what" that we choose to do. From this, "best practices" emerge. However, best practices are not a set of laws carved in stone, they are always subject to change through knowledge-based critical thinking and creativity.

Not every paper presented at the meeting will depict perfect techniques and materials. In fact, more than a few authors will present specifically to get feedback on how they can better address a particularly troublesome project. You should always feel free (even obligated) to offer suggestions or even constructive criticisms that will help inform both the authors and the audience.

Join me in expressing our sincere appreciation to CFDC's Director Adolfo Cuetara and the rest of the Host Committee for their hospitality, and enjoy your early spring (or late winter!) in Morden!

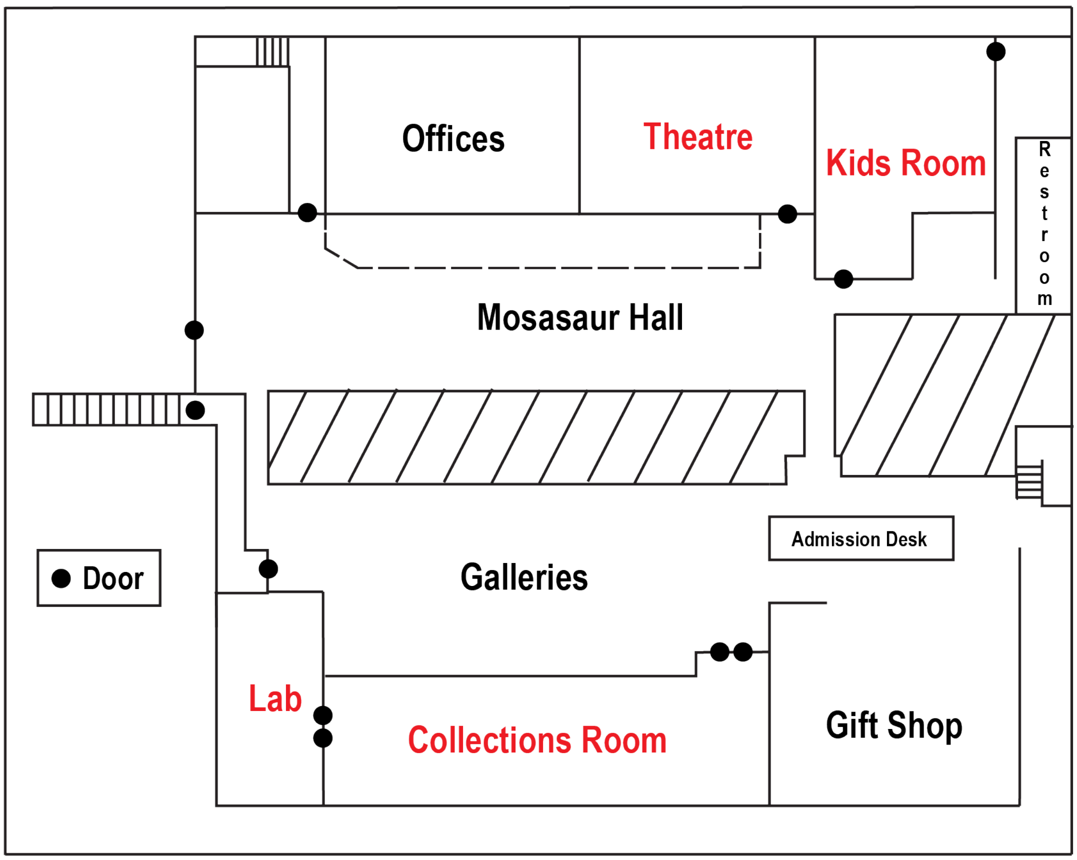
Gregory Brown
AMMP President



1	Canadian Fossil Discovery Centre Entrance (downstairs)
2	Huron Window Corporation Arena
3	Co-op Arena
4	Manitoba Baseball Hall of Fame
5	Community Hall
6	Crocus Corner Meeting Room
7	Lions Meeting Room (upstairs)
8	Chiropractic Centre Meeting Room
9	United Way Concession
10	Washrooms
11	Vern's Carpets Play Centre
12	Buffet Room
←	Exits

*Designated AMMP spaces outlined in red.

Canadian Fossil Discover Centre



*Designated AMMP spaces in red.

Schedule of Events ~ Overview

Monday – May 6	US Central Time (UTC)	Location
Registration	19:00–22:00 (00:00–03:00)	Best Western Plus Morden
Tuesday – May 7		
Field Trip (Morden Geol. and Paleo.)	09:00–17:00 (14:00–22:00)	Access Event Centre
Registration	19:00–22:00 (00:00–03:00)	Best Western Plus Morden
Wednesday – May 8		
Registration	07:00–08:30 (12:00–13:30)	Access Event Centre
Welcome	08:45–09:00 (13:45–14:00)	Access Event Centre
Symposium Session 1	09:00–10:00 (14:00–15:00)	Access Event Centre
Break	10:00–10:30 (15:00–15:30)	Access Event Centre
Symposium Session 2	10:30–12:00 (15:30–17:00)	Access Event Centre
Lunch	12:00–13:30 (17:00–18:30)	On your own
Committee Meetings/ Self-Guided Museum Tour/ Self-Guided Morden Tour	13:30–15:00 (18:30–20:00)	Access Event Centre
Opening Reception	18:00–22:00 (23:00–03:00)	Access Event Centre
Thursday – May 9		
Workshops-Session 1	08:30–10:00 (15:30–15:00)	Various
Break	10:00–10:30 (15:00–15:30)	Access Event Centre
Workshops-Session 2	10:30–12:00 (15:30–17:00)	Various
Lunch	12:00–13:30 (17:00–18:30)	On your own
Workshops-Session 3	13:30–15:00 (18:30–20:00)	Various
Break	15:00–15:30 (20:00–20:30)	Access Event Centre
Workshops-Session 4	15:30–17:00 (20:30–22:00)	Various
Poster Session	18:00–20:00 (23:00–01:00)	Canadian Fossil Discovery Centre
Trivia	20:00–22:00 (01:00–03:00)	Canadian Fossil Discovery Centre
Friday – May 10		
Oral Presentations	08:55–15:00 (13:55-20:30)	Access Event Centre
Closing Banquet	17:00–22:00 (22:00-03:00)	Access Event Centre
Saturday – May 11		
Field Trip (University of Manitoba and Manitoba Museum)	10:00–17:00 (15:00–22:00)	Winnipeg, Manitoba

GatherTown is our virtual conference space. This year's oral presentations, posters, and a select number of workshops in addition to meeting content from 2021 and 2023 are available for you to view. The space is available to **all** paid registrants May 3 through June 3. Code of Conduct applies to all spaces, including virtual. Please make sure to enter your first and last name for your avatar. Download the GatherTown Guidance Document for more information. To access the space, click here or on the link on the Schedule webpage. Only registered conference attendees will be able to access the virtual conference space using the email listed in their registration.

If you experience any issues while using GatherTown, please contact Conni at annualmeeting@paleomethods.org.

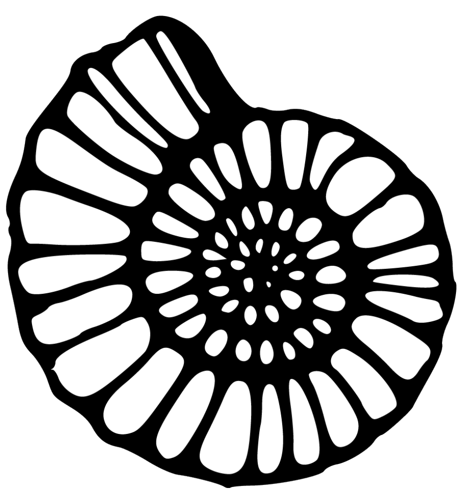
The Tuesday field trip will explore the geology and paleontology around Morden. The area was shaped by the Laramide orogeny and several local basins were filled with Cretaceous and Paleogene sediments. These sediments were subsequently overlain by Pleistocene sediments associated with Glacial Lake Agassiz forming the current landscape. Participants will visit the excavation site of "Bruce", the Discovery Centre's iconic mosasaur as well as active quarry sites in the Pierre Shale along with a visit to Alexander Ridge Park to explore Late Pleistocene fluvial, shoreline, and deltaic sediments associated with Glacial Lake Agassiz.

Meet at Access Event Centre entrance by 8:30a CT
Depart at 9:00a CT sharp!
Tour time: 9:30a – 4:30p CT
Return by approximately 5:00p CT

Schedule of Events – Wednesday, May 8

Symposium ~ Access Event Centre – Community Hall

07:00 – 08:30 CT	REGISTRATION
08:45 CT (13:30 UTC)	WELCOME/ANNOUNCEMENTS
09:00 CT (14:00 UTC)	Jacketing the Desert Sands Marilyn Fox
09:30 CT (14:30 UTC)	Finding Fossils in Denali – Working Off-Trail in the Alaskan Backcountry Cassandra L. Knight
10:00 CT (15:00 UTC)	BREAK
10:30 CT (15:30 UTC)	Fossil Collecting in the Neotropics: Experiences from the Greater Antilles Jorge Velez-Juarbe
11:00 CT (16:00 UTC)	PANEL Q&A DISCUSSION
12:00 CT (17:00 UTC)	LUNCH (on your own)
13:30 CT (18:30 UTC)	COMMITTEE MEETINGS/SELF-GUIDED MUSEUM TOUR/ SELF-GUIDED MORDEN TOUR
18:00 CT (23:00 UTC)	OPENING RECEPTION



FROM NEAR AND ABROAD: GLOBAL PERSPECTIVES ON FIELD TECHNIQUES, CHALLENGES, AND RATIONALES

Field experiences worldwide present unique challenges and situational techniques developed for different regions, including physically removing fossils from the ground, preparation in unusual conditions, and preservation of sites and specimens. These techniques have site specific justifications and often push the boundaries of our science. This symposium seeks presentations that discuss different perspectives, field experiences, data collection methods, curation challenges, and best practices from around the globe.

JACKETING THE DESERT SANDS

Marilyn Fox
Yale Peabody Museum, New Haven, Connecticut, United States of America
laresdomestici2@gmail.com

In 2007-8 and 2010, teams from the Yale Peabody Museum of Natural History traveled to Abu Dhabi, United Arab Emirates, to work in conjunction with the Abu Dhabi Authority for Culture and Heritage (ADACH), now merged with the Abu Dhabi Department of Culture and Tourism (DCT). The team prospected in Miocene age deposits of the Baynunah Formation along the Persian Gulf coast and discovered and excavated specimens that included an elephantid jaw, a partial ratite, a partial crocodilian skeleton, among others. During our first trip in 2007, I was tasked with molding in situ elephantid tracks. I made choices of materials and techniques based on the availability of tools and materials. I opted to bring latex rubber, rather than silicone or polyurethane rubber. I preferred this material as it would require no precision in measuring and would leave no oil residue on the site. In fact, when visiting the site a year later, all evidence of molding had disappeared. While Abu Dhabi is truly a sand desert, coastal sites are quite humid, slowing plaster drying times significantly. The excavation of bone that was fractured apart by evaporites and weathering, lying in soft and loose sand, presented several issues that were considerably different from those presented by the more usual siltstones or mudstones. This created a learning experience, as previously learned techniques needed some rethinking. The typical pedestal method for jacketing was less than successful in such sand, because the partially capped jackets usually slumped over prior to flipping. One answer was to heavily consolidate the specimen and surrounding sand, but again, due to the humidity, consolidant drying time was slowed. Overzealous consolidation in the field, furthermore, creates later challenges to preparation. Butvar B76 or PVA B15 (Vinac) in acetone, as less viscous consolidants, proved to be more appropriate than thin Paraloid B72 in acetone, while an attempt to use Aquazol 200 in water proved ineffective. Consolidant tests in the lab proved this to be true, and demonstrated some surprising results. Another technique is to jacket far more of the matrix than is needed for the stability of the specimen and cut away the extraneous plaster and matrix after the jacket is flipped over. As the sites are along the shoreline and near the sabkha (salt flats), the fossils contain high concentrations of salts. Salts within fossils can cause degradation if they are not stored in a humidity and temperature-controlled storage space. This presentation will discuss some of the logistics involved with this and other international fieldwork, as well as considerations of methods and materials for

consolidation and excavation of fragile specimens in loose sands. This talk will also discuss some of the techniques developed specifically for this situation, as well as the need to be open to rethinking expectations on the fly.

FINDING FOSSILS IN DENALI – WORKING OFF-TRAIL IN THE ALASKAN BACKCOUNTRY

Cassandra L. Knight
Museum of the Rockies, Bozeman, Montana, United States of America
cassi.knight@montana.edu

Denali National Park and Preserve (DENA) is known for its vast wilderness which is largely trail-less. This creates the iconic undisturbed landscape and abundant wildlife that visitors come to experience. This also creates a unique set of challenges for accessing fossil sites and completing paleontological surveys within the park. With only a single 90-mile gravel road, few hiking trails, and the fact that the park lands are federally designated wilderness or eligible wilderness (meaning no motorized transportation or tools are allowed), field work in DENA takes on a unique character. DENA preserves a diverse assemblage of fossil dinosaur tracks and fossil plants in the 70-million-year-old Cantwell Formation. The majority of field work in DENA consists of surveys for new fossil sites and condition reporting for known sites, as part of the National Park Service's Inventory and Monitoring Program. These surveys were typically accomplished by week-long backpacking trips, meaning paleontology staff need to be proficient both in the backcountry and at recognizing and recording paleontological data. This talk will discuss the overall planning process, backcountry and navigational skills, and equipment for data collection needed for paleontological surveys in a remote setting such as DENA. It will also address how paleontological data can be collected using non-destructive techniques (required by the National Park Service) and how some limited fossil collecting is accomplished. To help illustrate these topics, several case studies will be discussed: a reconnaissance survey for new sites, a remote survey for new and of known sites, and the helicopter-supported collection of fossil dinosaur tracks for a new public exhibit.

FOSSIL COLLECTING IN THE NEOTROPICS: EXPERIENCES FROM THE GREATER ANTILLES

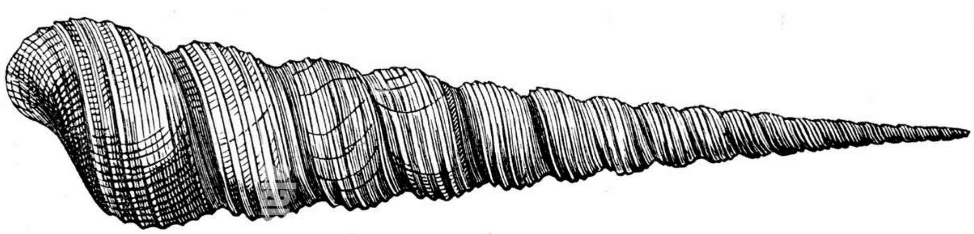
Jorge Velez-Juarbe
Natural History Museum of Los Angeles County, Los Angeles, California, United States of America
jvelezjuar@nhm.org

The islands of Puerto Rico and Hispaniola, located in the Caribbean region, have a complex geologic history that is intimately tied to the formation of the Caribbean Plate, wedged between North and South America. Their geologic history combined with their rich biodiversity makes them a perfect study case for understanding evolution in and around tropical islands, and how local and global geologic and climatic phenomena have shaped and influenced their past and present biodiversity. Documenting the past diversity of these islands is greatly dependent on the fossils that can be collected, prepared and studied. Fossiliferous deposits in these islands range from the Jurassic through the Quaternary and include multiple types of

fossil preservation, each with their unique challenges. While fossil bearing deposits are primarily marine limestones, there are also more siliciclastic coastal deposits that tend to harbor a mix of marine with rare terrestrial plants and animals. Additionally, extensive subaerial exposure of the limestone deposits, primarily during the latest part of the Cenozoic, has resulted in the formation of karst topography, which has facilitated the accumulation and preservation of terrestrial vertebrates in fissures and caves.

Types of preservation include silicified micro- and macrofossils of marine invertebrates in heavily recrystallized limestones which often require the dissolution of the surrounding matrix using different types of acids, or making thin sections of rocks to study microfossils or cross sections of the shells of larger invertebrates, such as rudist bivalves, that allow for assessment of their morphology and taxonomy. While other deposits consist of a softer matrix, fossils can often be fragile, and require the use of consolidants that work better in humid climates.

Besides the challenges related to the types of preservation there is also the ephemeral nature of the fossiliferous outcrops. Dense, quick-growing tropical vegetation covers most of the natural areas in these islands, so outcrops often occur as the result of construction, particularly new or improvements to existing roads and highways. New outcrops resulting from these activities are often overgrown by vegetation after a few years so collecting efforts need to be maximized across a relatively short period of time. More naturally-occurring outcrops can often be found along the banks of rivers or along coastal cliffs, but these are also constantly changing due to water erosion, particularly after the rainy/hurricane season. On the other hand, cave deposits generally consist of unconsolidated sediment and are more protected from vegetation, however access to these sites can be more complicated and often entails finding paths across densely forested areas, and in some cases may require rappelling skills and equipment. Besides these challenges, renewed interest in paleontological research in the Caribbean has grown substantially over the last 20 years, led by collaborative efforts spearheaded by local and external institutions, resulting in a growing understanding of the past and present diversity of the region.



Schedule of Events – Thursday, May 9

Workshops and Collection Tours

08:30 – 10:00 CT (13:30 – 15:00 UTC)	SESSION 1

A Review of Basic Properties of Consolidants and Adhesives, with Hands-On Practical Tips for the Uses of Paraloid B-72 in Vertebrate Paleontology
Leaders: Gregory W. Brown, Marilyn Fox
Location: Access Event Centre – Lab

Centralizing Resources for Conservation-Grade Materials
Leaders: Christina Byrd, Amanda Millhouse, Vanessa Rhue
Location: Access Event Centre – Chiropractic Meeting Room

Conni's Crafting Corner: The Lindoe Technique
Leaders: Conni O'Connor, Shane Tucker
Location: Canadian Fossil Discovery Centre – Kids Room

Forming and Applying Adhesive Films for Gap Fillers in Fossils
Leader: Stevie Morley
Location: Canadian Fossil Discovery Centre – Theatre

How to Create Stereophotos in Three (or More) Easy Steps
Leader: JP Cavigelli
Location: Access Event Centre – Lions Room

Rotocaster Demonstration/Collections Tour
Leader: Adolfo Cuetera
Location: Canadian Fossil Discovery Centre – Collections Room

10:00 – 10:30 CT (15:00 – 15:30 UTC)	BREAK

10:30 – 12:00 CT (15:30 – 17:00 UTC)	SESSION 2

A Review of Basic Properties of Consolidants and Adhesives…(cont'd)
Leaders: Gregory W. Brown, Marilyn Fox
Location: Access Event Centre – Lab

Centralizing Resources for Conservation-Grade Materials REPEAT
Leaders: Christina Byrd, Amanda Millhouse, Vanessa Rhue
Location: Access Event Centre – Chiropractic Meeting Room

Conni's Crafting Corner: The Lindoe Technique REPEAT
Leaders: Conni O'Connor, Shane Tucker
Location: Canadian Fossil Discovery Centre – Kids Room

Forming and Applying Adhesive Films for Gap Fillers in Fossils (cont'd)
Leader: Stevie Morley
Location: Canadian Fossil Discovery Centre – Theatre

How to Create Stereophotos in Three (or More) Easy Steps REPEAT
Leader: JP Cavigelli
Location: Access Event Centre – Lions Room

Rotocaster Demonstration/Collections Tour REPEAT
Leader: Adolfo Cuetera
Location: Canadian Fossil Discovery Centre – Collections Room

12:00 – 13:30 CT (17:00 – 18:30 UTC)	LUNCH

13:30 – 15:00 CT (18:30 – 20:00 UTC)	SESSION 3

3D Scanning on a Budget: Digitizing Specimens in Three Dimensions Cheaply and Efficiently Using the Scaniverse App
Leader: Edward Chase Shelburne
Location: Canadian Fossil Discovery Centre – Theatre

Basics of Digital Preparation with Open-Source Software
Leader: Anne Kort
Location: Access Event Centre – Lions Room

Intermediate to Advanced Moldmaking
Leaders: Carrie Herbel, Jeremy McMullin
Location: Canadian Fossil Discovery Centre – Lab

Solving a Challenge: Selenite-Encrusted Fossils
Leaders: Gerry Peters, Adolfo Cuetara
Location: Access Event Centre – Collections Room

Storage Networking
Leader: Marilyn Fox
Location: Access Event Centre – Chiropractic Meeting Room

15:00 – 15:30 CT (20:00 – 20:30 UTC)	BREAK

15:30 – 17:00 CT (20:30 – 22:00 UTC)	SESSION 4

3D Scanning on a Budget: Digitizing Specimens in Three Dimensions Cheaply and Efficiently Using the Scaniverse App (cont'd)
Leader: Edward Chase Shelburne
Location: Canadian Fossil Discovery Centre – Theatre

Basics of Digital Preparation with Open-Source Software (cont'd)
Leader: Anne Kort
Location: Access Event Centre – Lions Room

Intermediate to Advanced Moldmaking (cont'd)
Leaders: Carrie Herbel, Jeremy McMullin
Location: Canadian Fossil Discovery Centre – Lab

Preparation Literature Working Group
Leader: Marilyn Fox
Location: Access Event Centre – Chiropractic Meeting Room

Poster Session ~ Canadian Fossil Discovery Centre – Theatre

18:00 – 20:00 CT (23:00 – 01:00 UTC)	POSTER SESSION

Becky M.S. Barnes
THE USE OF DRY PIGMENTS AND WEIGHTING TO MAKE HANDHELD CASTS MORE ACCURATE TO THE ORIGINAL FOSSIL

Cornelia A. Clarke*, Stephany Potze, Aisling Farrell, Mariana Di Giacomo, and Aaron Celestian
PYRITE DECAY AND MITIGATION OF LATE PLEISTOCENE MAMMALIAN AND AVIAN FOSSILS FROM RANCHO LA BREA

Carson Cope*, Alex Landwehr, Kale Link, Israel Rivera-Molina, and Laura E. Wilson
ASSESSING UNSTABLE FOSSILS FOR LONG TERM STORAGE

Adolfo Cuetara* and Darren Tanke
EXPEDITED RECOVERY OF FOSSIL MARINE MEGAVERTEBRATES IN INDUSTRIAL MINE SITES: THE MANITOBA (1972-1984) AND ALBERTA (2007-PRESENT) EXPERIENCES

Abigail M. Glass*, Clint Boyd, Jeff Person, Trissa Ford, and Mindy Householder
CURATION OF A PALEOCENE COLLECTION OF SOFT-SHELLED TURTLES IN THE NORTH DAKOTA STATE FOSSIL COLLECTION

Brady P. Holbach
THE USE OF HYDROGELS IN FOSSIL PREPARATION: A NOVEL MATERIAL AND METHOD IN CLEANING AND REMOVING MATRIX FROM BONE

Catherine Lash
A CASE STUDY OF A FLIPPING TECHNIQUE FOR LARGE OR DELICATE FOSSILS

Stevie L. Morley* and Stephany Potze
LIMPING ALONG: CONSERVATION OF A PATHOLOGICAL *SMILODON FATALIS* PELVIS AND FEMUR FOR EXHIBITION FROM RANCHO LA BREA, CALIFORNIA

Martin Muthuri*, Louise Leakey, and Maeve Leakey
KOOBI FORA RESEARCH PROJECT - FIELD PROTOCOLS FOR DOCUMENTATION AND COLLECTION OF FOSSILS IN TURKANA BASIN

Vicki L. Yarborough* and Lisa Herzog
MANAGING FOSSIL PREPARATION THROUGH ERGONOMIC EFFICIENCY

*Presenting author

GatherTown Q&A		
18:00 CT (23:00 UTC)	Becky M.S. Barnes	Cornelia A. Clarke
18:15 CT (23:15 UTC)	Carson Cope	Adolfo Cuetara
18:30 CT (23:30 UTC)	Abigail M. Glass	Brady Holbach
18:45 CT (23:45 UTC)	Catherine Lash	Stevie L. Morley
19:00 CT (00:00 UTC)	Martin Muthuri	Vicki L. Yarborough

*All poster presenters will report to their poster in GatherTown at their designated time to answer questions from virtual attendees.

*Two computer stations will be provided for in-person presenters to access GatherTown.

20:00 – 22:00 CT (01:00 – 03:00 UTC) TRIVIA

Join us for a fun trivia challenge featuring questions by Canadian Fossil Discovery Centre Executive Director and Host Committee Chair Adolfo Cuetara.

Schedule of Events – Friday, May 10

Platform Presentations ~ Access Event Centre – Community Hall

08:55 – 09:00 CT (13:55 – 14:00 UTC)	WELCOME/ANNOUNCEMENTS

09:00 CT (14:00 UTC)

Cinzia Ragni* and Edoardo Martinetto

VALDUGGIA FOSSIL LEAVES: EXTRACTION, CONSOLIDATION, AND PREPARATION

09:15 CT (14:15 UTC)

Dumitru-Daniel Badea* and Bogdan Gabriel Rățoi

COLLECTION MANAGEMENT OF FOSSIL ELEMENTS BELONGING TO FOSSIL MICROVERTEBRATES IDENTIFIED IN THE LATE MIOCENE FROM THE NORTH-EASTERN PART OF ROMANIA, EASTERN EUROPE

09:30 CT (14:30 UTC)

Emma C. MacKenzie* and Christina Byrd

CONSERVATION OF OVERSIZE FOSSILS AND CUSTOMIZING DUST COVERS

09:45 CT (14:45 UTC)

Jennifer L. Cavin* and Nicholas A. Famoso

VIBRATION EXPOSURE LIMITS FOR WORKING WITH AIR SCRIBES

10:00 – 10:30 CT (15:00 – 15:30 UTC)	BREAK

10:30 CT (15:30 UTC)

Stevie L. Morley* and Greg B.P. Davies

LEVERAGING DIGITAL SCIENTIFIC ILLUSTRATIONS TO IMPROVE AVIAN FOSSIL PREPARATION AT LA BREA TAR PITS & MUSEUM

10:45 CT (15:45 UTC)

JP Cavigelli

STEREOPHOTOGRAPHY 101: SIMPLE WAYS TO CREATE STEREOPHOTOS

11:00 CT (16:00 UTC)

Darren H. Tanke* and Amy Kowalchuk

THE 2003 FORD EXPLODER INCIDENT: THE DANGER OF FIELD VEHICLES AND THEIR HOT EXHAUST SYSTEMS, PRAIRIE FIRE AND MITIGATION RECOMMENDATIONS

11:15 CT (16:15 UTC)

Marilyn Fox

NO SAW JACKETS

*Presenting author

11:30 CT (16:30 UTC)

Ian P. Macdonald

PROJECT CALLI: A RECORD OF THE VARIOUS TECHNIQUES EMPLOYED IN THE PREPARATION OF A BIG, BEAUTIFUL CHASMOSAURINE SKULL FROM ALBERTA, CANADA

11:45 CT (16:45 UTC)

Cornelia A. Clarke* and Stephany Potze

VAPOR PRETREATMENT: A NEW TECHNIQUE FOR ASPHALTIC FOSSIL PREPARATION

12:00 – 13:30 CT (17:00 – 18:30 UTC) LUNCH

13:30 CT (18:30 UTC)

Alan W. Zdinak*, Louise Leakey, Maeve Leakey, and Steve Jabo

THE WELL DRESSED ELEPHANT: JACKETING A MASSIVE SKULL AT A REMOTE SITE IN KENYA

13:45 CT (18:45 UTC)

Evan M. Tamez-Galvan*, Alexandria Polich, Natalie Toth, and Kristen MacKenzie

LARGE-SCALE PROJECT MANAGEMENT FIT FOR A JURASSIC GIANT

14:00 CT (19:00 UTC)

Elizabeth G. Flint* and Jonathan M. Hoffman

REVIVING THE SANTA BARBARA MUSEUM OF NATURAL HISTORY'S PYGMY MAMMOTH FOSSIL LEGACY COLLECTION TO FOSTER NEW RESEARCH

14:15 CT (19:15 UTC)

Mindy L. Householder* and Clint Boyd

THE IMPACT OF ADHESIVES, CONSOLIDANTS, AND SOLVENTS ON GEOCHEMICAL DATA: AN EXAMPLE USING X-RAY FLUORESENCE

14:30 CT (19:30 UTC)

Joel P. Crothers* and Isaac Pugh

ANCIENT ÉCORCHÉ: 3D PRINTING AS AN INEXPENSIVE TOOL FOR MUSCULOSKELETAL ANATOMICAL REFERENCE IN THE CLASSROOM

*Presenting author

Schedule of Events – Friday, May 10

Closing Banquet ~ Access Event Centre – Community Hall

17:00 CT (22:00 UTC)	BUSINESS MEETING / AWARDS / ELECTION RESULTS / IN MEMORIAM*

*The In Memoriam video is available on the GatherTown site in the Poster room.

18:30 CT (23:30 UTC)	DINNER SERVED

19:30 CT (00:30 UTC)	SILENT AUCTION / LIVE AUCTION

A very happy Gregory W. Brown with his live auction win in 2023.

University of Manitoba Museum/Manitoba Museum Tours

AMMP <u>WILL NOT</u> be providing transportation to/from Winnipeg.

Participants staying at the Hilton Winnipeg Airport Suites on Saturday night can drop off luggage and other items of value before heading to the University of Manitoba (Department of Earth Sciences, University of Manitoba (Fort Garry Campus), 240 Wallace Building, 125 Dysart Road, Winnipeg, Manitoba, R3T 2N2 Canada). Parking is free at the Q Lot on Dysart Road. Meet at the south entrance of the Wallace Building at 9:50a CT.

Kirstin Brink, Assistant Professor and Paleontologist at the University of Manitoba (www.umanitoba.ca), will lead a two-hour tour of the paleo lab. She will also show what they are doing with material from the Canadian Fossil Discovery Centre. Participants will also have time to view the fossil and mineral exhibits at the Museum.

There will be a short amount of time for a quick lunch before meeting at 1:20 pm CT at the corner of Rupert Avenue and Lily Street next to the Manitoba Museum, the provincial museum of human and natural history (190 Rupert Ave). There are plenty of parking options close to the museum.

The Manitoba Museum (manitobamuseum.ca) houses 2.9 million artifacts and specimens. Curator of Palaeontology and Geology Dr. Joseph Moysiuk will lead a tour of the collection and lab spaces including areas for thin sectioning, and microfossil sorting and screening areas. Participants will also have time to view the nine museum galleries highlighting modern ecosystems and the ancient past before the museum closes at 4:30p CT.

University of Manitoba

Manitoba Museum
HISTORY · NATURE · SCIENCE

3D Scanning on a Budget: Digitizing Specimens in Three Dimensions Cheaply and Efficiently Using the Scaniverse App

Level: Intermediate

Leader: Edward Chase Shelburne

Specimen digitization continues to be a major priority for many collections for the purposes of conservation, data accessibility, and education. The value of three-dimensional (3D) digitization cannot be overstated, as it provides a complete visual record of the specimen unattainable through photography alone. However, expenses for the necessary scanning hardware, software, and proper training in their use still lie outside the budget of many smaller and underfunded institutions. Thankfully, as smartphone technology improves and the price of memory storage decreases, the cost of entry into fast and effective 3D digitization continues to drop as well. The purpose of this workshop is to teach participants an efficient 3D digitization workflow that can be performed for little to no cost using only an iPhone and computer.

Participants will learn:

- The basics of 3D scanning and modeling (principles, terminology, etc.),
- How to establish an efficient workspace for 3D scanning,
- How to set up a specimen safely and in a way that maximizes scanning efficiency,
- How to use the free iOS application Scaniverse to digitize specimens,
- How to clean and stitch 3D scans to create a single watertight 3D model using the free software MeshLab,
- How to photograph specimens and overlay images onto 3D models using MeshLab,
- How to save and store 3D models, and
- How to export them to external viewers like Sketchfab.

This workshop will take participants from a raw, undigitized specimen to a fully complete 3D model using only free software. Participants will also learn several optional steps of improving images for texture overlay using Adobe Photoshop. Each participant will get hands-on experience digitizing a fossil specimen from scratch! Specimens will be provided, though you are encouraged to bring your own.

Participants must download the free iOS application Scaniverse from the App Store prior to beginning the workshop. Participants are REQUIRED to bring any one of the following Apple devices to fully engage in the workshop:

- iPhone: • iPhone 14 / 14 Plus / 14 Pro / 14 Pro Max • iPhone 13 / 13 Plus / 13 Pro / 13 Pro Max • iPhone 12 / 12 Plus / 12 Pro / 12 Pro Max • iPhone 11 / 11 Pro / 11 Pro Max • iPhone XR / XS / XS Max • iPhone SE (2nd and 3rd generation)
- iPad: • iPad (8th generation or later) • iPad Air (4th generation or later) • iPad Mini (5th generation or later) • iPad Pro 12.9” (3rd generation or later) • iPad Pro 11” (any generation)

If you do not own one of the above listed devices and still wish to participate, recognize that you will not be able to engage fully with the curriculum and can only follow along with the instructor using 3D scans provided to you. Additional Apple devices will not be provided.

Laptops and associated software will be provided. Average competency in the use of Windows operating systems is expected.

A Review of Basic Properties of Consolidants and Adhesives, with Hands-On Practical Tips for the Uses of Paraloid B-72 in Vertebrate Paleontology

Level: Intermediate

Leaders: Gregory W. Brown, Marilyn Fox

Part 1: PowerPoint and discussion on basic principles and properties of commonly used adhesives and consolidants and related conservation principles, with an emphasis on Paraloid B-72.

Part 2: Hands-on practical applications using Paraloid B-72 as an adhesive, consolidant and coating, with tips on its use in surficial reinforcement, archival numbering and other techniques. Efficient preparation of solutions, calculation of concentrations and viscosity, maximizing effective consolidant penetration and retention, manipulation of joins using heat or solvent, and safety considerations will all be covered.

Listed as an intermediate level workshop, but entirely suitable for beginners as well. Participants will receive a workshop outline, copies of PowerPoint presentations, and copies of relevant publications. All materials, including safety glasses and gloves, will be provided.

Basics of Digital Preparation with Open-Source Software

Level: Basic

Leader: Anne Kort

CT scanning has become increasingly important in paleontology for preparation, research, and digital preservation. However, expensive software and a steep learning curve can prohibit newcomers from taking advantage of this versatile technology. In this workshop, we will teach participants how to process CT data from a beginner level using the free, open-source software package 3D Slicer. The resulting mesh can be used for a variety of methods like geometric morphometrics or finite element analysis, 3D printing, or sharing 3D data.

Participants will learn:

- Differences in formats of 3D data and how to choose a format,
- How to load and resample CT data in Slicer,
- Tools for segmenting CT data in Slicer, and
- How to export a 3D mesh from Slicer.

Centralizing Resources for Conservation-Grade Materials

Level: Basic

Leaders: Christina Byrd, Amanda Millhouse, Vanessa Rhue

The preservation and conservation of fossil specimens is an important aspect of collections management and it is equally important to use materials that are stable and long lasting. While there are currently some online resources in existence, they are highly variable by type (e.g., publications, presentations, websites), content (e.g., focusing on specific materials), and/or ease of accessibility (e.g., paywalls, individual knowledge). Participants will review the different conservation-grade materials used in paleontology collections, centralize this information for easier reference, and discuss ways in which this information could be disseminated in the future (e.g. an online virtual glossary).

Materials reviewed will include foam, paper, containers, adhesives, tools, and other supplies. Case studies will also be shared to demonstrate how these materials are used in different contexts. Through a group discussion, participants will help to draft a template for each material group as preparation for creating a visual glossary, including the scope of materials that will be covered, the type of information that should be shared about each material, and the website format.

To implement these ideas, participants will be invited to join smaller working groups under the purview of the AMMP Resources Committee to research and write content that can be used to build the visual glossary on the AMMP website.

Conni's Crafting Corner: The Lindoe Technique

Level: Basic

Leaders: Conni J. O'Connor, Shane Tucker

First described by Clive Coy and Allan Lindoe, the "Lindoe Technique" is a method of creating hyper-realistic replicas of very low-relief or no-relief specimens. A slightly modified technique was used to create and exhibit strikingly accurate replicas of plant and insect fossils from the Florissant Fossil Beds in Colorado and the Kilgore Formation in Nebraska. Get your hands dirty and take home your own "fossil". Ideal for display, teaching, and hands-on activities without risking the original specimens.

Forming and Applying Adhesive Films for Gap Fillers in Fossils

Level: Basic

Leader: Stevie L. Morley

It is not uncommon for fragments of fossilized remains to have become disassociated or lost during preservation, leaving voids during the reconstruction process. At times, it is advantageous to fill these voids to improve structural integrity, to protect fossils from dust and pests, and even for aesthetic purposes. A variety of methods have been used in paleontological preparation over the years to fill voids in fossil material (e.g. plaster, white glue, glyptal, archival paper). Each of these gap fillers represents the introduction of an additional material, which can be disadvantageous for research investigations. In all of these cases, the gap fillers are applied either directly to the fossil or, in better practice, over a separating layer of a removable archival adhesive. Films made from the same adhesive used during reconstruction and conservation of a specimen eliminates concerns about the introduction of additional materials or chemical signatures. While other gap fillers visually obscure the internal structures of the fossil, adhesive films do not.

With several different bonding materials available on the market, the properties and stability of adhesives should be considered when selecting an adhesive. Paraloid B-72 is one of the most frequently used acrylic polymers. It is suitable as a consolidant used in murals and oil paintings, as well as a fixative for charcoal and chalk drawings (Whitten et al. 1997). It has a wide range of applications in the conservation of objects, such as glass, plastics, ceramics, wood, metals, fossils, bones and ivory (Koob 1986). Paraloid B-72 is appreciated for its mechanical properties, stability, ease of use, excellent adhesion, fast setting time, and reversibility. La Brea Tar Pits and Museum (LBTPM) Fossil Lab uses Paraloid B-72 in reconstruction and conservation, which led to investigating adhesive films as a gap filler.

A trial was performed which tested the viability of filling voids for fossil bone reconstruction using adhesive films (Morley 2023). A suitable gap filler for LBTPM needed to address the following criteria: transparency, easy to create and apply, easy to remove, no introduction of additional materials, and to be economically feasible. Acrylic films, developed as described here, are nearly undetectable beyond their ability to reflect light, such that they vanish when photographed. Forming acrylic films is relatively simple after only brief practice, and application requires little time or effort. Strength tests were qualitative assessments of response to gentle pressure but all test films withstood tapping and pressing with a finger from underneath.

The aim of this workshop is to introduce participants to methods currently under investigation in the LBTPM Fossil Lab. After a video demonstration of adhesive film production, participants will have an opportunity to practice the application of pre-made adhesive films to fossil proxies. Discussion is encouraged throughout the workshop for interactive dialogue that can continue to enhance and support paleontological preparators in training techniques.

How to Create Stereophotos in Three (or More) Easy Steps

Level: Intermediate

Leader: JP Cavigelli

Despite the burgeoning availability of creating rotatable three-dimensional models using photogrammetry, laser scanners and the like, there is still a role for stereophotography in paleontology. This workshop will cover quick and easy ways to make stereophotos, whether for research, publication, as prep aids for collections databases, or simply for fun. Techniques will include taking the photos with a camera or pocket computer and using easily available software to create the stereo image. Step by Step instructions will be given for using a few different softwares. Creating stereophotos of very small specimens using a microscope (stereo as well as single lens) will also be covered.

Intermediate to Advanced Moldmaking

Level: Intermediate/Advanced

Leaders: Carrie Herbel, Jeremy McMullin

This workshop is for participants who work in small labs/museums with minimal equipment. The participants should have basic molding and casting experience. Workshop components: hands-on molding techniques of jaws with obscure flash lines; small specimen research molding setups; discussion of techniques in construction of small 3-part molds; and tricks/shortcuts in moldmaking. Although there will be significant discussions on various molding rubbers, rubber will not be mixed in this workshop due to safety concerns.

Preparation Literature Working Group

Level: Advanced

Leader: Marilyn Fox

Relevant literature exists for fossil preparation, although much of it comes from the field of conservation. This group will explore using existing literature when thinking about new techniques and when thinking about new materials, as well as ideas about how we can publish more within the field of preparation.

Do you use existing literature? How do you search? What do you search for? What search terms do you use? How can we encourage people to do literature research?

Are you familiar with any of these sites?

- Google Scholar - https://scholar.google.com
- CAMEO, Conservation & Art Materials Encyclopedia Online - https://cameo.mfa.org/wiki/Main_Page
- JAIC online- https://cool.culturalheritage.org/jaic
- Canadian Conservation Institute (CCI) - https://www.canada.ca/en/conservation-institute.html
- National Park Service Conserv O Grams - https://www.nps.gov/museum/publications/conserveogram/cons_toc.html
- BCIN, Bibliographic Database of the Conservation Information Network - https://bcin.info/vufind/
- AATA online - https://aata.getty.edu/primo-explore/search?vid=AATA
- STASHc - https://stashc.wpengine.com
- SVP Prep page - https://vertpaleo.org/preparators-resources-2

How can we make our information available? How do we get people to publish more techniques?

- Where can we publish?
- AMMP resources page - not set up yet, might not be peer-reviewed
- Academia.edu - not peer-reviewed
- SVP pages? - for presentations from SVP meetings
- JVP - now seems to be accepting more techniques submissions
- Geological Curator
- SPNHC Collection Forum - published irregularly

- Journal of Paleontological Techniques (JPT) https://www.jpaleontologicaltechniques.org/
- Other ideas?

What would be a good, achievable outcome for this working group?

Rotocaster Demonstration/Collections Tour

Level: Intermediate

Leader: Adolfo Cuetara

Participants will learn the basics in design and engineering of a rotocasting machine, which builds hollow replicas with silicone rubber molds. A tour of the Canadian Fossil Discovery Centre's collections will be conducted after the demonstration.

Solving a Challenge: Selenite-Encrusted Fossils

Level: Intermediate

Leaders: Gerry Peters, Adolfo Cuetara

The biggest challenge working with Manitoba Cretaceous marine fossils is the profusion of crystalized selenite/gypsum growing on the fossil surface, which dramatically affects the preservation and subsequent scientific research. This roundtable will ask participants to discuss which techniques are used in their collections for mitigating selenite on specimens during storage. Participants will have the opportunity to view mosasaur elements encrusted with selenite.

Storage Networking

Level: Basic

Leader: Marilyn Fox

Many of us have been involved with housing or rehousing our collections and have therefore had a long-standing interest in materials and techniques for storage. Any number of presentations and websites have discussed materials and techniques for storage. A materials display exists with SVP and partially at AMMP. This display is carried from meeting to meeting, showing better and worse materials for storage of collections. As yet, there are few sites where these techniques are accessible in one place. One is STASHc - https://stashc.wpengine.com.

This roundtable will ask participants to bring a list of the materials and techniques in use in their collections. We will discuss our choices, and why those choices were made. Most often, cost is the greatest barrier in widespread changes in collection housing. Collections support grants or even small, incremental changes can eventually bring great improvements to collections storage.

AMMP has the possibility to become a central repository for Best Practices in specimen housing and training, this roundtable can be the beginning of that growth.

COLLECTION MANAGEMENT OF FOSSIL ELEMENTS BELONGING TO FOSSIL MICROVERTEBRATES IDENTIFIED IN THE LATE MIOCENE FROM THE NORTH-EASTERN PART OF ROMANIA, EASTERN EUROPE

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The Museum of Natural History in Iasi, Romania, accepted the donation of a collection of fossil microvertebrates from the Late Miocene of northeastern Romania. These include isolated teeth of small mammals, mandibular or jaw fragments, fossil eggshells, postcranial bones, osteoderms, or dental elements of fish or reptiles. Besides these, fossil elements of gastropods, fossil seeds, operculum of gastropods, or algal fruits from the Chara group can also be found. All these fossils were identified through the study of sedimentary rocks, sand, clays, sandy clays or sands with clay intercalations from the Moldavian and Scythian Platform formations, which are part of the Eastern European Platform. All these fossil specimens were discovered while field works and later donated by the author of this work to the museum mentioned above.

The present paper refers to the management of our collection of microvertebrate fossil elements. It is important for us to have an easy and quick identification of each fossil element in the collection. This is a unique collection of this type, and the method of assigning accession numbers for each fossil element in the collection rests entirely with this paper's first author. Together with the fossil material, images taken with an electron microscope, in electronic format, were donated to the museum.

The method of washing the sediments and the way of identifying all the existing fossil fragments in the sedimentary deposits are presented in works in which various associations of small mammals are reported such as Badea et al., 2022 and two papers from 2023. The technique of preparation and conservation of these fossil elements is presented by to Badea et al., 2023, having presented the laboratory materials needed to handle these elements, the model of the electron microscope and the sputter coater used, respectively the type of adhesive used to fix the fossil fragments on the stubs, as well as the boxes in which they are kept.

The collection of fossil elements representing more than 750 fossil fragments is preserved in plastic SEM storage boxes that can hold eight SEM stubs (see Badea et al., 2023). The entire collection is kept in three plastic boxes, one box holding two stubs, a second holding seven stubs and the third holding eight stubs. Each box receives from the museum an identification number from the Vertebrate Fossil Collection register. For the clear identification of each fossil element, a number is assigned to each stub and finally each fossil fragment receives the number of images taken with the electron microscope. For example, a glirid tooth was chosen, *Vasseuromys pannonicus*, the upper first molar (right M1) from the Dolhești-1 locality (material reported by Badea et al., 2023). This tooth has the identification number MNHI-224-8-22, where MNHI are the initials of the museum, 224 is the number of the box where the stubs are kept, 8 is the stub number, and 22 is the number of the image taken during the electron microscope photography in which find the glirid tooth (see Figure 1). Where several fossil elements are found in a single image, letters such as a, b, c, etc. are used for differentiation and written on an image that accompanies the specimens.

This method is beneficial because eight stubs can be stored in a single plastic box. Given the fact that the size of the fossil specimens is millimetric, on average more than five dozen elements can be preserved on a safe stub. Such a method is also beneficial because several fossil elements can be metallized at once. All fossil elements from this collection are undergoing morphological description and systematic identification in order to present the faunal associations existing in the Late Miocene from the north-eastern part of Romania. This collection is easily accessible at the Natural History Museum in Iasi for future research. This method of managing microvertebrates fossil elements will continue to be used for future discoveries of this type that will be photographed with SEM.

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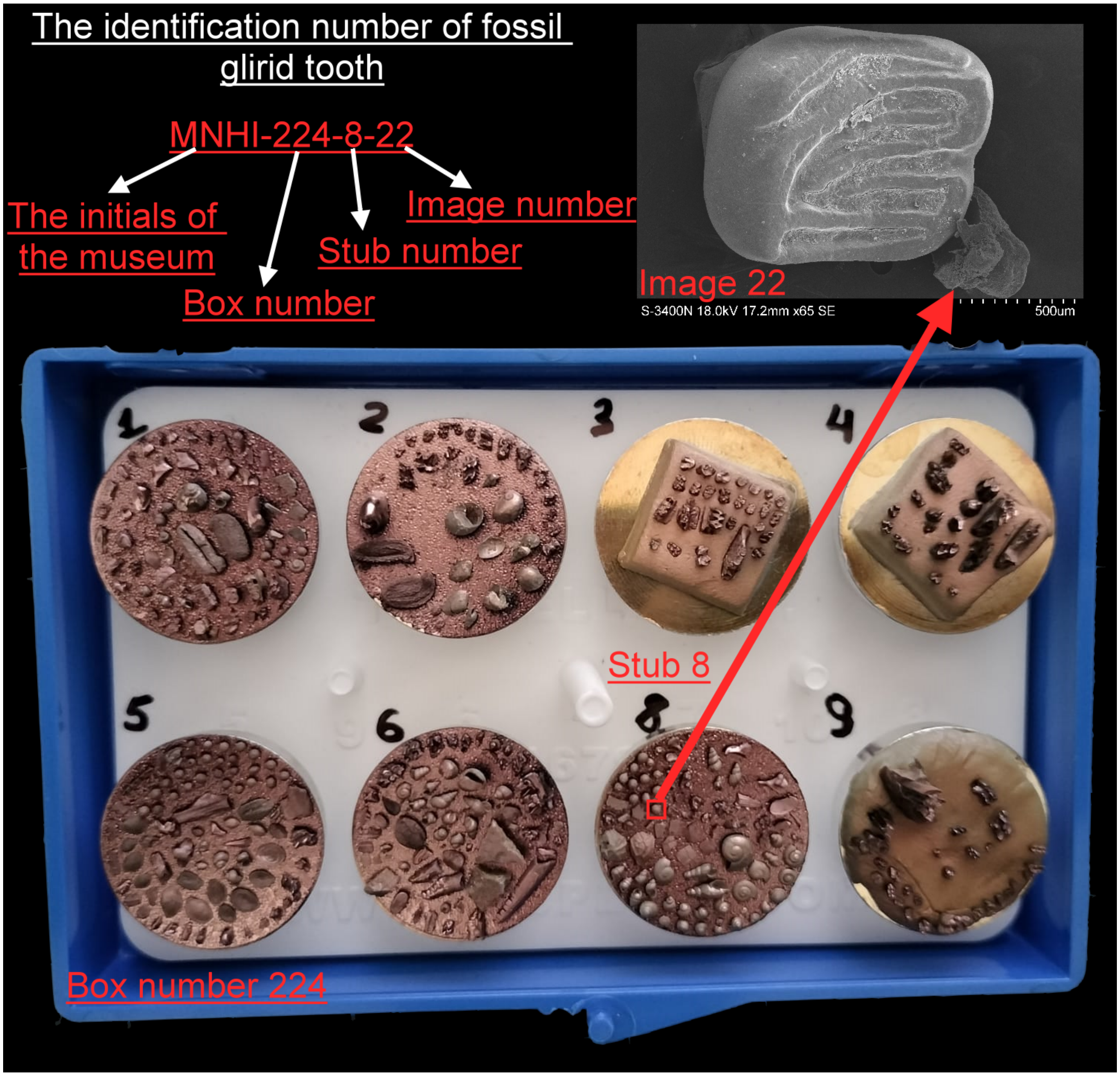

Figure 1. Exemplifying the assignment of the identification number of a fossil element of a small mammal.

THE USE OF DRY PIGMENTS AND WEIGHTING TO MAKE HANDHELD CASTS MORE ACCURATE TO THE ORIGINAL FOSSIL

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The Project

Working with the public using small handheld fossil casts is a great way to extend the life of the original fossil, but we have found that if the cast isn't the right weight or color, they can be dismissed quickly by the more discerning individual. With painted specimens, over time impact with counters, floor, jewelry, etc., can cause paint to rub off casts. With specimens cast in lighter plastics, some people pick them up expecting the heft of a rock, but quickly realize they are not holding a genuine fossil.

The goal is not to fool someone into believing they are holding a real fossil – but to lessen the tactile disconnect between the cast and the original fossil. This way when a person picks up a cast, they focus on how similar it is to the original fossil, rather than obvious differences which may decrease the initial desire to learn. We addressed this issue by matching the weight of the cast to the original specimen, and by extending the life of the paint on the cast.

Health and Safety

All work with molding, casting, and painting chemicals were done within the "Clean Lab" room, which includes an eyewash station, fully stocked first aid cabinet, fume hood, and personal protective equipment (glasses, gloves, lab coats, masks). Some wet or dry pigments may contain toxins or heavy metals or produce combustible dust or fumes. Proper eye and respiratory protection were used, along with nitrile gloves for handling pigments.

Any urethanes, epoxies, resins, or other molding and casting materials were handled using nitrile gloves, with mixing and curing done using the fume hood while wearing respiratory protection. Some staff are more sensitive to urethanes, and a magnetic warning sign was placed on the outside of the door as a warning that casting was in progress.

Procedures/Results

There are a variety of pigments produced that are made to be mixed directly into resins or epoxy which add color, such as Smooth-On's UVO opaque colorants and their SO-Strong translucent colorants. While effective, these tend to be cost prohibitive for programs with a smaller budget. Instead, we used a dry pigment, such as concrete pigment, to dust the insides of a silicone mold before pouring the cast. Benefits to using a dry pigment coating include adhesion to the underlying casting material, as well as acting as a basecoat and primer for paints added later to the surface. A trial pigment kit from Direct Colors includes 5 colors chosen from 105 pigments, in 4-ounce packs. We emptied each pack into a separate container. A small silicone mold was dusted with each pigment color separately, filled with Smooth-Cast 320, and then after curing attached to the lid of each pigment container so the final color of each could be viewed, rather than having to guess at the subtle dust color differences. A very small amount of dry pigment was needed for this purpose.

For large bones that needed to be light yet sturdy, a slip-cast of urethane resin to catch surface details, then fill with 2-part foam was useful. For small casts, replicating the weight of the original fossil could be difficult even when solid urethane resin is used. In these cases, we started by weighing the original fossil to be mimicked. We mixed the urethane on a scale, then added BBs to the mixture until the desired weight was achieved. To distribute the BBs, the mold must be rotated throughout the curing process, or else the cast will be extremely heavy on one side. Our lab does not have the space for large rotational equipment, thus only small fossil casts with the intention of being handled are weighted with BBs, and the mold rotated by hand in a figure-eight motion to ensure even distribution.

The combination of these two methods made for small casts with durable color and more accurate weight. This was ideal for touchable fossil casts that facilitate comparison to the real fossil. We also found that offering these weighted casts to individuals that were considering donating fossils to our institution increases their willingness to agree to a donation and their satisfaction with the transaction.

STEREOPHOTOGRAPHY 101: SIMPLE WAYS TO CREATE STEREOPHOTOS

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Stereo photography is used to help viewers see items in three dimensions, rather than the standard of flat photography. It is a technique almost as old a photography itself. Despite the burgeoning availability of creating rotatable three-dimensional models using photogrammetry, laser scanners and the like, there is still a role for stereo photography in paleontology. Among other uses, stereo photos can aid to preparation and can be useful in cataloging and record-keeping.

Stereo photos can be made of specimens as large as sauropod femurs to microscopic insectivore teeth.

Advantages of stereo photography over 3D images is that they are much quicker to create, and are saved in files that are smaller by orders of magnitude. Stereo photos can also be created simply on almost any computer, including cell phones. Stereo photos can be viewed using a stereo viewer but many viewers can also see them without the aid of a stereoscope.

There are three steps to creating photos in 3D: 1) set up specimen, 2) take photos, 3) make stereo photo. Feldman 1989 is an excellent detailed primer for this process.

Specimen set up: The first step is to set up the specimen. Basic photography protocols should be followed such as lighting from the upper left and a scale bar should be included. If the specimen has one axis longer than the other, then the long axis should run vertically in the photo.

Taking the photos: Stereo photos are created by taking two pictures that simulate a photo from the left eye and one from the right eye. The two photos should be taken with the camera placements about 2 ½ inches apart. These two photos are then placed next to each other to be viewed by whatever means necessary. Some cameras can show the image screen divided into nine equal 'squares'. If the camera has these, then the specimen should be placed touching the left side of the center box for one photo and conversely touching the right edge of that box for the second photo. For each picture, it is best to keep the camera aligned on a left to right line so that there is no rotation of the specimen or the camera between photos. The camera needs to be the same distance from the subject for each shot. The exact placement of the specimen within the frame is not necessarily defined precisely; if it is off, the final stereo photo will be either too flat or too three dimensional. It may be necessary to do a few trial runs to find the optimum positioning.

A tripod or camera stand can be helpful here, in which case the camera is kept its position and the specimen is moved within the frame. If a tripod or camera stand is used, the specimen can also be manipulated differently. The specimen should be positioned on a solid, flat base; a board, a box or a piece of foamboard, etc. For the first photo, the base is tilted roughly 4 degrees by slightly elevating the right edge of the base with some sort of wedge. For the second photo, the left edge of the base is elevated an equal amount. The key is that the photos should be taken at 8 degrees separation from each other. Notes should be taken as to what is being used to lift the edge of the base, and where exactly it was placed, so that if the

3D effect is unsatisfactory, it can be corrected the next time and a more detailed protocol for the individual's set-up can be finalized.

Creating the stereo image: This is written for Microsoft computers but the concept remains the same for other computers. The photos should be transferred to the computer to be used. The editing can be done in most picture editing software. The first step is cropping the photos. This is fairly straightforward. Making sure that indeed, the specimens in both photos are parallel to each other. If needed, one of the photos should be rotated a few degrees until they are parallel. The specimens should also be the same size in each photo. Putting the two photos together into a new photo file can be done in both Photoshop and Word, and maybe in the standard Microsoft Photo editor that is on most Microsoft machines. In photoshop, choose one photo and copy it to a new project. The new project should be three times as wide the photo that has been copied. (Photoshop gives you options for dimensions of the new project when you create one). Then copy the second photo to the new file. Using the Move Tool, drag the second photo to either left or right of the first photo. At this point there should be two photos side by side, with the two images of the subject/specimen parallel to each other. The stereo effect should be observable at this point, whether with the naked eyes or with a stereo viewer. The images may need to be made smaller, as a unit, to create the stereo effect. If the stereo image shows the peaks as indentations, the pictures need to be switched with each other. In this case, use the Move tool to move the second photo to the other side of the first photo. Check the stereo effect again. If it is too flat or is exaggeratedly 3D, then the photos will have to be retaken with slightly different parameters.

Photoshop is quite versatile, but this can also be done much faster in Word. The pictures can be simply imported into a word document and placed side by side. Then they can be cropped and rotated as needed. A snipping tool is very useful here and easily downloaded if the computer does not have it. Use the snipping tool to snip the twinned photos as a unit and this can be saved as a jpeg. This is the stereo photo. One advantage to Photoshop is that if you need to do any adjusting of the rotation; in Word this leaves an unattractive angled gap between the two photos, whereas in Photoshop this can be eliminated.

Using a cellphone: After saying all of this, there are now apps available for cell phones that make stereo photography incredibly easy. One example is demonstrated in a video by Brian May (https://www.youtube.com/watch?v=0mWoiJPytco).

Microfossils: To take stereo photos of microfossils using a microscope, there are a few options. Some binocular microscopes include a third ocular for photography. To use the third ocular, the fossil will have to be manipulated as mentioned above by tilting it 4 degrees one way, then 4 degrees the other way. The same process should be used for single view digital microscopes such as DinoLite. A potential advantage to using a single-lens digital microscope is that many are equipped with focus stacking, which will give much better results. With a binocular microscope, taking a photo through each ocular can be done, but takes a little practice. Before doing this, it is good to clean both oculars and the camera lens as the camera may inadvertently contact the oculars. Any such accidental contact is best done grit-free. Camera settings may need to be adjusted for the best through-the-ocular results. For example, some cameras work well in macro mode others do not. You want to aim for a photo that maximizes the size of the specimen. Focus stacking is possible with a binocular microscope, but it is time consuming. Once you get the two photos taken, follow the editing procedure described above.

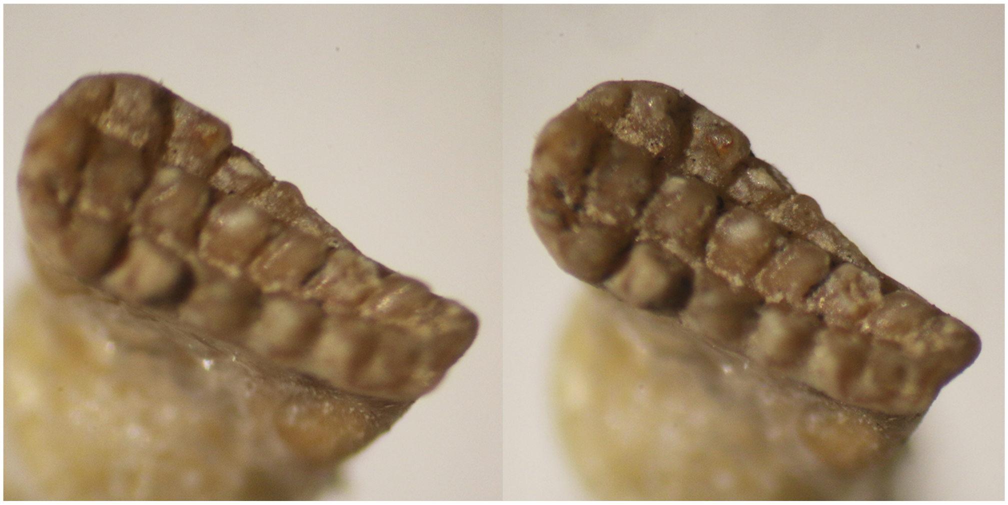

Figure 1. A set up for use with a digital microscope. The specimen here, for ease of viewing, is the blue pin in a sandbox. It is on a foam core plank angled to roughly 4 degrees by using a pencil. A Brunton or a simple angle measuring device available in hardware stores can be used to measure the angle and find the best placement for the pencil. This is the set up for the first photo. For the second photo, the pencil will be moved to an equivalent spot on the right end of the foam board. The yellow sticky note reminds users how to do this.

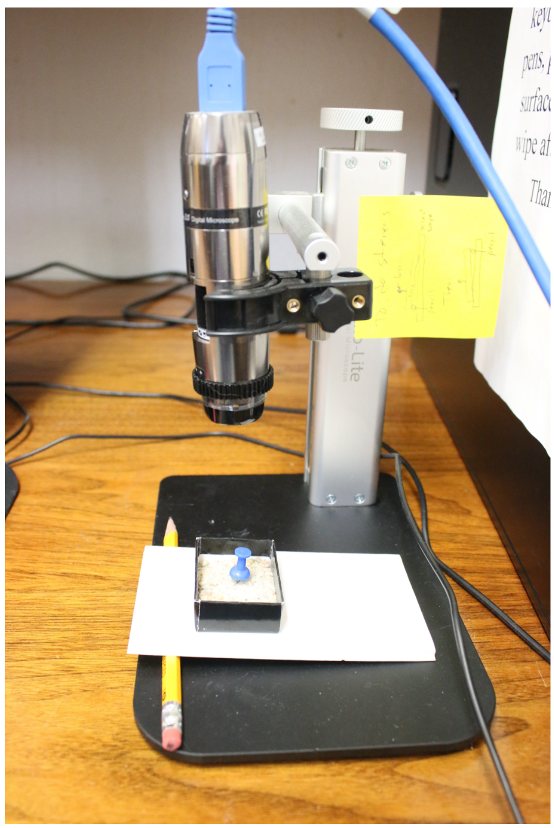

Figure 2. A Lance Formation multituberculate molar mounted on a toothpick as an example of a stereophoto taken with the set up in Figure 1. The specimen number is added later onto the photo. A scale bar should be included for most uses. This photo is an entry in the Tate Museum catalogue for this specimen.

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VIBRATION EXPOSURE LIMITS FOR WORKING WITH AIR SCRIBES

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The hazards of working in a paleontology laboratory are many and varied. When we think about the hazards involved in doing fossil preparation work, the common themes are noise, dust, and chemical use. We routinely wear safety googles to protect our eyes from flying matrix. Ear plugs are worn to protect against the high decibel levels of noise produced in the laboratory. Dust masks and ventilation are used to keep suspended particulates from entering the lungs. Gloves and lab coats can be worn as a barrier for any chemicals used. Personal Protective Equipment (PPE) concerns often only focus on these commonly accepted hazards. What often gets overlooked is the amount of damage that can occur to the body from the repetitive and prolonged use of a vibrating tool, such as an air scribe. Prolonged use of air scribes can cause injuries such as vibration syndrome, carpal tunnel syndrome, or lateral epicondylitis (tennis elbow).

In the United Kingdom, the Control of Vibration at Work Regulations 2005 was enacted to protect workers from the health hazards caused by vibration exposure. Currently, there are no such regulations in the United States even though the Occupational Health and Safety website, https://ohsonline.com, warns that "repeated exposure to high levels of vibration is known to cause injury to workers over time," and the CDC states that "a comprehensive study recently completed by NIOSH demonstrates the seriousness of vibration syndrome in workers."

To calculate safe exposure limits of vibration for air scribes, we first looked at the accepted exposure action value and exposure limit value established by the European Union for hand-arm vibration under European Directive 2002-/44/-EC. Simply stated, if daily vibration exposure is likely to exceed 2.5 m/s^2, action should be taken to reduce exposure to below this value. Also, under no circumstances should any worker be exposed to a daily vibration exposure of more than 5.0 m/s^2. We also looked at the limits for maximum exposure, called the Threshold Limit Value (TLV) established by the American Conference of Industrial Hygienists (ACGIH) (Table 1).

Total Daily Exposure Duration	Maximum value of the frequency weighted acceleration
4 to less than 8 hours	4 m/s^2
2 to less than 4 hours	6 m/s^2
1 to less than 2 hours	8 m/s^2
Less than 1 hour	12 m/s^2

Table 1: ACGIH Threshold Limit Values (TLVs)

The next step was to find the level of vibration for each air scribe. Any manufacturer providing power tools or machinery for use in Europe must provide the vibration exposure data to comply with Machinery Directive 98/37/EC. The United States has no such requirement which makes finding the values more complicated. It is possible to measure vibration levels produced by handheld equipment using a vibration meter which is available at reasonable prices from numerous online sources. For example, we at John Day Fossil Beds National Monument (JODA) purchased a Smart Sensor detached probe type vibration meter from an online source for under $200. However, it was strongly suggested by the Pacific West Regional Industrial Hygienist for the National Park Service that we hire a trained ergonomist to conduct an ergonomic exposure assessment and other necessary ergonomic evaluations.

The initial testing of our lab's air scribes at JODA produced some eye-opening results. We tested the ten air scribes currently in use at the lab using a Smart Sensor handheld portable vibration meter. Without some form of padding, none of the air scribes tested below 9 m/s^2 which would mean even the lowest vibrating tools in our lab could only safely be used for less than an hour according to the threshold limits set by the ACGHI (Table 1). To mitigate this problem, we used vet wrap to wrap the tools at the point of tool/hand contact to a thickness of at least 5mm. Vet wrap, also known as self-adherent cohesive bandage, is a self-adhesive, stretchy, flexible bandage made of natural rubber latex which only sticks to itself and comes in multiple colors and sizes. We then retested the vibration levels. A *t*-test was performed in R for wrapped vs. unwrapped vibration ($t = -7.4515$, df = 10.38, p-value < 0.0001). The vibration levels between the wrapped and unwrapped tools are shown to be statistically significant (Table 2 and Figure 1).

Tool Name	Vibration NOT wrapped (m/s^2)	Vibration wrapped (m/s^2)
MicroJack 1 (stubby)	15.4	4.4
MicroJack 2	9.4	1.2
MicroJack 4	10.2	1.9
MicroJack 5 (standard)	11.7	4.5
MicroJack 5 (stubby)	15.8	5.5
MicroJack 6	18.0	4.6
Aro	19.6	4.7
ME 9100	14.3	4.5
HW-1	16.3	3.8
HW-10	25.7	3.5

Table 2: Vibration levels of tested air scribes

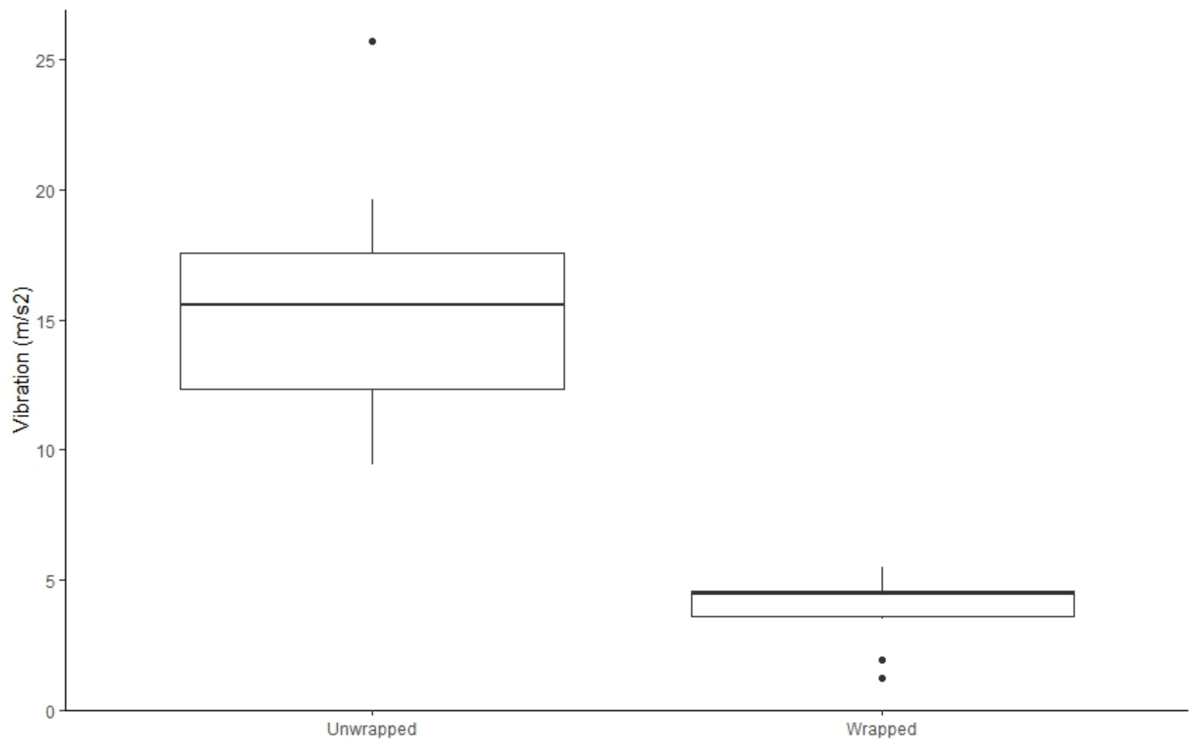

Figure 1: Plot showing t-test results of unwrapped vs wrapped tool vibration levels.

These data allowed me to make a table (Table 3) for our lab listing acceptable time usage for each of our air scribes based on the TLVs in Table 1. Besides restricting the over-all time a tool can be used, other considerations to help reduce the effects of prolonged use are encouraging frequent breaks, ensuring equipment is maintained in good working order, and exercising hands and fingers. These considerations have been added to a new fossil preparation Standard Operating Procedure (SOP). Because fossil preparation is often focus intensive, preparators can habitually forget or do not want to disrupt their concentration to take breaks, we mandate a one-hour break from tool usage after working with a specific tool for a limited time. This is reflected in Table 3.

Tool Name	Time use limit before break	Total daily time use limit
MicroJack 1 (stubby)	3 hours	7 hours
MicroJack 2	4 hours	8 hours
MicroJack 4	4 hours	8 hours
MicroJack 5 (standard)	3 hours	7 hours
MicroJack 5 (stubby)	2 hours	6 hours
MicroJack 6	3 hours	7 hours
Aro	3 hours	7 hours

ME 9100	3 hours	7 hours
HW-1	4 hours	8 hours
HW-10	4 hours	8 hours

Table 3: Working time limits established for JODA tools.

It is important to remember that these time limit values are for wrapped tools only, and only for the tools specifically used and tested in the JODA's paleontology laboratory. This is not an all-inclusive study. While wrapping our tools in vet wrap is how we are currently mitigating the problem of high vibration levels from our tools, there are other ways to reduce vibration that could be tried and tested (i.e., vibration reduction gloves, rubber grips). We highly recommend that every lab tests their own tools before establishing working time limits, and labs should re-test their tools periodically as use of the tools will change the vibration levels over time. While poorly functioning tools could shorten working times, properly maintained and sharpened tools could result in longer working times.

VAPOR PRETREATMENT: A NEW TECHNIQUE FOR ASPHALTIC FOSSIL PREPARATION

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The Project

Asphaltic fossil preparation is a specialized chemical technique, requiring degreasing solvents to remove matrix consisting of hardened asphaltic sediment. Preparation of paleontological material at Rancho La Brea (RLB), a late Pleistocene asphalt locality, uses liquid Novec™ 73DE applied to targeted areas to soften matrix allowing for manual removal with hand tools. A new technique, vapor pretreatment, was developed and tested to ease bulk matrix removal while maintaining specimen integrity. Vapor pretreatment involves placing unprepared specimens in airtight tanks (vapor chambers) above liquid Novec™ 73DE, allowing the vapor to soften the asphaltic matrix before bulk matrix manual removal with no direct application of liquid solvent. Vapor chambers can be constructed and customized from non-specialized equipment. Asphalt saturated waste Novec™ 73DE can be reused in vapor chambers. Results from this study indicate that vapor pretreatment significantly reduces preparation effort, time, tools, and solvent without impacting specimen condition. Vapor pretreatment is not limited to asphaltic bulk matrix removal. There may be applications in other preparation and conservation contexts with volatile solvents like acetone and ethanol, e.g. to ease removal of glyptal coatings while reducing overall solvent amounts and personal exposure.

Health and Safety

All work with Novec™ 73DE was conducted wearing proper PPE (lab coat, closed toe shoes and pants, safety glasses, and neoprene gloves) and with extraction ventilation (3M™, 2023). Vapor pretreatment chambers (vapor chambers) were placed near extraction ventilation to avoid exposure to Novec™ 73DE while opening and closing. Industrial hygiene testing at RLB found that personal exposure to Novec™ 73DE during vapor pretreatment and manual

Figure 1. (a) Vapor pretreatment chamber, (b) Preparation series of a Canis latrans *vertebra LACMP23 43460 with vapor pretreatment.*

preparation work is less than 0.5% of the 200 ppm Cal/OSHA permissible exposure limit on an eight hour time weighted average.

Introduction

Previous work investigated new solvents and techniques to improve preparation of osteological material at RLB (Potze et al., 2023). Novec™ 73DE replaced the former degreasing solvent, 1-bromopropane, to mitigate the health and safety concerns, such as a low Cal/OSHA permissible exposure limit of 5 ppm (Reliance Specialty Products, Inc., 2015). Exclusively manual preparation (manual preparation) replaced soaking, a previous technique involving complete submersion of a specimen in solvent. Soaking required large amounts of solvent and indiscriminately removed matrix, often disassociating bone at sutures and cracked areas. Manual preparation uses small amounts of solvent in a targeted area to retain internal supportive matrix and reduce fragmentation. However, manual preparation requires more time and effort to remove bulk amounts of matrix, increasing the resources required to prepare fossils. To assist in removing bulk matrix while maintaining control over matrix retention and specimen integrity, vapor pretreatment was investigated.

Vapor pretreatment is based on vapor degreasing, which is commonly used in manufacturing to clean heavy oils and greases from metals, plastics, and other non-porous materials (American Society for Testing and Materials, 1976). A vapor zone is created in a tank between a pool of heated degreasing solvent and below cooling coils. Vapor condenses onto materials suspended in the vapor zone, dripping back into the solvent pool carrying the contaminating oils. RLB used an industrial vapor degreaser with trichloroethylene in the 1970-80s to process matrix for microfossils (Shaw, 1982). This vapor degreaser was not designed for fossil preparation and often clogged due to heavy amounts of sediment. Due to operational and maintenance difficulties, soaking replaced vapor degreasing.

Although traditional vapor degreasing failed at RLB, the concept had promise, especially if the need for expensive equipment and heated solvent was eliminated. Novec™ 73DE has a higher vapor pressure than previously used solvents, reducing the need for heated solvent. A simple airtight tank with a stand to hold fossils above a shallow pool of Novec™ 73DE still produces vapor effectively (Figure 1a). A glass vacuum desiccator and three glass liquid chromatography tanks previously used in chemistry labs were donated to RLB for vapor chambers. Both the desiccator and the liquid chromatography tanks have ground glass joints that are airtight with silicon-based vacuum grease. The vacuum desiccator has a ceramic plate that rests on an internal lip, forming a table over the bottom of the tank. For the liquid chromatography tanks, 0.75 cm steel wire mesh was folded into a box to create an internal support for fossils. To aid in loading and unloading fossils into the chambers, trays were made of 0.3 mm steel wire mesh. A unique metal tag attached to a wire mesh tray assisted in labeling fossils when multiple specimens were pretreated in the same chamber.

Early tests with *Paramylodon harlani* dermal ossicles, ~1 cm fossils that are typically soaked with the matrix processed for microfossils, demonstrated that vapor pretreatment did soften the matrix and allow for easy manual removal. Unlike industrial vapor degreasing, this pretreatment does not remove the matrix from the fossil; the matrix softens but remains in place. Once out of the vapor treatment, the matrix can be removed with hand tools like toothpicks and paintbrushes without adding liquid Novec™ 73DE. There is a limited working window; within an hour the solvent absorbed into the matrix evaporates and the matrix re-hardens. These tests also demonstrated that previously used and asphalt-saturated Novec™ 73DE was still effective in vapor pretreatment and established general exposure times. Reusing asphalt-saturated solvent that can no longer be used in manual preparation supports our ongoing sustainability efforts. Given these early results, an experiment was designed to compare preparation resources and outcomes for fossil preparation with and without vapor pretreatment.

<u>Experimental Design</u>

Canid (n=27) and avian (n=3) phalanges and 30 carnivoran vertebrae from three deposits were selected to test the effectiveness of vapor pretreatment for different matrix compositions and skeletal elements. Carnivora and avifauna are common at RLB, representing the majority of large fossil remains. Deposits 9, 13, and 14 from the ongoing Project 23 excavation represent a wide range of matrix compositions, from sand- to gravel-dominated Deposit 13 to the silt- and clay-heavy Deposit 9. Phalanges are small, morphologically simple elements while vertebrae are larger and more complex. For each element and deposit, five specimens were vapor pretreated and five were manually prepared without vapor pretreatment as a control. Similar ranges of fossil size and matrix coverage were selected between each treatment set to limit variation. Specimens were photographed, weighed with an AWS-100 scale, and assessed pre-preparation, post-vapor treatment, post-manual preparation, and after nine months (Figure 1b). Photographs were taken with a Canon EOS6D camera at posterior, anterior, ventral, dorsal, and lateral views. Assessments tracked changes in asphalt stability (oozing and dehydration) and fossil integrity (breaks and cracks). Although pre-preparation assessments were limited as the matrix obscures cracks, breaks, and other features, several fossils selected had observable cracks and breaks pre-preparation.

Phalanges were vapor treated for approximately four hours and vertebrae for approximately 16 hours. Immediately after taking specimens out of the vapor chamber, bulk matrix was removed with wooden tools and paintbrushes, without application of liquid Novec™ 73DE. Specimens were left to offgas and dry for at least 16 hours. Specimens with resistant matrix during vapor pretreatment were returned to vapor chambers for two to four hours then tried again. Specimens were manually prepared using targeted application of Novec™ 73DE with paintbrushes, foam tipped applicators, and cotton swabs. Once all desired external asphaltic matrix was detached, remnant clay was removed with ambient tap water and cotton swabs. Fossils were not consolidated or repaired until after the nine month assessment to avoid external factors influencing specimen condition, except for seven fossils with small fragments (<1cm²) or in more than 3 pieces to prevent potential loss during an extended storage period. After the final assessment, fossils were repaired and consolidated as necessary with Paraloid B72 in acetone.

Active preparation time, solvent amount, and tools were tracked to quantify preparation resources. One person prepared all fossils to control for variation in preparation styles. Active time counted the duration to load and unload specimens for vapor pretreatment, post-vapor bulk matrix removal, and manual preparation, excluding time spent in the vapor chamber. Consolidation and repair time for specimens after the 9 month assessment was also included in active time. Solvent amount was calculated by measuring Novec™ 73DE before and after work in a 50 mL graduated cylinder. Solvent used in the vapor chambers was not included, as the Novec™ 73DE used in vapor chambers is waste solvent that cannot be reused in manual preparation work. Tool cost per specimen was calculated based on the average cost of wooden tools (toothpicks and manicure sticks, $0.03), foam tipped applicators ($0.32), and cotton swabs ($0.01). To standardize data collection, templates for condition assessments and preparation resource tracking were created. Statistical significance was assessed using the Student’s t test (Student, 1908).

<u>Results</u>

For phalanges, there was no significant difference between vapor pretreatment and manual only preparation for preparation time and tool cost. Solvent amounts were significantly reduced for vapor prepared specimens (p-value 0.03). On average, manual phalanges took 21 minutes with 2.2mL of solvent and required $0.74 worth of tools to prepare manually; vapor prepared phalanges took 21.4 minutes with 1.2 mL of solvent and required $0.60 worth of tools.

Preparation time, solvent amount, and tool cost all were significantly reduced for vapor pretreated vertebrae (p-values 0.03, 0.0003, and 0.001, respectively). On average, manually prepared specimens took 190 minutes with 36 mL of solvent and a tool cost of $3.81. Vapor pretreated specimens took 124 minutes with 12.6 mL of solvent and a tool cost of $1.35. On average there is a 35% decrease in time, 63% decrease in solvent amount, and 43% decrease in tool cost for vapor specimens. Vapor is especially effective in deposits with predominantly sand to gravel sized sediments and less effective for fossils with clay and silt heavy matrix.

Specimen condition was similar between vapor pretreated and manually prepared specimens, with a few differences observed during preparation and over the assessment period. Control over matrix retention was maintained for vapor pretreated specimens, with no loss of internal matrix during preparation (Figure 2a). With one exception, retained matrix was stable throughout the nine month assessment period; a vapor pretreated vertebra had a small piece (<1mm²) of matrix detach (Figure 2b). This minor change is likely attributed to the lack of consolidant applied to the fossil rather than vapor pretreatment. Internal asphalt was stable for manually prepared phalanges and all vertebrae, with no oozing or dehydration noted from pre-preparation to the end of the 9 month assessment. No vapor pretreated phalanges had observed dehydration, but six of the 30 phalanges had one to two spots of asphalt ooze after vapor pretreatment. While these spots cleared easily during preparation, one phalanx did start to re-ooze after nine months (Figure 2c), indicating that even with short vapor exposure times phalanges may be over-saturated, destabilizing internal asphalt.

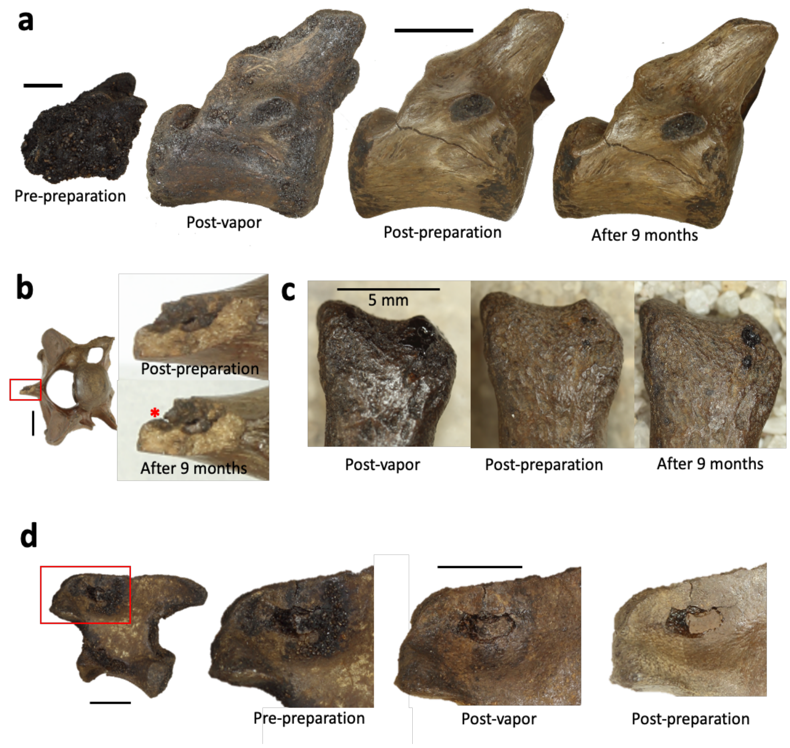

Figure 2. Notable specimen conditions. All scale bars are 1 cm. (a) LACMP23 43483 C. latrans vertebra with retained internal matrix and stable crack. (b) LACMP23 43485 Aenocyon dirus *vertebra, red box highlights inset area and red asterisk highlights lost matrix. (c) LACMP23 43467 C. latrans phalanx with asphalt ooze. (d) LACMP23 43444 C. latrans vertebra, red box highlights the inset area with a destabilized chip.*

During preparation, three manually prepared and five vapor pretreated specimens fractured. Although more vapor pretreated specimens had breaks, manual specimens fractured into more pieces compared to vapor (ranging from 4-7 pieces versus 2-4, respectively). All manual specimen breaks and one vapor specimen break occurred along pre-existing cracks during bulk matrix removal, typically when effort was required to remove stubborn matrix. One specimen separated around a clearly visible continuous crack during vapor pretreatment. Three vapor specimens had small fragments (<1cm^2) that were solely attached to the specimen by matrix that loosened during pretreatment and detached during manual preparation (Figure 2d). Not all matrix-supported fragments were loosened by vapor; some were stable throughout preparation. No crack widening or lengthening was observed for any specimens, vapor pretreated or exclusively manual, including both small hairline and larger cracks (Figure 2a).

Discussion and Conclusions

Vapor pretreatment is an effective technique for large and morphologically complex fossils, reducing resources required to prepare fossils without unduly impacting specimen condition. Preparation output is increased without additional time, solvent, or tools. Solvent previously regarded as waste can now be reused in vapor pretreatment. Vapor pretreated matrix is easily removed from the fossil, sliding off with the slightest of pressure. Especially for clay-heavy stubborn matrix, vapor pretreatment greatly reduces the force required for removal and lessens the risk of damage to specimens. Vapor pretreatment increases preparator and volunteer morale by reducing the frustration and time of bulk matrix removal. Control is still maintained over matrix removal which allows for the retention of supportive internal matrix. While vapor pretreatment can lead to destabilization of matrix-supported fragments, it is a minor effect that can be ameliorated through preparator awareness. If a preparator notices internal matrix or matrix-supported fragments loosening, they can leave the specimen to offgas, re-hardening the matrix and stabilizing the fossil.

For small fossils like phalanges, vapor pretreatment does not have substantial benefits over manual preparation, and may destabilize internal asphalt. Phalanges and similar fossils will continue to be exclusively manually prepared, while larger and more complex specimens will be vapor pretreated.

Future studies on larger avifauna specimens are in progress to test vapor pretreatment suitability for fragile and pneumatized bones. Vapor pretreatment may also assist in asphaltic fossil preparation from other asphaltic localities as manual preparation and Novec™ 73DE both worked well with specimens from Tanque Loma in Ecuador and Forest Reserve in Trinidad (Clarke and Potze, 2022).

Although asphaltic fossil preparation is a niche field, vapor pretreatment may be applicable in other preparation and conservation contexts with volatile solvents like acetone and ethanol. Vapor treatment could aid in removing stubborn glyptal coatings without applying large amounts of liquid or gelled solvent. Additionally, solution adhesives like Paraloid B72 could be re-softened in vapor for easy re-working of misaligned fits. Vapor pretreatment may provide benefits for reducing effort, the amount of solvent required, as well as personal exposure to solvents in these contexts.

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PYRITE DECAY AND MITIGATION OF LATE PLEISTOCENE MAMMALIAN AND AVIAN FOSSILS FROM RANCHO LA BREA

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Rancho La Brea (RLB), located in Los Angeles, California, is one of the richest Pleistocene fossil localities in the world, renowned for its abundance and diversity of specimens, and the excellent preservation from unique asphaltic taphonomy. Recently, three osteological specimens presented signs of pyrite decay, previously undocumented at RLB. Iron sulfide minerals, like pyrite (FeS_2), are commonly present in some fossils. Depending on the mineral type and environmental conditions, iron sulfides can oxidize, producing sulfuric acid and volumetrically expanded iron sulfates that damage specimens (Tacker 2020).

The three impacted specimens are a horse *Equus occidentalis* 1st phalanx (LACMHC 104072), a juvenile sloth *Paramylodon harlani* humerus (LACMHC 143635), and an extinct goose *Anabernicula minuscula* proximal tarsometatarsus (LACMK 4808). These specimens were excavated between 1908 and 1913, but no preparation documentation was archived. The presence of pyrite decay on the horse phalanx and sloth humerus was discovered before April 2022. The horse phalanx is approximately 90% covered with yellow and white mineral crusts, has a mild sulfurous odor, and is intensely fractured and fragmented, crumbling with even slight contact. The sloth humerus is less impacted, with only a small area at the distal area showing yellow mineral crusts and a slight sulfur smell. These two specimens have been located in open storage drawers ~100 feet from each other, against the same exterior wall since the late 1970's. The collection area is not climate controlled and seasonal humidity ranges from RH 25% to 77%. Other specimens in the surrounding storage area do not present mineral crusts, sulfurous smells, or fractures. Pyrite decay on the goose tarsometatarsus was identified later in June 2023; the proximal surface is intensely fractured with disassociated fragments, and there is a light yellow to white mineral crust lightly covering most of the specimen. It was located in open storage drawers in a different collection location on the opposite side of the building, approximately 150 feet away. This collection area is not climate controlled, and nearby specimens were unaffected.

To confirm pyrite decay, powder residue from the horse phalanx was collected, and melanterite ($Fe^{2+}(H_2O)_6SO_4 \cdot H_2O$) was identified through x-ray diffraction (Proto AXRD) (Figure 1a). Melanterite is a known oxidation product of pyrite decay (Tacker 2020). X-ray fluorescence microscopy (Horiba XGT-7200) identified higher iron and sulfur content in the mineral crusts of the horse phalanx and the sloth humerus compared to visually unaffected bone on the same specimen. On the horse phalanx, mineral crusts had a lower sulfur to iron ratio (0.6) than visually unaffected bone (1.6), indicating higher iron content in pyritized areas (Figure 1b). Raman spectroscopy with a Horiba ExploRa+ Dispersive Raman Microscope was unsuccessful at identifying original iron sulfide minerals in the mammalian specimens, perhaps due to a high background reading caused by asphalt.

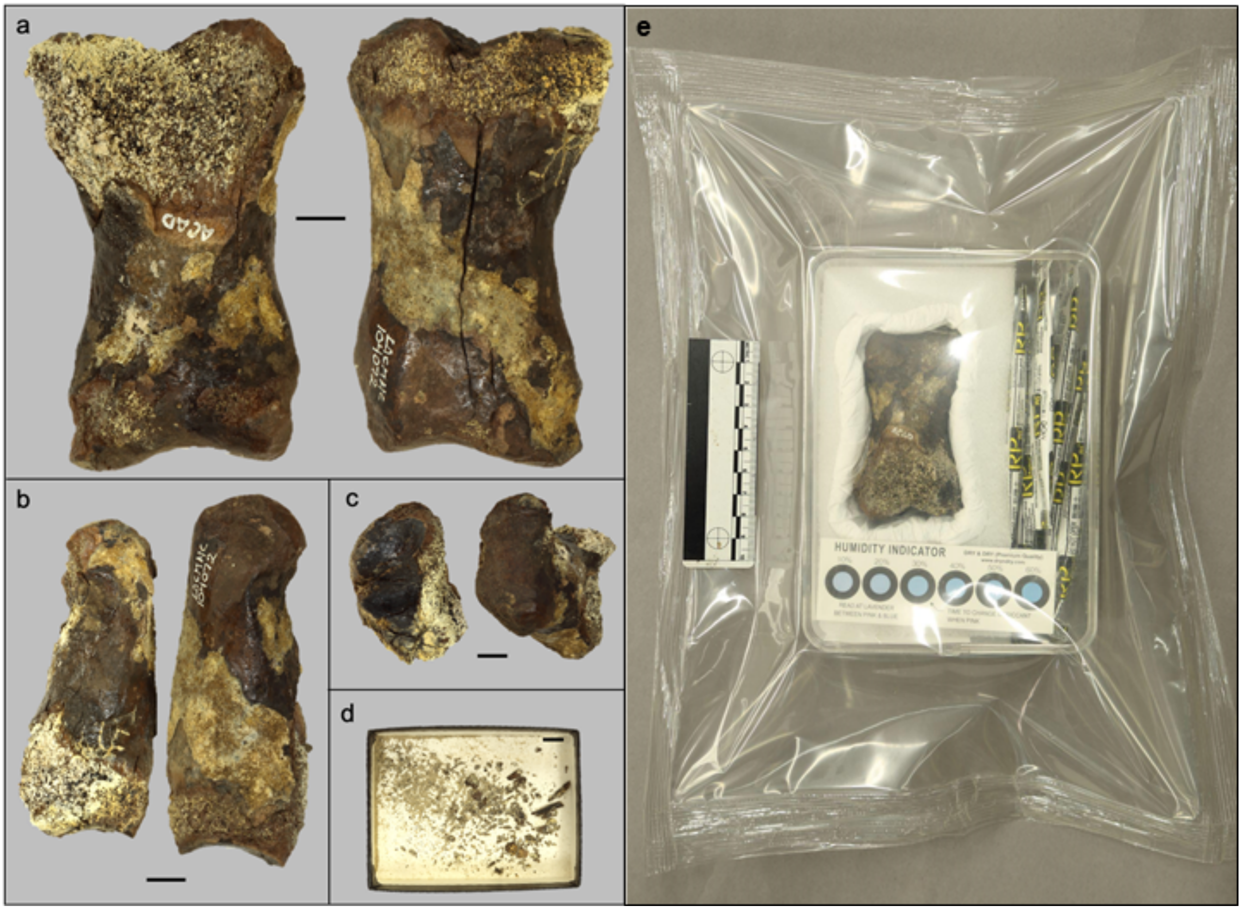

Figure 1. LACMHC 104072, an Equus occidentalis 1st phalanx. Scale bars are 1 cm. Dorsal and ventral views (a), lateral views (b), and posterior and anterior views (c) pre-enclosure, mineral dust/ bone fragments (d), and the specimen in its anoxic enclosure (e).

While pyrite decay is irreversible, storage in anoxic and low humidity microenvironments is a common mitigation technique to prevent further degradation (Burke 1992, Fenlon and Petrera 2019). All work with suspected pyrite decay specimens was performed in a ventilated area with gloves and safety glasses. Before enclosure, specimens were photographed and dry brushed with acrylic paint brushes to remove as much mineral crusts as possible without causing further damage. Pillow style barrier bags were created using a Futura Portable Cello tacking iron with a wide element sealing press (Trafford and Allington-Jones 2017). Specimens were placed in separate ceramic barrier film bags with a Dry & Dry Premium humidity indicator card and RP A-Type System oxygen absorber and desiccant. The number of RP-A sachets to add to each bag was calculated by dividing the airspace volume of the bag by the capacity of the RP-A, then rounding up to a whole number. Specimens were then photographed in the enclosure in order to provide a comparison for monitoring.

The materials and methods were archived as a protocol in case of future pyrite decay on specimens at RLB. This protocol, along with having excess materials on hand, allowed for the goose tarsometatarsus to be enclosed soon after it was discovered. Since enclosure, no observational changes in humidity, mineral crusts, or fossil condition have been noticed on any of the specimens. Monitoring of these enclosures will aid in determining the suitability of this protocol and any modifications it may require in the future.

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ASSESSING UNSTABLE FOSSILS FOR LONG TERM STORAGE

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In 2022, Fort Hays State University's Sternberg Museum of Natural History (FHSM) was awarded a three-year IMLS grant to address the long-term preservation of a Late Miocene mammal collection. These fossils come from an Ogallala Formation locality called the Minium Quarry. This project builds on paleontology collection improvements initiatives that started in 2016 to institute a relational database and advance digitization and data-sharing efforts by the Stenberg Museum. However, some important aspects of the project are novel and have required new protocols. Specifically, many of the fossils from the Minium Quarry were poorly consolidated, which left them prone to significant (and rapid) degradation over time. This has been accelerated by improper storage of uncurated specimens and over-crowding of curated specimens in cabinet drawers.

To address these issues, Year 2 activities of our IMLS grant focuses on fossil stabilization. Stabilization efforts include sediment removal, applying consolidants, fabricating cavity mounts, and/or building cradles. As a result, we developed a new assessment workflow consisting of two evaluation tools (Tables 1 and 2) to help categorize the risk factors for specimens and determine how to address stabilization issues. First, each fossil in the Minium Quarry collection was assessed for whether the fossil was high risk or low risk for permanent damage. Assessment criteria include checking for rectifiable breakage or damage to specimens, inspecting the state of the materials used to house each specimen, and ensuring the specimens have ample room in their respective drawer. Specimens were placed into one of four categories (Table 1). Category 1 represents a specimen that needs immediate work due to heavy breakage, an unstable housing environment, or urgent stabilization needs. Category 2 represents a specimen that needs stabilization, rehousing, or minor reassembly but is not in immediate danger. Category 3 specimens need eventual work but are in no immediate need of assistance. Category 4 specimens have satisfactory housing, no stabilization needs, and were either complete or could not be reassembled.

	Breakage	Stabilization	Matrix	Housing
Category 1	Large, complete breaks through	Very unstable, fractures forming or	Significant matrix buildup	Improper housing actively contributing

	bone and/or many shattered bones	extremely fragile bones prone to powdering	not needed for stabilization	to deterioration with obvious risk of future damage
Category 2	Some complete breaks, simple reassembly required	Minor stabilization needed, small fractures	Minor surface matrix	Improperly housed with foreseeable, but not urgent, risk of future damage or deterioration
Category 3	Minor to no breaks, reassembly may or may not be feasible	No stabilization needs	No matrix	Not ideal housing, but could remain stable with current housing
Category 4	No breaks or reassembly not possible	No stabilization needs	No matrix	Best possible housing achieved

Table 1. Criteria used to place fossils into stabilization categories.

Further criteria were employed beyond categorization of preparation and housing needs to determine the kind of housing required. After categorization, fossils were evaluated for whether archival cradles, cavity mounts, or archival boxes were needed for long-term stabilization (Table 2). Fossils were assessed based on size, stabilization concerns, resting position (related to bone shape and how the specimen needs to be stored), and the research potential of the specimen. This assessment workflow has been vital for maintaining consistency and clear communication among a team where members work asynchronously on similar projects and we often need to train new team members.

Required Housing	Specimen Size	Stability	Resting Position	Diagnostic Value for Research
Cradles	Medium to large	Unstable (Category 1 & 2)	On vulnerable points or highly curved surfaces	High
Cavity mounts	Small to medium	Unstable (Category 1 & 2)	On vulnerable points or moderately curved surfaces	Any
Archival box with ethafoam padding	Small to medium	Stable (Category 3 & 4)	Mostly flat	Any

Table 2. Criteria used to determine long-term storage solutions for fossils.

Standard materials were used for both preparation and housing following prioritization. Stabilization and reassembly of fossils used Paraloid B-72 dissolved in acetone, cavity mounts were constructed of ethafoam, tyvek, polyester batting, and archival boxes, and cradles consisted of fiberglass and plaster with either ethafoam or felt lining. None of these materials had special safety concerns, and both cradles and cavity mounts were light enough to be safely handled by one person, aiding in the asynchronous nature of this project.

This Minium Quarry project is the first time we have addressed long-term stability issues in the collections other than re-housing specimens in archival boxes. However, with the addition of workflows for assessing specimen stability and protocols for making cavity mounts and archival cradles, we are better positioned to consistently address stability issues in the future.

ANCIENT ÉCORCHÉ: 3D PRINTING AS AN INEXPENSIVE TOOL FOR MUSCULOSKELETAL ANATOMICAL REFERENCE IN THE CLASSROOM

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The Project

3D printing and free online databases have revolutionized the accessibility of paleontological specimens and resources to museums, schools, and hobbyists. The large number of skeletal and fossil scans, provided by this technology, has allowed for the easy physical recreation of thousands of vertebrate taxa, both extinct and extant. The availability of these specimens on free online databases provides a unique opportunity to incorporate osteological and musculoskeletal reconstructions as educational models and as phenomenological teaching tools. In order to test the application of this practice, we printed the skulls of four tetrapods with differing cranial and fenestra structures, including *Camarasaurus lentus* (CMNH 11338), *Gorilla gorilla* (OKC 8018), *Procolpochelys charlestonensis* (CCNHM 893), and *Dimetrodon* sp. (MSU specimen). These taxa were chosen because, although they each have an autostylic jaw joint, they represent a variety of feeding modes, ecological niches, body sizes, and geologic time periods. The skull models were selected for their high levels of symmetry and fidelity, and because they represent examples of synapsid, diapsid, and "anapsid" cranial anatomy. After the skulls were printed, the musculature of their jaws was rigorously recreated in clay using available literature as a reference. The application of this technique rendered realistic écorché-style models and was found to have enormous potential in terms of making both educators and students think critically about the structure, function, and biology of ancient vertebrates.

Health and Safety (H&S)

All PLA (polylactic acid) printing conducted during the creation of these models was carried out with rigorous safety guidelines. All personnel trained in the use of Ender-3 fused deposition modeling (FDM) printers are taught how to properly handle equipment, clean and repair printer parts, and avoid heated areas such as the bed and nozzle during maintenance and printing. Printing is conducted in a well-ventilated room with constant airflow. No toxic thermoplastic substances such as acrylonitrile-butadiene-lignin (ABL) are used in our printing space, nor are any UV-curing acrylic or epoxy resins. A working dry chemical fire extinguisher is kept within reach of the printing room at all times and is inspected regularly. All aerosol paints and coats are applied outside of the building, and students are required to wear respirators while applying these products to 3D prints. Two-part epoxy gel coatings and polyvinyl acetates are applied with latex-free disposable gloves and eye protection, and dust masks are worn when applying epoxies.

Procedures/Results

All of these skulls were downloaded from free online sources, including sketchfab.com, phenome10k.com, and morphosource.com. These four skulls were printed in miniature with PLA filament on an Ender-3 fused deposition modeling (FDM) printer, one of the least expensive commercially available 3D printers. After the supports were removed and the print was properly trimmed, each skull was primed with XTC-3D™ High Performance 3D Print Coating two-part epoxy and Paraloid B-72 to smooth the filament texture of the printing material. During the priming process, the individual skull bones and sutures were accentuated to emphasize their shape and functions. After the epoxy and Paraloid had set, the jaw and temporal muscles were approximated using Counter Culture DIY brand Culture Sculpt two-part modeling compound and sculpted with clay tools on one half of each skull. The other half of the skull was left with the bone exposed. This asymmetrical approach was chosen so that one side of the skull could represent the morphology of the cranial bones, and the other could showcase how the muscles interact with the osteological frame. After the clay had properly dried, the exposed side of the animal's skull was painted to more closely resemble fossil or modern bone (depending on the organism). The finished musculatures and skulls were painted with Apple Barrel brand acrylic paint and sealed with Rust-Oleum Matte Clear™ polyurethane coating to protect the paint, and aid in durability. The final product is a series of educational models that approximate the morphology and biomechanics of each organism's jaws and are thus useful tools for classes that discuss topics such as evolution, homology, comparative anatomy, biomechanics, zoology, and adjacent concepts. The *Dimetrodon* model in particular served as a reference for students as they compared deformed fossil specimens to the printed skull, with recreated muscles, in the University of Colorado, Boulder's vertebrate paleontology course in the fall of 2023. This visual reference was especially important as a visual aid regarding early synapsid jaw anatomy and heterodont dentition. In addition to the final products being effective educational tools, what was perhaps even more informative, was the performative task of adding musculature to these skulls. Pulling from the traditions of forensic art and the Renaissance techniques of écorché, we found that during the act of adding clay onto the bones, the sculptor was forced to grapple with and understand the anatomy of the animal's skull and jaws. From this phenological level, we suggest that this technique possesses enormous implications within the classroom, as an engine for scientific art and illustration.

All of the materials utilized in this project were chosen because they are relatively inexpensive, and are readily available in most craft and/or hardware stores in the United States. Excluding the PLA filament and thermoplastic printer itself, these detailed models were created from less than $45 of materials. In the creation of the four printed skulls, we used a total of 274 grams of PLA filament, which is roughly $6.85 of this material. This low-cost method of both creating educational tools and providing educators/students with experiences in forensic/artistic skills can be employed within a variety of settings, such as undergraduate or high school-level classes or workshops. With the increasing accessibility of free online 3D models and both thermoplastic and UV-curing resin printers, we encourage classrooms, small museums, and universities to utilize this inexpensive, but extremely educational technique within their exhibitions, courses, and workshops. It is through this method of augmenting inexpensive 3D prints with inexpensive, but effective materials, that we encourage students to think critically about the mechanics, feeding strategies, and adaptations of ancient and modern life.

EXPEDITED RECOVERY OF FOSSIL MARINE MEGAVERTEBRATES IN INDUSTRIAL MINE SITES: THE MANITOBA (1972-1984) AND ALBERTA (2007-PRESENT) EXPERIENCES

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Megavertebrate fossils can be found through the digging activities of industry, here defined as subsurface and surface mining, road building, construction, pipeline trenching, etc. This is increasingly true in western Canada over the past 50+ years. In southwestern Manitoba (MB), mining of Late Cretaceous bentonite clay near Morden, MB beginning in 1934 has yielded megavertebrates like plesiosaurs, mosasaurs, sharks, bony fish, and smaller specimens. Collecting of these finds by professionals was sporadic and thus some specimens were sadly lost to science. It was not until the 1972-1984 that local high school teacher Henry Isaak and others made dedicated efforts to save the fossils.

Oilsands mining in northeastern Alberta (AB) and ammolite mining in southern AB have produced diverse megavertebrate assemblages. Oilsands mining in Early Cretaceous rock has resulted in the discovery of mostly plesiosaurs, some ichthyosaurs, the nodosaurid dinosaur *Borealopelta*, undescribed unfossilised wood pickled in oil, and some invertebrates. Ammolite mining south of Lethbridge, AB in Late Cretaceous rock has revealed mosasaurs, plesiosaurs, dinosaurs (hadrosaurs mostly), turtles, shark teeth, bony fish, invertebrates, and plants. A more expanded review on the history of these particular mine operations and the fossils found therein by the authors is underway (Tanke and Cuetara, in prep.).

Rapid recovery of megavertebrates, the focus of this study, by industry digging activities in AB and MB has been particularly important. While bentonite mining in MB ceased in 1990, ammolite and oil sands mining continues with the Royal Tyrrell Museum (TMP) acquiring, on average, about 1.2 new marine reptile or dinosaur skeletons annually.

Finding and collecting megavertebrates from natural outcrops can be worked at the institution's own comfortable pace. With an experienced TMP crew, with good weather and no other distractions; large marine reptile or dinosaur skeletons can be collected in ~1 month. Sometimes work is done over several summers. There is no incentive to go faster, which can increase the risk of injuries to personnel and/or damage the specimen. If there is no hard deadline, the project will be done when it's done, with the work conducted steadily and carefully. Quarry maps, taphonomy and other information are recorded, and photographs taken. The skeleton will be divided up into numerous smaller and manageable jackets for ease of transport.

Skeletons found in mines present a different scenario. Friction between the mine and the institution may exist. Perhaps the mine only reported the find because it is required by law. There will naturally be worries about mining delays. Mines and paleontologists have different work cultures, ethics, and expectations. Some workers may resent fieldworkers on site, fearing the find will be so important that the mine will be shut down and they will be unemployed.

These worries are of course unfounded, but workers and site managers have communicated such concerns previously. Paleo workers might remove small amounts of rock during a 7.5-hour day, whereas mines move tens of thousands of tons of rock or more per day, 24 hours a day. Paleontologists do slow, careful and detailed work with small hand tools, miners do massive, coarse work with explosives and heavy machinery. Work expectations between paleontologists and miners are therefore vastly different.

To mitigate these conflicts, it is critical to establish a good working relationship with mine management and site workers. After all, we are in their active worksite; disturbing them, interrupting or delaying work schedules/quotas, introducing new safety concerns, and being a distraction to mine workers. What mines want is for the fossil excavation work to go by safely and especially quickly, so it is important to expedite the work. In 2023, at an ammolite mine, the TMP was able to collect a nearly complete mosasaur, at ~5.5 metres (~18′) long in two large jackets in just seven work days. Comments on how rapid work was achieved in AB and MB are given below. Expedited work calls for some cutting of corners and inventiveness. We don't recommend all these ideas, but they work(ed) for us in Alberta. The rough and especially rapid technique in Manitoba is included here mainly for historical purposes. We don't endorse it.

Work in mines is inherently dangerous. TMP crews abide by mine training and protocols, wearing hardhats, steel-toed work boots, high visibility vests, safety glasses, hearing protection, and dust masks as needed. Sun block is provided. In cold temperatures, the TMP provides crew with winter clothing, chemical hand warmers, collapsible shelter and propane-powered heater with proper ventilation. Health and safety precautions for field paleos at the Manitoba mines are unknown given the passage of time.

In Manitoba:

1. Miners reported finds or volunteers from the Morden Museum walked behind heavy machinery salvaging what they could and looking for big skeletons. Sometimes bulldozer operators could feel the blade catching on something hard, which was the first skeleton indication. Sometimes, operators would salvage bigger or "more picturesque" fossils. Unexperienced people, usually the farmer owning the land mined, or miners, would get notice of some find and recover a specimen by just picking up the biggest elements and piling them up in boxes.

2. Once found, the area was marked off and miners avoided the area for a short period of time. It appears there was much less time to dig in MB than AB so there was more urgency to get the skeleton out – some taken out in hours to just a day or two. At times, people had to work from sunrise to sunset in order to unearth the specimen, in efforts to not interfere with mine operations. Car headlights illuminated the work area at night.

3. The skeleton was quickly uncovered to delineate its occurrence (Figure 1). Glyptal in acetone was used to stabilize the bones which would otherwise crumble into dust on air exposure after a few days.

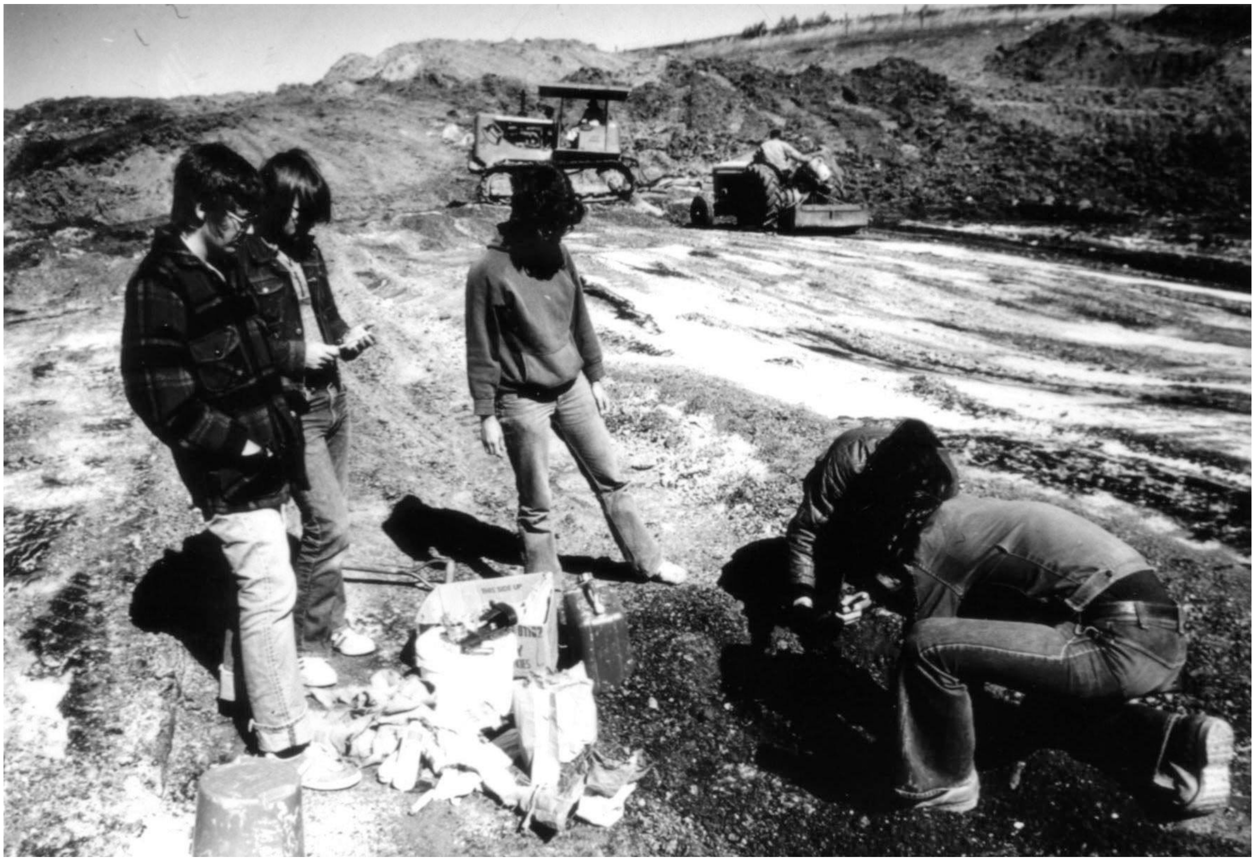

Figure 1. July, 1974 recovery of the mosasaur "Bruce" a Tylosaurus in an active bentonite mine on the Lumgair farm, near Thornhill, MB with mining equipment nearby.

4. Once uncovered, two main urgent procedures were followed:

   a. Plaster of Paris was mixed up and a single larger or multiple smaller pours of plaster were made directly onto the bones without separator. Plaster-soaked burlap strips could then be added in one to three layers depending on dimensions. Occasionally, pieces of lumber were used to keep rigidity in some thin slabs.

   b. Once set, the entire slab was grabbed at one edge by 3-4 people and turned over. Heavy machines from the mining company were used to recover big plaster slabs. Any bone pieces still in ground were saved.

This was a crude, perhaps shocking, rapid technique. It is fraught with issues, particularly damage to the specimen and loss of parts so we don't encourage it, but relate it here for historical purposes only. Nevertheless, some significant research quality specimens were secured in this manner.

A partial *Ichthyodectes* fish (TMP 1986.224.0155) was collected by the Black Hills Institute in the same manner noted above, so the technique has been used elsewhere.

In Alberta:

Albertan industry digs have unique challenges particular to each site so here are some procedures and advice that the TMP utilizes.

1. On receipt of a fossil discovery report, a TMP crew of two is sent out. This is often on the same day for an on site reconnaissance. A fully equipped team is sent out the next day.

2. Dark-colored bones are hard to see in dark shale. Bones can be outlined with dotted lines of "White-Out"*-type typewriter correcting fluid, especially on the periphery of the quarry. Outlined bones are easier to see and thus saves time and potential damage.

3. To speed up glue drying time, the "burnt dope technique" can be utilized. This involves lighting of the Paraloid glue on fire to flame off the acetone solvent. This warms the bone and is useful, especially if outside temperatures are cold and/or the rock damp, the shale at ammolite mines is ~15% water by weight.

4. If a well-permineralized bone breaks, there is less priority of effecting a field repair if it's not critical. The bone piece(s) can be simply bagged, a label identifying it and other notes put inside, and then laid alongside the affected bone and incorporated into the larger jacket.

5. Detailed site mapping with a grid box, baseline, and graph paper is not done. Rough sketch maps are made instead and many digital photographs taken.

6. In lieu of small jackets, where an isolated (disarticulated) bone is heavily permineralized and cracked into larger pieces, the bone can be removed in pieces for reassembly later. This practise is usually done for bones that are in areas being trenched. Quick setting Gypsona* jackets can also be used.

7. Sometimes skeletons are found inside large and heavy concretions with large cracks. Here, the concretion is disassembled and only the exposed bone is covered with separator and then Hydrocal FGR-95* cement (FGR) and burlap. The rest of the hard rock is not jacketed, in a sense it becomes the jacket.

8. Work longer days and even at night. Gas-powered electric generators and floodlights can help expedite the work. In one case, it was very late in the year and weather forecasts suggested extreme winter conditions to occur within a day or two. It was imperative to get the project done right away.

9. Initially the TMP used plaster of Paris on industry digs. We then decided to use FGR. Use of FGR cement instead of plaster of Paris saved time. FGR sets extremely hard, and one FGR layer for strength = ~3-4 layers of plaster of Paris and burlap. Use of FGR for jackets reduces jacket making time. In cold weather, hot tapwater is taken to the site to make the FGR mix. This cools down a bit before use but is still warm enough to ensure curing, even in moderately cold conditions with success inside a "heated" shelter with floor temperatures as low as -5oC (14oF) -19oC (-2oF) outdoor temperatures. FGR and fiberglass mat further expedites the work but is messy to work with.

10. One hour lunch breaks and two 15-minute coffee breaks are permitted. However, fieldworkers sometimes work through the coffee breaks and take a shorter lunch break.

11. Trackhoes can be utilized to expedite work. Their first use was in 2007, on a large skeleton of what became the type specimen of the 11.2 metres (37') long elasmosaur *Albertonectes vanderveldei*. The entire unjacketed specimen was trenched in < 45 minutes resulting in 3 large jackets, though now we cap specimens prior to similar trackhoe use. Given the size of the animal, trenching by hand would have taken several weeks and delayed the project. On all specimens, a shallow trench is dug by hand around the specimen to just below bone level to ensure nothing is there prior to the trackhoes finishing the work. Now we make use of heavy machinery of different types on most mine/other industry calls. Site managers are told we can be there a month and do the work all by hand, or they can help us for a few hours here and

there, dealing with overburden removal, trenching, jacket flipping and block removal (Figure. 2) and loading and we'll be gone in about a week. Hearing this, the machines are always provided.

*Figure 2. Trackhoe lifting one of two large blocks containing most of the skeleton of a subadult mosasaur (*Prognathodon*) at the Enchanted Designs Ltd. mine near Lethbridge, AB.*

12. Jackets can be made much larger as heavy equipment can assist with flipping and lifting. Dividing an animal up into smaller blocks and worries about weight are less of an issue. Blocks can be flipped onto a cushioning rubble pile with lifting straps laid on top and then lifted out to an area peripheral to the main work site for pedestal removal, jacket trimming, and final FGR work. The TMP has a large forklift that can lift up to 5 tons so unloading heavy blocks at the museum is not an issue.

*Product names herein are not an endorsement by the TMP or the Alberta Government. They're provided for educational and historical purposes only.

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REVIVING THE SANTA BARBARA MUSEUM OF NATURAL HISTORY'S PYGMY MAMMOTH FOSSIL LEGACY COLLECTION TO FOSTER NEW RESEARCH

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The Santa Barbara Museum of Natural History (SBMNH) is fortunate to reposit most of the mammoth fossils that have been found on the Northern Channel Islands off the coast of southern California. The Northern Channel Islands are the only home of *Mammuthus exilis*, known commonly as the pygmy mammoth. SBMNH's mammoth collection is important because it provides the largest sample of *M. exilis*, a species that resulted from insular dwarfism. The legacy collection was the basis for nearly all pygmy mammoth research (excepting the Stock and Furlong 1928 holotype) from the 1940's to the 1990's.

Scope

SBMNH's mammoth fossil collection predates the establishment of Channel Islands National Park in 1980. The Museum was chosen as the park's fossil repository due to its proximity to the islands and legacy collections. The National Park Service collection has been maintained through accepted best practices for field collecting and the management of contextual data and is outside the scope of this extended abstract.

The SBMNH legacy collection consists of mammoth fossils collected in two eras, both before 1980, and primarily from Santa Rosa Island (SRI). From the mid-1940's through the 1960's, SBMNH Curator of Paleontology and Anthropology Phil C. Orr collected over 500 mammoth fossils from SRI (Orr Collection). The Vail & Vickers Company operated a cattle ranch on SRI, which they owned, through most of the 20th Century and Orr collected with their permission and cooperation.

The next era of collecting took place during the 1970's, when a member of the Vail family, Boris Woolley, amassed over 100 additional mammoth fossils from SRI. After Mr. Woolley died, his family donated those fossils to SBMNH (Woolley Collection). The fossils in the Woolley Collection were identified and catalogued by paleontologist Dr. Larry Agenbroad and his wife Wanda Agenbroad in the 1990s. The combined Orr and Woolley Collections have approximately 700 specimens.

Purpose

The purpose of this project is to better preserve SBMNH's mammoth fossil legacy collection and increase its scientific value with the aim of fostering new research. We hope to achieve this goal by reestablishing the connection between the fossils and their contextual data and significantly improving the quality of those data.

Problems

The main problem with SBMNH's mammoth legacy collection is that, over time, the connection between the fossils and their contextual data has been obscured or lost, thus diminishing its scientific usefulness. Most of the field notes for the Orr Collection were destroyed and the Woolley Collection never had field notes. Finding a fossil's contextual data was difficult because there was no centralized database. Instead, information had been conserved and scattered across several archives requiring extensive searching to locate information. While fossils from both collections have been cited in numerous papers and studies, there was no quick and reliable way to find the correct fossil that had been cited, making further study difficult.

The physical state of the legacy collection was also challenging. None of the fossils were in archival-quality housing and many of them were incorrectly labeled or had no label. The numbering systems were confusing, among other issues. As a result, over 700 fossils were not easily accessible for research nor properly conserved.

Health and Safety

Moving the fossils presented the most significant health and safety concern as the shelves were heavy and could cause serious injury if mishandled. Any shelf that was weighty or high up was moved by two people. If a ladder was needed (the highest drawers were 72" high), a second person would hold it to ensure it did not tip over. Collecting data involved sitting in awkward positions for long periods of time, so frequent breaks were encouraged.

Methods

In 2023, new cabinets were installed for the SBMNH Earth Science Collection, including the legacy mammoth fossils. The renovation project presented an opportunity to address the collection's challenges. The fossils were removed from the cabinets and housed in temporary, mobile shelving structures dubbed "The Arks". Care was taken to ensure the organization was retained because the fossils had been grouped by Dr. John E. Cushing, a former SBMNH research associate who worked on the Orr Collection in the 1980's and 1990's. Cushing's organization was maintained by leaving the fossils in their drawers and moving them into the Arks, which were purpose-built to accommodate the original shelves.

Before working directly with the fossils, we focused first on reviewing and digitizing the legacy collection's documentation. Orr's field notes had been lost for decades, so critical information was missing. Fortunately, an archive of Orr's files was housed at the SBMNH Library. The archive included the original manuscript and notes for Orr's 1968 book The Prehistory of Santa Rosa Island, museum reports and publications, correspondence between Orr and other researchers, scientific papers, newspaper articles, photographs, and 35mm movies that provided context to the collection. These documents were digitized and uploaded to Google Drive.

The SBMNH Collection and Research Center housed a critical document, the handwritten Paleontology Field Record (PFR), which is an inventory of Orr's work from 1947 to 1960. Notably, there was a copy with Cushing's notes. The PFR was written by Wilbur A. (Buck) Davis, an associate of Orr's who excavated on SRI with him in the late-1950's. Davis later received his PhD in Anthropology from Reed College in 1962.

The PFR is difficult to use because its organization is convoluted and, as a handwritten document, is not digitally searchable. The PFR first list fossils by Field Number, then lists the same fossils by Paleo Number. Different information regarding the same fossils was sometimes provided in the Field Number versus the Paleo Number section. Alternatively, there might be no information in the Paleo Number section, just an entry referring to the Field Number.

Despite its complex organization, the PFR had essential information, especially considering the loss of Orr's field notes, regarding each fossil such as year collected, specimen description, locality data, collector, and preparator. The next step was to transcribe the PFR into an Excel spreadsheet to create a verbatim, archival version.

We followed the PFR's organization as closely as possible. Columns included: Paleo Number, Field Number, Associated Paleo Numbers, Year Collected, Prepared, and Phil Orr/Buck Davis Description. We added a column to capture Cushing's notes scribbled on the PFR in the 1980's. Information from multiple pages of the PFR, i.e. from either the Paleo Number or the Field Number entry, regarding the same fossils was incorporated into one row. This spreadsheet preserved the PFR's information but was difficult to use due to its lumping of information, such as specimens collected and localities, into one cell which made it unsortable.

As such, we created an expanded version of the PFR spreadsheet and separated the notes into categories of information which could easily be sorted for analysis and data quantification. In the expanded version, we sorted the data by Field Number and then added information from the archives, organized by field year, such as who participated, the approximate dates of the expeditions, and number of fossils collected. The following columns were added to increase sortability: Expedition Number, Genus, Species, Adult/Juvenile/Infant/Fetal or Newborn, and whether the specimen was listed as being part of the pygmy mammoth composite skeleton on display. Locality information was parsed into seven new columns: Island/Mainland, Which Island, North/South, Vicinity, Quarry or Locality Number, General Description, and Member. Each specimen type was entered into its own row whereas Orr/Davis lumped numerous specimens under one Paleo or Field Number and description.

We transcribed the Woolley Collection's database into an Excel spreadsheet. The quality and organization of that information was excellent because it had been prepared by mammoth experts Larry and Wanda Agenbroad, so the information was entered verbatim. The database included the following columns: Specimen #, Accession #, Species, Locality, Identifier, Prep Treatment 1, Prep Treatment 2, Collection Date, Elements, and Notes. Each fossil was entered into its own row. However, there is almost no locality information because the fossils were surface collected by an island resident rather than excavated by trained paleontologists. Further research will be needed to determine locality data, if possible.

The digitized spreadsheets are an integral part of this project because they provide a snapshot of what fossils SBMNH should have in its collection. The next step was to use the expanded database as a foundation to create a Condition Report to record what fossils SBMNH actually had in its collection. Attempting to create a Condition Report without the contextual data captured in these spreadsheets would have been highly frustrating if not impossible.

To create the Condition Report for the Orr Collection, we took the expanded version of the PFR spreadsheet described above and sorted it by Paleo Number because most specimens were labeled by that number. We added columns to describe where the specimen is located and to record our preliminary observations. For the Woolley Collection, we took the Excel version of the original database and added a few columns to describe where the specimen is located and to record our preliminary observations.

With these resources in hand, we reviewed 81 drawers of fossils in the Arks to complete a first draft of the Condition Report. Each drawer was photographed, and the fossils' information was recorded in the Condition Report if it could be confidently identified, in terms of both element and Paleo Number or Field number. If the fossil could not be identified, it was added to a list of "problems." Common reasons for addition to the problems list was no number, a nonsensical number, too many fossils with the same number, and not matching the description in the Condition Report. All contextual information, such as notes near the fossil, and observations regarding the fossils' physical traits were recorded.

This process was repeated for the Oversize Shelves, about 20 other drawers scattered around the collections room, and for specimens on exhibit, including a composite skeleton containing dozens of elements with different Paleo Numbers. During this process, the same Health and Safety protocols described above were followed. We have completed a preliminary Condition Report, and the results are described below.

Results

Completeness of the Collection

Despite the decades-long gap between now and when the fossils were collected and catalogued, the majority of the Orr Collection has been located. The number of fossils identified will increase after the Condition Report is completed because of the contextual data entered and organized in the spreadsheet. This tool will allow us to compare our list of "problems", the fossils that could not be identified in the first review, to the "missing" fossils in the spreadsheet, thus reestablishing the connection between more fossils and their contextual data. In further good news, all but two of the Woolley Collection fossils have been found.

"New" Specimens

Our work on the Condition Report has revealed several specimens that have not been catalogued. In some cases, the PFR description of specimens collected under the same number did not list all elements found, so those fossils will need to be better described and quantified to create a complete list. A tusk fragment collected locally in 1950 was found that had not been identified in the PFR and there was no record of it, not even a newspaper article, in the Orr archive. The Woolley family recently found another mandible and tooth and donated it to the museum to add to the Woolley Collection. It had not yet been added to the database. These are just a few examples of fossils that need better cataloguing and documentation.

Quantification

We can now theoretically count the legacy collection using the spreadsheets. Once the Condition Report is completed, we will have an actual count. The theoretical count has been helpful to see trends in the data such as Orr collected almost all of the over 500 pygmy mammoth fossils he found in the early years, from 1947 to 1949, when he was trying to obtain enough fossils to create a composite skeleton for display. He collected relatively few mammoth fossils in the later years, the 1950's, when his research focus shifted to finding a link between humans and pygmy mammoths.

We know generally where 93% of the Orr fossils were collected from, and which side of SRI and which localities were the most productive. Many of these localities are sufficiently described to be ground truthed to provide GPS coordinates and create a GIS map to guide future excavation. Orr provided stratigraphic information for about half of the collection and about 43% of the fossils came from the same member.

As identified by Orr, footbones, ribs, teeth, and vertebrae were the most numerous fossils. Thirteen skulls, 27 humeri, and 22 femora are also listed. Six percent of the specimens are identified as subadult. Seeing the data yield useful information early in the project provided much needed encouragement during an often tedious process. Once the Condition Report is finalized, the contextual data has been bolstered, and taxonomic identification has been completed, we will be able to provide far more robust element quantification.

Future Work

Further work is required to complete the Condition Report. Then the fossils will be reorganized, rehoused, and probably renumbered (for specimens that have not been referenced in the literature). Numerous preparation and conservation issues are already evident, such as the need to repair damage and create archival cradles and mounts. More complicated issues, such as what to do about glyptol, shellac, and plaster applied directly to some fossils, need to be researched and addressed.

The contextual data for the pygmy mammoth fossils needs bolstering. For example, we would like to link every paper and study citing a fossil from the SBMNH legacy collection to the specimen database to reestablish that connection. Locality data needs to be ground truthed and entered into a GIS map to aid the annual monitoring program. Another goal is adding photographs and 3D scans. Finally, taxonomic identifications need to be confirmed and any other relevant information, such as evidence of pathologies, age, sex, or transport, from the fossils need to be entered into the database.

Conclusion

Ultimately, we will add all these data to the SBMNH vertebrate paleontology database, using Specify database platform software. We would also like to create a Compendium Database of every mammoth fossil collected from the Northern Channel Islands, including those reposited at other institutions. With these resources, we hope to spur a new era of research on the pygmy mammoths of the Northern Channel Islands.

NO SAW JACKETS

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Many large or fragile specimens require jackets, cradles, clamshells or other plaster and fiberglass supports. The method most used is to layer plaster and fiberglass well over the edges of the specimen, wait until the plaster is dry, remove the specimen, and saw off the edges. This is a dusty process, requiring appropriate PPE, such as gloves, N95 respirators, eye and hearing protection, and protective clothing, to avoid breathing or wearing harmful flying plaster and fiberglass dust. It should always be performed with a vacuum or dust collector. It can leave fiberglass splinters sticking out of the rough jacket edges, requiring either covering with an additional layer of plaster or even blowtorches. Fiberglass splinters in hands, and the annoyance and damage from plaster and fiberglass supports are the subject of many methods discussions among preparators and collections staff.

Here at the Yale Peabody Museum, we use a technique that eliminates the step of sawing the edges of our support jackets. We simply stop applying the fiberglass approximately one-half inch (1 cm) inside of the planned edge of the jacket. Depending on the size of the finished jacket, the un-fiberglassed edge may be as much as one inch (2.54 cm). When making clamshell jackets the edge is deep enough that the hardware stays within the fiberglassed area.

We continue plastering that last half inch around the edge manually making a nice, rounded edge. This method works for any kind of jacket, cradle or clamshell. Either Hydrocal or

Hydrocal FGR 95 work well with this method. As a barrier between the plaster and the specimen we have used felt, Ethafoam, or a clay layer that is replaced with Ethafoam. We primarily use continuous strand mat (having a lifetime supply on hand already), but we have also used fiberglass veil, fiberglass fabrics of various weights, carbon fiber veil, and fiberglass scrim purchased from Fibre Glast. Once the plaster has set, but before it is fully dry, the jacket is lifted from the specimen and the edge is cleaned up quickly with a Sur-Form.

This method does require some understanding of the properties of plaster and how to work with them. For example, as the plaster sets and thickens it can be used to build up any thin sections around the edge. It can be sculpted with a steel sculptor's spatula. It can be smoothed with spatulas or hands with a bit of water. Tools used include silicone mixing bowls, spatulas - a variety of small and large metal and plastic tools, and Sur-Form tools (this tool consists of a steel strip with holes in a handle; one side of the hole is sharpened to make a cutting edge). The preparator should, of course, use appropriate PPE, such as N95 masks, gloves, and eye protection when working with plaster and fiberglass.

The edge is as sturdy as a cut edge, easier and cleaner to achieve, and much less aggravating.

CURATION OF A PALEOCENE COLLECTION OF SOFT-SHELLED TURTLES IN THE NORTH DAKOTA STATE FOSSIL COLLECTION

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The Project

During the late Paleocene, North Dakota had a warmer climate and was largely covered by swamps and wetlands. This made it the perfect habitat for animals such as crocodiles, champsosaurs, fish, and turtles. The North Dakota State Fossil Collection holds a sizeable collection (2,233 cataloged specimens) of fossils from the Ash Coulee Quarry, a North Dakota locality that is situated within the Sentinel Butte Formation. The majority of this collection (89%) is composed of the remains of one Trionychid turtle species: *Hutchemys rememdium*. A collaborative project between the United States Forest Service (USFS) and the North Dakota

Geological Survey (NDGS) provided funding for the cleaning, repair, rehousing, identification, organization, and cataloging of specimens from this locality. Curation of this collection improved the preservation and longevity of the fossils, created a more detailed record of this paleontological fauna from USFS managed land, and provided increased accessibility to specimens and their associated data for visiting researchers. Here we provide an overview of the methods employed and benefits gained during this project.

<u>Health and Safety</u>

Standard lab protocols and procedures were used during cleaning and repair of fossils. Gloves were worn in the micro-air abrasive. An air filtration system with HEPA filters was utilized to prevent inhalation of dust and sodium bicarbonate. When using pneumatic tools, ear protection, masks, and safety glasses are worn. Procedures and Results Though the first excavations at the Ash Coulee Quarry began 30 years ago, many of the specimens remained uncatalogued and in need of additional preparation and stabilization. Further work also needed to be done to separate out and identify individual skeletal elements and to differentiate associated specimens from isolated elements. The turtle fossils were previously identified as *Plastomenus* sp., but recent re-examination of the specimens by outside researchers concluded that most of turtle specimens from this locality were from a single species: *Hutchemys rememdium*. Other taxa present at this locality include: *Amia* sp. (bowfin), Crocodylia, *Champsosaurus* sp., *Protochelydra* sp. (snapping turtle), *Piceoerpeton* sp. (salamander), and a single femur from a plesiadapiform mammal.

Micro-air abrasion with sodium bicarbonate was used to clean the specimens, and Ethyl Methacrylate co-polymer Paraloid B-72 in Acetone was used for consolidation and repair. Rehousing smaller specimens involved moving fossils from larger vials stored horizontally, to smaller more secure vials stored vertically when appropriate. This method consolidates space and reduces movement of the specimens, which could potentially cause damage when drawers are opened and closed. Specimens that contained many fragments were moved to appropriately sized boxes with high sides to prevent spillage. Ethafoam cavity mounts with soft structured Tyvek were used to stabilize larger and more fragile fossils, and finger holes were added to ensure specimens could easily be removed and replaced in their cradles. This included many nearly complete-complete carapaces and plastrons (Figure 1).

Figure 1. Hutchemys rememdium *plastron (NDGS 1758) housed in an ethafoam cavity mount with soft structured Tyvek. Cleaning and cradling done by Trissa Ford. Scale bar is in mm.*

Some specimens were incorrectly reconstructed. For example, there was one specimen cataloged as a complete carapace, that was found to be two anterior halves of two different carapaces. Other specimens were collected from the field with no spacer between the inside of the plaster jacket and the fossil. This method left the fossil embedded in the plaster, making these specimens difficult or impossible to prepare. The challenge of removing fossils from plaster was overcome by using hand tools such as scalpels and picks to carefully scrape the material off, and by using micro air abrasion with the air pressure on high to slowly wear the plaster down (Figure 2). Some specimens were so badly imbedded that their attempted removal would cause unnecessary damage to the fossil. Therefore, these specimens were left in their plaster imprisonments, surface cleaned, and stabilized as best as possible.

Figure 2. Hutchemys rememdium *partial carapace (NDGS 10355), dorsal view, housed in an ethafoam cavity mount with soft structured Tyvek. This carapace was completely encased in plaster on the ventral side but was successfully freed after careful preparation. Cleaning done by Trissa Ford. Plaster removal and cradling done by Abigail Glass. Scale bar in mm.*

Specimens were organized by taxon, but since the bulk of this locality contains one species, *Hutchemys rememdium* was further organized by skeletal element, starting with the skull and continuing anteroposteriorly. Lastly, specimens needed to be renumbered into our new catalog system and cross referenced with data associated with the old numbers. The final step is to enter this data from our catalog books into our online database in Specify, which will be completed in spring 2024. This project is now complete, and specimens are in the proper condition and arrangement for their long-term preservation, and convenient access to visiting researchers. Similar work is currently being undertaken on other USFS sites to improve the overall quality of our North Dakota State Fossil Collections.

THE USE OF HYDROGELS IN FOSSIL PREPARATION: A NOVEL MATERIAL AND METHOD IN CLEANING AND REMOVING MATRIX FROM BONE

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One of the most common materials in fossil preparation that's been used even before preparation was considered a career is water. Water is most often used to soften the matrix and dirt in the early stages of fossil preparation. The use of water and scrubbing tools was vital prior to the technological advancements in fossil preparation ranging from air scribes, air abrasion, and sonic cleaning technologies. It is still one of the most commonly used methods of cleaning fossils due to its effectiveness in removing the majority of fine sediment on fossils and bones. The use of water on fossils and bones however does come with certain flaws and restrictions in certain scenarios. Fossils can have relatively thick, compacted, and/or stubborn layers of sediment built on the bones surface. While water can be used to remove these layers of sediment only two methods currently exist to do so, each with its own flaws. The fossil can be slowly and repeatedly exposed to small amounts of water while using a scrubbing tool or small pick to remove the sediment layer by layer. The other method is soaking the fossil either partially or in its entirety in water for a prolonged period of time to soften the matrix for easier and faster removal at the risk of destabilizing the interior of the fossil. This scenario can often frustrate preparators as it can leave them in a difficult situation of needing to choose between risking damage to fossils from soaking or spending countless hours slowly and gently scrubbing a fossil with water to remove this matrix. Highly delicate and frail fossils don't even give the option of soaking and preparators are left carefully scrubbing or leaving the matrix on if other tools or methods are unavailable. This plight led to the idea of using a hydrogel that has the ability to rehydrate and solubilize matrices with minimal water exposure to the fossil.

Hydrogels

Hydrogels are a network of polymers with the ability to absorb and hold liquids. While the term may be unfamiliar to many, hydrogels are one of the most commonplace materials that everyone has used at some point in their life. Whether a person has used hair conditioner, made gelatin, or worn a disposable diaper, they have an experience with a hydrogel. Hydrogels come in a range of absorbency, water holding capacities, and desiccation tolerances. This range of properties makes hydrogels highly versatile in material industries and sciences. The goal of using hydrogels on fossils was to offer solutions in removing stubborn matrices that were; difficult to remove in a timely manner, risked damage from water soaking, or proved resistant or difficult to air abrasion. Another goal was to offer a way to improve fossil preparation without significant monetary cost and limited technical knowledge or training.

Rational and Procedure

The experiment used sodium polyacrylate, a common hydrogel polymer used in products such as diapers, artificial snow, and Orbeez™. The rationale for this polymer was for its ease of use and its ability to hold water strongly enough to form a gel, but not so much that it forms a resistant film like gelatin. It also is very similar in chemical structure to the common preparation consolidant Paraloid B-72 differing in having an ester group in Paraloid B-72 be replaced with an ionic grouping of the sodium and single bonded oxygen atom of the chemical (Figure 1). This chemical similarity allows any residue left, because of desiccation or improper cleaning to be removed in the same manner as Paraloid B-72 with either acetone or ethanol. A ratio of 1:100g of polymer to water was used in the experiment. The powder polymer was first added to a beaker and 100ml of room temperature water was added and stirred to make the hydrogel. Increasing the ratio of polymer to water would result in a thicker consistency that was not desired for initial testing. Fossils used in the experiment came from the Hell Creek Formation in southeastern Montana. The sediment in which many of these fossils are found were largely clay based and had very high levels of bentonite. This meant many fossils could not be soaked in water for prolonged periods as the swelling and subsequent shrinking of the internal matrix after drying would leave the fossils brittle and crumbly. All of the fossils used in the experiment were first cleaned using conventional water scrubbing techniques three times prior to the use of hydrogels. The gel was applied onto a range of *Triceratops* fossils; frills, nasal, horn core, and other unidentified bones. Small test spots were first applied onto highly degraded fossils to test for any unknown interactions and subsequent test spots were used on the *Triceratops* material as precaution prior to using larger amounts of hydrogel. No interactions were seen after a 24-hour period from visual inspection. The fossils would get an application of the hydrogel spread to be only a few millimeters thin. The applied areas were then covered or wrapped in plastic wrap to slow desiccation from air flow. Initial testing was done over a 24-hour period, this was then shortened for some fossils to 4-6 hours due to a high level of water absorbency. After application and hydration period any remaining hydrogel was wiped off with paper towel from the fossil and disposed of into the trash and the remaining amount was scrubbed off with water and a toothbrush. A non-applied area of the same fossil was also scrubbed for a similar duration of time with conventional methods to act as a control.

Results

Results were organized into three categories based on visual inspection; major effect in which most of the sediment was removed compared to the control. Minor effect if a small portion of sediment was removed, and minimal to no change if virtually no sediment was removed. The fossils used in testing were a large *Triceratops* frill (MC35+14) which had four test spots, a smaller partial frill (Maddie frill) with a single test spot, a nasal along with two associated fragments (SS5, frag1 frag2), a syncervical, and 2 unknown bones (MC56 & 65). Applications would be applied for 24 hours cleaned and reapplied unless clean for up to 72 total hydration hours excluding for the SS5 elements which were given shortened times due to higher water absorption. MC 35+14 had minimal to no change after the whole 72 hours, the material was highly phosphatized and already proved resistant to air abrasion. Similar results were found for the Maddie frill having a minor effect in the first 24 hours and then no change after. The Syncervical had a minor effect in the first 24 hours and then no change after. SS5 and SS5 frag1 experienced minor effects in the first two 4-6 hour cycles and then no change after 2 additional cycles. SS5 frag2 experienced three minor effects over 4 cycles resulting in majority sediment removal from the surface. MC 56 & 65 (Figure 2) both had major effects after the 24 hour period and were removed after this period due to having virtually no sediment left to remove.

Conclusion

The hydrogel had mixed results ranging from minimal effect to significant sediment removal. The potential of success in sediment removal still makes this method valuable to have as it was able to save on what would have been multiple days of slowly scrubbing and in instances like SS5, where conventional water scrubbing had no effect at all, a cleaner fossil than thought possible. This experiment was also only done using a single type of polymer and room temperature tap water. Other polymers may have different results and different solution capacities. Other polymers may have different controls such as pH and temperature when forming a hydrogel. Potential uses for hydrogels in fossil preparation could extend to spot applications of acids or other chemical agents that could remove matrices but are often unused due to their all or nothing approach in application. This experiment was quite cheap to perform, only costing about $20 US for a single 35g bag of sodium polyacrylate and no authorization was required to purchase the chemical. This method could prove to be especially useful to smaller or developing institutions that lack the resources for more expensive equipment. Depending on the type of hydrogel used it is limited to certain types of matrices and fossils. For sodium polyacrylate it is not recommended to be used on fossils with dissolvable calcium carbonate such as limestone for long periods. The dissolved limestone will add additional ionic compounds to the gel, "Ca ions & Carbonic acid" destabilizing the hydrogel back to its original parts of water and sodium polyacrylate powder. This would apply to other acrylic acid based polymers as well. Hydrogels are not recommended for ultra-thin fossils as even with very slow release hydrogels, it would pose the same risk as soaking due to the lack of material holding the fossil in place.

Health and Safety

Many hydrogels are quite safe to handle and use even with long exposure, in gel form, and standard practices are all that is required for the powdered form. The powder form is not highly combustible, and its only potential danger comes from inhalation of powder in larger quantities. (RECYC PHP, 2022) It can also be a skin irritant from larger quantities of the powder. As a gel the greatest concerns are from potential spills causing a slipping hazard. Cleaning of hydrogel powder should be done with a dust mask or respirator to prevent inhalation and the gel form should be disposed of in the trash as it can cause clogging in sinks and drains with large amounts.

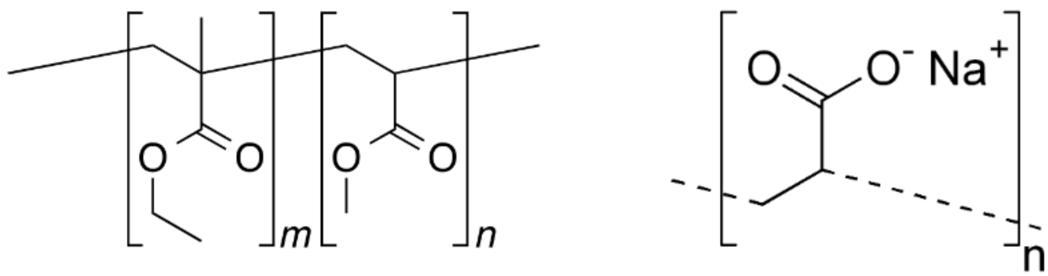

Figure 1. Paraloid B-72 (left) and sodium polyacrylate (right) molecules normally form repeating chains with other like molecules. Both are capable of being dissolved in ethanol or acetone.

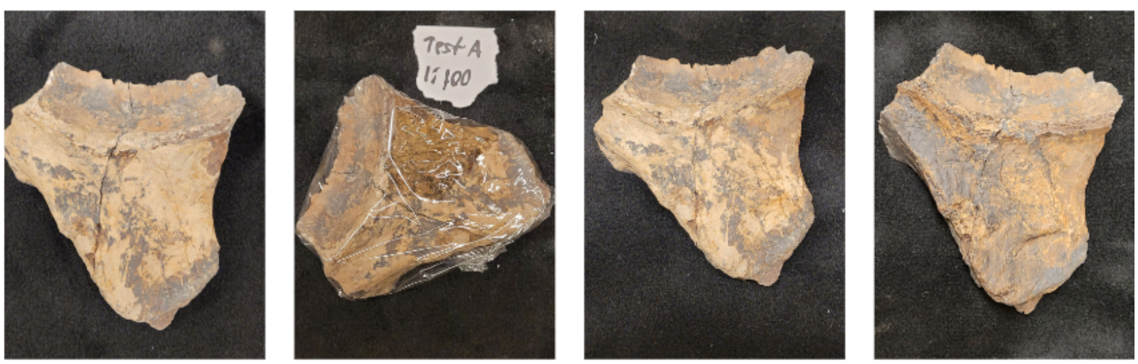

Figure 2. MC 65 from its initial cleaning from water scrubbing (far left), initial application (middle left), initial result (middle right), to full application result (far right). The fossil was cleaned initially with conventional water scrubbing methods three times for approximately 15 minutes. The Hydrogel was then applied to a small portion and compared to the other half. A large portion of removed sediment can be seen in the following image and complete removal after a full application was applied.

Acknowledgements

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THE IMPACT OF ADHESIVES, CONSOLIDANTS, AND SOLVENTS ON GEOCHEMICAL DATA: AN EXAMPLE USING X-RAY FLUORESENCE

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Adhesives are an integral part of the preparation process. They are necessary for the stabilization of fossils both in the field and in the laboratory and their use is ubiquitous in paleontology. However, the effect that applying these chemicals may have on future geochemical studies remains largely unstudied. To explore this question, a series of tests was conducted on commonly used adhesives, both historic and modern, using a Niton XL5 pXRF spectrometer. Seventeen different adhesives and five different solvents for a total of 47 different mixtures were tested. First, the unmixed dry products were scanned, if applicable, to determine if their actual elemental composition matched their published chemical formulae. Those adhesives were then mixed, with their appropriate solvent and allowed to dry in a glass petri dish. All specimens were both mixed and left to dry underneath a fume hood. A select sample of Polyvinyl Butyral (Butvar B-76) and Ethyl Methacrylate co-polymer (Paraloid B-72) in both Acetone and Ethanol were stored in Low Density Polyethylene (LDPE) and High-Density Polyethylene (HDPE) plastic bottles to determine if these plastics contaminate the chemicals stored within. The inner surfaces of the bottles were scanned before and after the above-mentioned adhesives and solvents were added and allowed to dry to determine if the elemental composition of the bottles was altered, which in turn would impact the composition of the adhesives stored in such bottles. The final test aimed to determine if and to what degree the presence of adhesives impacts the full spectrum of elemental data obtained from scans of matrix samples. For that test, 47 hand samples of non-fossil bearing sandstone were scanned before and after (in the same spot) the application of each different kind of adhesive or solvent. Additionally, Paraloid B-72 and Butvar B-76 were tested at different thicknesses to determine the impact at each level. Briefly summarized, the results show that all adhesives contain trace amounts of unreported elements (e.g., Si, Al, K, S) and that the solvents/adhesives do leach some elements from the plastic bottles (e.g., Si, Al, Cl, S), changing the chemical composition of the dried adhesive. The matrix tests showed a clear decrease in most detectable elements that was proportional to the thickness of the adhesive applied. However, the effect was not uniform as some elements (e.g., Si, Al, Mg, and P) were more strongly affected than others. The only element that showed increasing values with glue thickness was Cl, which resulted from contamination from the bottles/solvents. This study demonstrates that adhesives can both interfere with the collection of data from a pXRF spectrometer and introduce contamination to those data.

A CASE STUDY OF A FLIPPING TECHNIQUE FOR LARGE OR DELICATE FOSSILS

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Turning over or flipping a large and/or delicate fossil can be a daunting task that can potentially damage or destroy a specimen. Flipping a specimen is often necessary to expose the opposite side of a fossil which may need to be accessed for cleaning, repair, research, or to

be placed in a display or storage cradle. Two temporary plaster jackets using a weakly consolidated sand as an artificial matrix were constructed for a large, articulated phytosaur skull, *Smilosuchus adamanensis (*PEFO 42634) and a very thin, delicate *Hypsilophodon* egg nest (YPM 9528).

The *Smilosuchus* skull and jaw, measuring 1.06 m (3.5 ft) in length, needed to be turned to the opposite side to complete preparation. Much of the surrounding original fine sand matrix was removed, leaving the bone over exposed and under supported. Additionally, the right side of the jaw was severely weathered and broken. The *Hypsilophodon* nest, intended for display, needed a new, permanent archival display cradle. The eggs are contained within a very thin 0.5-1 cm matrix base and could not be consolidated because of potential future chemical analyses.

Play sand was used as the artificial matrix because it is inexpensive, readily available, and has a medium- to coarse- sand size that is small enough to contour the bone surface and large enough to be easily removed with minimal tools and effort (e.g. dental pick with brushes). In both cases, aluminum foil was used as a protective barrier between the bone and the artificial matrix. The play sand was weakly consolidated with very thin Paraloid B-72 in acetone (approx. 5% by weight or less) to keep it in place. Acetone was used as a solvent in these cases because of its rapid evaporative properties to allow the matrix to set quickly. Proper PPE (i.e. gloves, safety glasses) and ventilation (i.e. respirator, fume hood, or fresh air) should be utilized when using generous amounts of acetone. If this is not available, alternative solvents, such as ethanol or water, may be used with compatible adhesives (e.g. respectively, Butvar B-98 or Aquazol 200) or just water to consolidate the sand and keep it in place, but will take longer to dry. After the artificial matrix had dried, it was covered in plaster bandages and/or burlap and plaster for rigid support during and after the flipping process. Once the whole specimen was flipped, the original jacket was removed. Two or more people should be used to flip any specimen, for the safety of the specimen and for the personnel.

Both the *Smilosuchus* skull and the *Hypsilophodon* nest were successfully flipped, without breakage, using the artificial matrix technique. Because the consolidated sand encapsulates the fragile bone, both cushioning and supporting the specimen, these temporary jackets can be used for long periods of time (i.e. weeks to years).

PROJECT CALLI: A RECORD OF THE VARIOUS TECHNIQUES EMPLOYED IN THE PREPARATION OF A BIG, BEAUTIFUL CHASMOSAURINE SKULL FROM ALBERTA, CANADA

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Introduction

From January 2016 to August 2023, work was carried out on a spectacularly preserved *Triceratops* skull known affectionately as "Calli" and technically as TMP 2014.022.0022. The specimen was collected in 2014 by the Royal Tyrrell Museum of Palaeontology (RTMP) from the Maastrichtian of southwestern Alberta, Canada. The skull was encased in large amounts of matrix, consisting of a very hard sandstone and a more friable siltstone. Due to its size (the main block alone was ~1 m^3, 839 kg/ ~34 cubic feet, ~1850 lbs), the skull was collected in many pieces, separated along pre-existing cracks. These factors, in addition to requirements for mounting and display, produced several technical challenges, the solutions to which will be discussed below.

Gap-Filling/Consolidation

Taphonomic alteration of the specimen, both natural and anthropogenic (resulting from the multipartite collection of the specimen), produced a multitude of fractures through both matrix and bone, ranging in width from <1 mm to 50 mm (<0.04" to 2"). Additionally, despite extensive efforts to collect and document the position of even tiny bone fragments, material was lost between some of the bone contacts. Furthermore, the siltstone encasing some of the skull was friable and unstable. Gap-filling and consolidation were necessary to prepare the specimen for research and display. Gap-filling was accomplished using the strong, transparent, two-part epoxy Epo-Tek 301 (hereinafter Epo-Tek) and a combination of Epo-Tek and Por-A-Kast solid glass spheres. Consolidation was achieved using Paraloid B-72 in acetone, or Epo-Tek. The methods, as well as the properties, pros, cons, and reasoning behind the use of these products were discussed in Macdonald (2023).

Gap-Filling

As described in Macdonald (2023), gaps within and between the different blocks were filled with Epo-Tek. Due to its low viscosity, it was necessary to construct barriers to confine the epoxy to the desired fill area, to which end strips of 5 oz. Reemay Spunbonded Polyester Fabric impregnated with the natural latex 61-1000 Mold All Latex were employed. In two cases it was necessary to fill gaps for which the uppermost portion of the gap was not accessible due to overhanging bone, and this required the construction of a latex barrier with an integrated funnel that extended laterodorsally (relative to the skull, which was mounted in life position) from the dorsal-most portion of the gap. A small incision was made near where the funnel contacted the gap so that, when the gap was filled, a small amount of epoxy would begin to drip out, allowing me to avoid filling the entire pour spout and funnel with this painfully expensive epoxy.

Where reconstruction was required for structural reasons, plasticine was used to reconstruct the missing areas, then moulded the area using the latex and cheesecloth. Next, the mould and the plasticine were removed, then reaffixed the mould using fresh latex, and finally poured epoxy into the gaps. In some cases, it was necessary to grind down the epoxy for aesthetic reasons. To restore the epoxy's optical clarity (one of the properties for which this product was chosen), the abraded surface was painted with fresh epoxy.

The Gimbal Gamble

Attaching the left epijugal/jugal/quadratojugal/quadrate complex was challenging because there was minimal contact with the main portion of the skull, which was already mounted in life position. It was necessary to hold the complex in its tenuously connected position while latex barriers were made and the epoxy poured. A gimbal was constructed that could be posed along X, Y, and Z axes and attached to a support jacket which held the complex. X- and Z-axis movement was achieved using two lengths of wood sandwiched around a central piece of wood and held together with a bolt. Y-axis adjustment was achieved by mounting the upper portion of the construct onto a block of wood in which was drilled a socket to accept a threaded rod. The rod extended down through a wingnut which sat atop another piece of wood. Turning the wingnut caused the threaded rod, and thus the whole complex, to move vertically. The upper portion could be rotated around the vertical axis of the rod. In this way, it was possible to achieve a highly precise orientation which could be held stable indefinitely.

Consolidation

Although most of the consolidation was done using Epo-Tek, a significant amount of 10% (w/w) Paraloid B-72 in acetone was also used. Although the area wherein the Paraloid was deployed was riven with cracks, these cracks were quite narrow and thus the Paraloid had to be applied one drop at a time. The author being disinclined to spend hours lightly palpating a pipet, a slow-drip apparatus constructed by Darren H. Tanke was used instead. Consisting of a Nalgene bottle with a pipette affixed by epoxy putty to a hole in the bottom, the construct was suspended above the specimen and allowed to gradually drip Paraloid into the cracks while work progressed on other aspects of the project.

Matrix Removal

Much of the specimen was covered in large amounts of very hard sandstone, sometimes to depths of approximately 30 cm. Removing it with an air scribe, while possible, would have involved endless, soul-crushing hours of chipping through barren matrix. Fortunately, given that Calli's skull was both articulated and isolated, it was reasonable to remove large amounts of matrix without danger of destroying fossil material. Ultimately, 815 kg (~1800 lbs) of matrix were removed.

This was largely done by using an angle grinder to incise a series of grooves ~3.5 cm (~1.3") deep and ~2 cm (~0.7") apart, then knocking out the resulting slices of matrix using a hammer and chisel. The proximity of the grooves diminished the force required to knock out the slices, decreasing the amount of force being transmitted into the specimen.

When removing matrix from blocks containing frill pieces (which were predictably flat) a gas-powered Stihl Rock Boss GS 461 chainsaw was used to slice off large slabs of matrix parallel to the plane of the frill piece. The chainsaw, designed for cutting concrete, is water-cooled/lubricated and can cut into extremely hard sandstone to a depth of ~40 cm (~16") by plunging the guide bar directly into the rock. Used this way, it can make a 40x11 cm (16x4") cut in 1-2 minutes and in a variety of orientations. It can also be used to make draw cuts, though these are more strenuous for the user. It is substantially lighter, easier to control, and more manoeuvrable than a circular cut-off concrete saw, and much less dangerous in the case of mechanical failure (Kowalchuk et al., 2017). The RTMP also makes extensive use of the chainsaw for fieldwork. See Tanke (2014) for a discussion of hazards associated with angle grinders and cut-off saws.

For smaller blocks (maximum height ~16 cm/~6"), large chunks of sterile matrix were removed using a Felker Stone Mate SME-143 wet tile saw. Its maximum cutting depth is ~13cm (~5"), but a hammer and wedge were used to crack the remaining matrix if the block was thicker than this.

After using the above methods to get as close to the bone as was considered safe, a Stone Company HW-90 air scribe was used to further work down the matrix. In many cases this still required working through 10cm of hard matrix over large areas, and the author was experiencing joint strain from constantly holding and pushing this large air scribe using a precision grip. Because of the hardness of the rock, continuous pressure had to be applied to the air scribe to prevent it from simply bouncing back. To mitigate this strain, a secondary grip was constructed by shaping a scrap of 2x4 lumber into a handle, sanding one end into a concavity to conform to the barrel of the air scribe, and drilling a hole above this concavity, through which was passed a hose clamp which was used to affix the new grip perpendicular to the air scribe body. With this setup, the air scribe could be gently guided with a precision grip while using a comfortable power grip on the auxiliary handle to provide the necessary force.

Air Abrasion

Much of the frill was covered in an extremely thin layer of matrix/mud which seemed suited for air abrasion. Despite the thinness of the offending matrix, it was still hard enough to require the use of aluminum oxide (Al_2O_3) abrasive powder, typically at 60-90 psi. To accommodate oversized blocks, a walk-in abrasion chamber was constructed using thick plastic sheeting stapled to a wooden frame. The chamber entrance was a wall of plastic sheeting, half of which was stapled to the frame, and the other half of which was held to the frame with Velcro strips so it could be opened or sealed. A hole in one wall accommodated the dust extractor head, which both removed much of the aluminum oxide in the air and provided strong negative pressure in the chamber, preventing the powder from escaping. The lower margins of the plastic were weighted down to form a seal with the floor.

It was also necessary to abrade portions of the postorbital horn cores, this time using sodium bicarbonate ($NaHCO_3$), again at 60-90 psi. Because the author found himself insufficiently motivated to reassemble the large abrasion chamber used previously, it was decided to create miniature abrasion chambers that could enclose just the specific areas of the skull intended for abrasion. Plastic sheeting was used to encapsulate the intended work area and the dust extractor head, cutting a hole through which a hand could be inserted. Cardboard boxes and other rigid objects were used to prevent the chamber from collapsing into the vacuum. The result had the appearance of garbage but was effective.

Test Fitting Large Blocks

In some cases, blocks that had been separated in the field were difficult to reunite perfectly. One block containing the right side of the face was too heavy to practically allow test-fitting and adjustments. Therefore, a technique learned from Darren H. Tanke was employed, wherein a cast was made of the block’s contact surface and used to test the fit against the main block and make adjustments. Next, a jacket was constructed which gripped the block while leaving the contact surface unobstructed, then the block was lowered into place on the main part of the skull using a 2.7 tonne (3 US ton) overhead hoist.

Flipping the Skull

The skull’s exceptional preservation provided a rare opportunity to see the delicate palatal anatomy, which is often fragmentary, deformed, or obscured in other, less exquisite specimens (Caleb Brown, pers. comm., 2023). Thus, although it was known that the skull would be displayed in life position, the initial phase of the preparation exposed its ventral aspect for research purposes. However, once the figures and measurements were complete, it was necessary to flip the skull into life position so that it could be mounted.

While the ventral aspect was exposed, our blacksmith collaborators (Sandra Dunn, Lynn Gratz, Bronson Kozdas, and Aimie Botelho) created an armature using an artistic combination of hand-forged and laser-cut steel to support the skull while allowing a relatively unobstructed view of its underside. To keep the armature affixed to the skull during the flip, removable brackets were incorporated on either side of the main support post that could be used to anchor ratchet straps which were passed over the dorsal surface of the skull block.

It was necessary to construct a jacket that would support the specimen in several orientations as it was rolled into life position, as well as holding the armature in place. Furthermore, it was desirable that the jacket should be easily removed to avoid having to cut and pry it off once the skull was in position. To this end, a five-part jacket was constructed wherein the different segments were bolted together along flanges that projected perpendicularly from all the contact edges. Rope handles were incorporated for easy removal, as well as several strategically placed flanges as anchor points for lifting slings.

To flip the specimen into mounting/life position, it was rigged with a lifting sling and rolled so that the anterior-facing palatal aspect was reoriented to face ventrally. The specimen's descent was cushioned by a pallet covered in sandbags, with a gap between the pallet and the table to accommodate the armature post. Next, the sling was reconfigured to do a vertical lift, then the specimen was lowered so the post nested (with the aid of WD40 lubrication) into the corresponding part of the steel base.

<u>Transportation</u>

Once preparation was complete and the frill pieces had been mounted on a beautiful, hand-forged, dendritic armature (Dunn et al., 2023), it was necessary to transport the mount into our galleries, which would involve rolling a pallet jack over two uneven thresholds. Due to worries that the jostling could disastrously unseat or otherwise damage the frill, a somewhat modified version of the technique described by Pinsdorf et al. (2023) was employed. Packing cling wrap was wrapped around the frill in many different orientations to hold the frill pieces securely onto the armature. Scraps of Ethafoam polyethylene foam were used to fill the concavity of the frill's posterior aspect, so that the cling wrap could exert pressure evenly on all parts of the frill and armature. Success was achieved in preventing any movement between the frill and armature, but one area had been over-packed with Ethafoam, creating too much pressure and causing some minor damage to a thin area of the frill. The tension created by the cling wrap also caused one ramus of the armature to temporarily flex out of position. Ratchet straps, padded with Ethafoam, secured the rest of the skull to the ventral armature.

<u>Health and Safety Precautions</u>

Nitrile gloves, apron/lab coat, and eye protection were worn during the mixing and use of the Epo-Tek, which always took place in the RTMP's capacious and well-ventilated preparation lab. The Safety Data Sheet was easily accessible in a clearly labeled binder in that same lab. The same considerations applied also for the use of Paraloid, Latex, and fiberglass reinforced plaster.

For air abrasion, nitrile gloves, protective clothing, respirator, and eye protection were worn. When working with aluminum oxide in the large abrasion chamber, full goggles and a full-body painter's suit were also worn.

When manipulating large blocks with the overhead crane, all participants wore hardhats, work gloves, and steel-toed boots. The technicians involved also had hoisting and rigging certification. The plan was outlined in detail before beginning, and great emphasis was placed on the need for clear communication throughout the process.

When the angle grinder, chainsaw, or tile saw were used, work gloves, eye protection, hearing protection, cut-resistant apparel, and steel-toe boots were worn. Training was given by experienced colleagues and the contents of the user manuals were reviewed. A heightened level of concentration and awareness was maintained during the operation of these tools. Lab mates were always aware of the work so that the author would not be alone in the event of an accident and so that activities could be coordinated to minimize risk in the event of blade failure. The chainsaw, being gas-powered, was always operated outside.

When using air scribes of various sizes, eye protection was worn or the work was performed behind a large magnifying lens, and sensations in hands, wrists, and elbows were closely monitored to determine when breaks or adjustments in orientation were necessary.

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CONSERVATION OF OVERSIZE FOSSILS AND CUSTOMIZING DUST COVERS

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Preservation methods and storage for paleontological specimens is an important area of study, particularly when specimens are too large to be housed traditionally in collection drawers. Five such large fish and marine reptile fossil skeletons exist in the Vertebrate Paleontology collections at Harvard University's Museum of Comparative Zoology. The five specimens range from 35 to 71 inches in length and are bulky due to being mounted into wooden frames with a plaster backing. The plaster was painted to match the color of the matrix supporting the skeleton and an unknown coating was added to the fossil. These specimens are used frequently for research and collections tours and therefore sit openly atop low-level cabinets for visitors to stand and view them. However, the open air nature of this shelving leads to the accumulation of dirt and debris on the specimen and the plaster mount over time. To combat this agent of deterioration, the authors constructed a conservation treatment plan involving the cleaning of the specimens and the construction of protective dust covers.

The project was conducted over the span of three weeks. In all, 18 hours were spent designing, preparing, and implementing the project. Details of the process were documented in the departmental conservation records. We followed a protocol from the Carnegie Museum of Natural History to inform our specimen treatment and storage technique methods. All five specimens were vacuumed with a Nilfisk GM80 (vacuum with HEPA filter) with a cheesecloth barrier on the end of the nozzle while using a soft-bristled paintbrush to sweep off dust and loose plaster. We wore N95 masks while using the vacuum. After the specimens were cleaned, two dust cover methods were tested. The purpose of this test was to understand the benefits and pitfalls of using different cover materials with regards to cost, time spent constructing, and storage effectiveness.

For two of the specimens, we followed the Carnegie guide to create rigid, archival covers that include a cut-out window to view the covered specimen. This method used B-flute corrugated board (commonly referred to as blueboard) and four mil thick polyethylene plastic to create the window. We cut, folded, and used Thermogrip 6363 hot melt glue to assemble the blueboard frame. Then 3M 415 double-sided tape was used to adhere the polyethylene sheet to the blueboard to create an enclosed but transparent window (Figure 1A). Due to the sharp tools necessary for working with the blueboard, we wore cut resistant gloves throughout the process. It took approximately four hours to construct each blueboard cover.

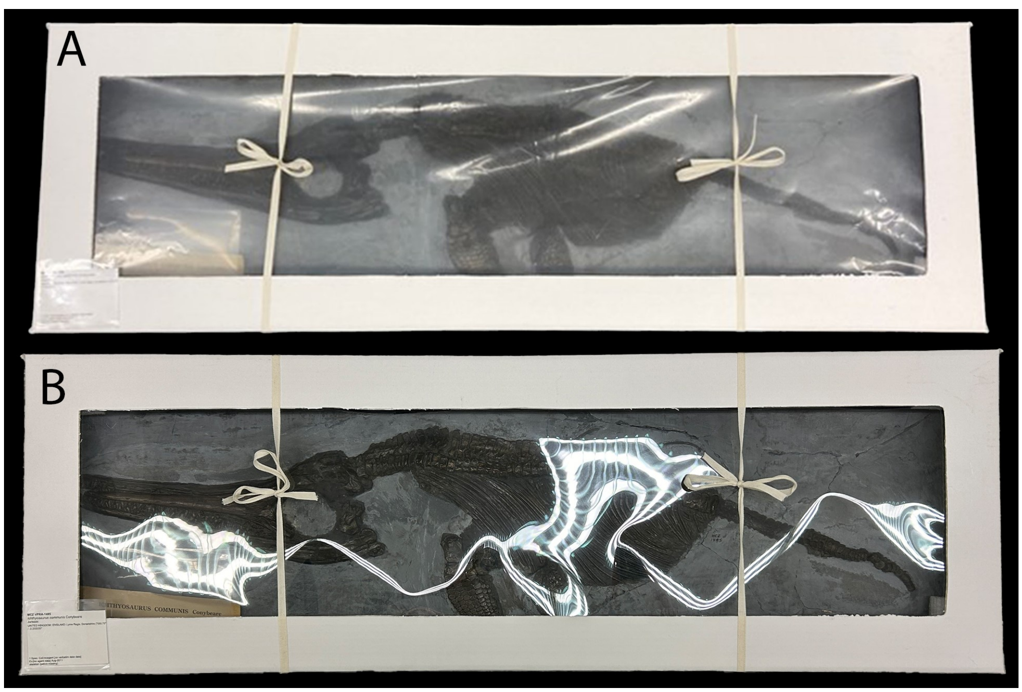

Figure 1. Specimen MCZ VPRA-1495 after treatment with blueboard window dust cover. A) Blueboard window with polyethylene sheeting as the window. B) Blueboard window with Mylar polyester sheeting as the window.

For the other three specimens, we experimented with constructing covers from Tyvek as a more economical and time-efficient dust cover technique. Tyvek was measured and the corners sewn using Nylon thread on a Singer sewing machine to create the dust covers. The corners were strengthened by applying 30% Paraloid B72 in acetone to the sewn area. Since the opacity of the Tyvek impedes viewing the specimen (Figure 2), to make referencing the fossils with these covers easier, each specimen was photographed with a Sony α7III mirrorless camera with a Sony FE 3.5-5.6/28-70mm lens. The photograph was printed on archival paper and inserted into a polyethylene plastic sleeve that was adhered to the cover with 3M 415 double-sided tape. It took approximately two hours to construct each Tyvek cover.

Figure 2. Specimen MCZ VPRA-1493 after treatment with Tyvek dust cover, new specimen label, and reference photograph.

For four of the five specimens, a piece of ½" thick sheet of Ethafoam was cut slightly smaller than the area of the specimen and placed under the mount. Raising the specimen with the smaller dimension Ethafoam created space under the frame, making it easier to lift the specimens. Cotton tape was used to hold the dust cover, specimen, and Ethafoam base together. The fifth specimen did not receive an Ethafoam base due to the extreme weight of the specimen. This specimen was treated in the storage space instead of being moved to the Vertebrate Paleontology workspace.

From this project, we found that the blueboard with window technique provided protection from dust as well as some physical damage. However, this technique cost three times more in cost of materials and twice as much time to produce. The added benefit of this technique is that the sturdiness of blueboard's material provides protection to specimens that are fragile or have delicate ornamentation. Alternatively, Tyvek covers were faster and cheaper to produce, taking two fewer hours to construct and costing about 35% of the blue board cost per cover. Due to the fabric nature of Tyvek, however, it will sag and come into contact with the specimen. We suggest only using this dust cover technique with specimens that have relatively smooth contours that are not likely to catch on the Tyvek when the cover is removed.

Polyethylene 4 mil thick plastic sheeting was used in the window at the time of the study. Later, four mil thick Mylar polyester sheeting was acquired, and we replaced the polyethylene window on one of the specimens (Figure 1B). There was a striking difference in clarity between the two. Aesthetically, the clear transparency of Mylar polyester is the best for viewing the specimen without removing the cover compared to the translucence of the polyethylene. Economically, polyethylene plastic is more affordable than polyester sheeting. Both are good dust barriers that permit visibility of the covered specimen.

In conclusion, both dust cover methods worked well for their primary purpose. The blueboard method provides further protection but it comes at a cost in both materials and labor. Each method comes with its own initial costs for material acquisition as well. When deciding between which method to implement, the authors recommend considering the protections that the rigid blueboard structure can provide versus using Tyvek covers to quickly protect large specimens from dust, dirt, and grime.

LEVERAGING DIGITAL SCIENTIFIC ILLUSTRATIONS TO IMPROVE AVIAN FOSSIL PREPARATION AT LA BREA TAR PITS & MUSEUM

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The Project

Avian fossils tend to be rare and often preserved in poor condition at most fossil-bearing Cenozoic localities. A notable exception are the late Pleistocene asphaltic deposits of southern California (Rancho La Brea, Carpinteria, McKittrick), which have yielded a profusion of superbly-preserved avian bones. More than 110,000 avian bones have been excavated, prepared and cataloged at La Brea Tar Pits (LBTP) from the early excavations at that site (Howard, 1962). These fossils constitute an outstanding record of the avian fauna of late Pleistocene California, albeit biased towards raptorial taxa (Miller & deMay, 1942; Howard, 1962; Stock & Harris, 2001). This trend mirrors the carnivore bias found in larger mammals at LBTP (Stock & Harris, 2001).

In 2006, fossiliferous asphaltic sediment was exposed during excavations for an underground carpark at the neighboring Los Angeles County Museum of Art. Sixteen asphaltic fossil deposits were found. A major effort to salvage these deposits involved the encasement of >50 tons of this late Pleistocene (~30-45,000 14C yr BP) asphaltic sediment in 23 wooden crates ranging from 2722 kg to 55,792 kg (6,000 lbs to 123,000 lbs) per crate. Hence, this salvage came to be called Project 23 (P23). The salvage boxes were transferred to the LBTP grounds and excavation of fossils from these crates of asphaltic sediment has been underway since 2008. Excavation, preparation and curatorial focus at LBTP has thus shifted to processing the tens of thousands of fossils still being excavated from P23.

Ongoing excavation of the P23 boxes is increasing the already enormous load of fossils prepared by three LBTP staff and a corps of approximately 25-30 volunteers. Of the vertebrate fossils exhumed, several thousand have represented avian species. The sheer volume of avian fossils called for familiarity with bird bones, their identity, the species and genera represented, and other background for the volunteer cohort. This ensures appropriate preparation of these specimens, by exposing all necessary morphological features for curation.

Adequate tools for the identification of avian bones, though, is a chronic problem in Cenozoic paleontology. Published resources are few, out-of-date, expensive, highly technical, have limited comparative coverage or are oriented towards archeological rather than paleontological needs (e.g. Olsen, 1979; Gilbert et al., 1981).

Within the discipline of avian paleontology, the use of the anatomical compendium by Baumel (1979, 1993) and its Latin nomenclature has been encouraged, but this standard work is "remarkably unapproachable…is no place for a beginner… [and] remains impregnable to those not at least somewhat familiar with the primary literature" (Gatesy, 1995). There are few comparative images. Furthermore, few scientists or fossil preparators today have a functional knowledge of Latin, making the work even more inscrutable (Homberger, 1980).

With this background, it was decided to illustrate representative avian taxa from LBTP, and provide contextual presentations for the volunteer corps. This paper discusses the aims, methods and results of the preparation of 76 illustrations of 12 avian taxa, including six extinct species (Figure 1). These numbers will expand by the completion of this project.

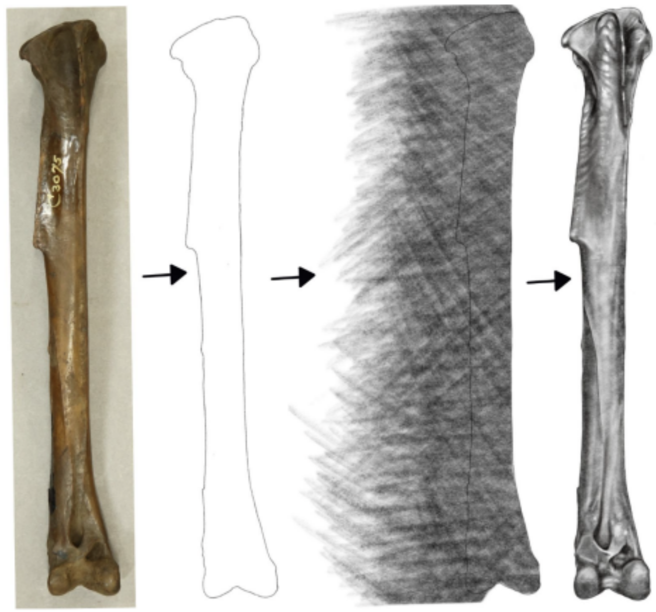

Figure 1: Progression of illustration process in Procreate®. (left to right) anterior view photograph of Aquila chrysaetos *LACM C3075 (layer 1); traced outline (layer 2); partially erased cross-hatched layer (layer 3); final image (layer 3).*

In this digital age, it may seem counterintuitive to spend time illustrating materials when photography is a quick and simple process. Photography suffers from issues of depth of field which are overcome by illustration (Holzenthal, 2008). Scientific illustration is also free from the shackle that photography bears of being bound to a single specimen. It is the scientific illustrator's aim to create an image that is descriptive not of a particular specimen or bone, but to describe an archetypical example of the desired object (Cerviño et al., 2015).

The benefits of creating illustrations in a digital format are numerous. Digital illustration apps from Photoshop to Procreate®, afford the user the versatility of working in layers, come preloaded with standard brushes that behave much the way that traditional media like pencils, pens, and paintbrushes do, and allow one to create or purchase custom brushes (Holzenthal, 2008). Layers are especially expedient in scientific illustration because a variety of options may be attempted without the commitment of working on paper. The array of tools available through digital art are seemingly endless, supported through YouTube tutorials and online forums. Digital illustration also eliminates the ongoing purchase of art supplies required by working with physical media, making the one-time investment in the materials a justifiable cost. Dissemination and storage of digital illustrations is simple and does not require careful scanning, uploading and storing of physical art.

Health & Safety

Because this project was fundamentally an artistic endeavor, greatest productivity occurred when in a flow state. Flow is a term used to describe "experiences during which the individuals are fully involved in the present moment…characterized by complete absorption…" (Nakamura & Csikszentmihalyi, 2002). In such a state, artists have been documented to be unaware of bodily signals such as hunger and discomfort (Getzels & Csikszentmihalyi, 1976).

The primary health and safety concerns during this project were those of ergonomics. The discipline of ergonomics incorporates the study of "people, technology and processes to optimize how they function as a whole" (Giving…2022). As Amick and Brewer (2008) eloquently remind their readers that "there is no evidence that magic bullets exist as a best practice. There are no ergonomic equivalents of penicillin." That is to say that every instance will require careful consideration of possible solutions and that what is a suitable intervention for one illustrator may be less useful for others. Therefore, it is important that each individual consider methods which have the greatest value for themselves, given their unique combination of physical and psychological needs.

Non-neutral wrist postures are common in the use of tablet devices, such as the one used to create the illustrations for the LBTP avian skeletal reference (Dennerlein, 2015). Non-neutral postures and prolonged work periods can lead to discomfort. While there is no definitive time limit, tablet users may experience the best results by frequently changing their posture. During early illustrations this illustrator adopted non-neutral postures which resulted in lower back and hip pain. Conscious limitation to neutral postures reduced discomfort and increased productive time.

In the event that discomfort occurs, the use of a timer can prove efficacious as a reminder to stretch, check that the body is held in a neutral posture, and to drink water and consume regular meals. It is important to ensure that lighting is set at a comfortable level on the tablet screen and that ambient and overhead lighting is even to avoid struggling with shadows. Regular breaks from the digital screen and the use of lubricating eye drops can also provide relief from dry eyes resulting from reduced blink rate and completeness (Sheppard & Wolffsohn, 2018). These simple measures can greatly reduce eye strain which can lead to headaches during extended viewing of digital screens.

<u>Procedures / Results</u>

Previous projects done by this illustrator exclusively used traditional media. A digital format was adopted for this project and there was a learning curve when adapting to digital tools. Therefore, certain methods may exist that would further streamline this workflow, and this process will doubtless evolve over the remainder of the project. Digital illustrations can be made with a variety of computer-based tools such as Adobe Photoshop, Corel Painter, GIMP, Adobe Illustrator, Inkscape™, and others (Holzenthal, 2008). There are also a range of tablet-friendly options available such as Sketchbook and Infinite Painter for Android™ devices, Corel Painter 2022 and Procreate® for iOS tablets, with Clip Studio Paint available for both Android and iOS. The tools used for this project were already available and were more familiar to the illustrator than the alternatives.

A 6th generation iPad Pro was used with a 2nd generation Apple Pencil to draw in the Procreate® App (Version 5.3.6). Photos of the avian skeletal elements were taken using a Canon EOS 6D camera with a Canon EF 24-105 mm full frame lens. The camera was attached to a Manfroto focusing rack, screwed onto a copy stand for overhead shooting. EOS desktop application was used on a laptop to enable remote shooting. This prevented blurring from contact with the camera. Ceiling fluorescent lights were supplemented with two Ottlights set at approximately 45 degree angles from the specimen. When necessary, sandbags, sand boxes, oil clay blocks, or ethafoam were used to stabilize fossils to achieve consistent, standardized images. All photos were taken with a gray poster board background and a 7 cm scale bar, and were stored on the LBTP Fossil Lab's shared Google Drive.

Photograph angles were selected by the second author, to ensure that diagnostic features were presented in the illustrations. Three basic angles were photographed: anterior (cranial), posterior (caudal), and medial or lateral aspects. These were found to illuminate all or most of the important osteological characters on a given element. These photos were uploaded to the iPad Pro in the Procreate® app.

A photo was set as Layer 1 of a new canvas (Figure 1). In this new canvas, a new layer was created (Layer 2) and a Procreate® standard HB Pencil brush, at 100% opacity, was used to outline the fossil in the photo. At this point, Layer 1 was deselected in the layer dropdown menu, leaving only the outline of the fossil visible. A new file was created in Procreate® that contained a single layer of cross-hatching drawn by the illustrator, holding the Apple Pencil at an oblique angle, with the Procreate® standard HB Pencil brush at 100% size and opacity. Using Procreate® ability to drag a layer from one canvas to another, the cross-hatched layer was dropped into the target canvas as Layer 3.

Adding the cross-hatched layer from the original file required opening the cross-hatching canvas, holding pressure on the layer containing the cross-hatching, dragging the layer to the gallery and then into the desired canvas and depositing it in the layer drop-down menu. Selecting the cross hatched layer with the Transform tool (an arrow pointer at the top left of the canvas toolbar) allowed that layer to be stretched and moved to fill the outline of the fossil. The overlapping parts of the cross-hatching could now be erased using the Procreate® standard Soft Brush from the Airbrushes series at approximately 25% size and 100% opacity (Figure 1). This method allowed the cross-hatched layer to be re-used for subsequent drawings, streamlining the process, and reducing wear on the Apple Pencil tip and the screen protector on the iPad.

Asphalt from the Southern California Late Pleistocene deposits bestows a characteristic darkening to the bones. As such, the technique described here, using a cross-hatched base layer, focused on accurately defining forms of each element while maintaining comparable shades between the illustration and the fossils. It is possible that a more traditional schematic style of illustration would be more applicable with lighter bones, however, more realistic images naturally resulted from the process of working with a darker background. Initial test illustrations in a variety of schematic styles, incorporating purchased cross-hatch brushes and basic line-drawing, were unsatisfactory. A more realistic aesthetic led to improved results and seemed more accessible than schematic images to volunteers and lay people.

It is worth noting that the cross-hatching layer could be replaced by simply dragging any neutral color from the circle at the top right of the screen and depositing it within the tracing of the fossil in Layer 2. The choice to use cross-hatching was one of personal preference.

At this stage, the image appears relatively flat (Figure 1). The outline affords only the most basic form to the image. Initially, the reference fossil was set upright with sandbag supports, and held in place with fine finishing pins. These pins were strong enough to prevent the fossil from shifting much, but fine enough not to obscure features or cast shadows. Consistent LED light illuminated the specimen from above and remained static until the illustration was completed. This allowed the fossil to be "drawn from life" as with any still-life. The downsides to this included potential shifting of the fossil, extended time when the fossil was not in a protective housing, lighting differences between the photos and the illustrations, and the limitation of working on illustrations only in one location.

Procreate® offers the ability to use a reference image which can be moved and resized as needed. The photo used for tracing was duplicated into the Photos app on the iPad Pro and then selected as the reference image. This offered comparable results to the traditional still-life setup without the risks and limitations. Layer 1 could be selected at need to double check accuracy and correct errors. This became the preferred method and will be used moving forward.

Guided by the reference image, the eraser was set to approximately 50% opacity and a large medium size, as needed, to begin laying in the highlights in the image. This was performed in a loose manner. Moving in a generally top-to-bottom workflow, the shadows were added, then reverting to the eraser for corrections, refinements were added to the lighter areas of the image. It was useful to mentally remove the idea of drawing a bone and to simply focus on the shapes and intensity of light and dark areas of the image. Best results were achieved when starting with larger shapes and brush/eraser sizes and working on smaller details at the end of the process (Figure 1).

When all the most diagnostic features of the element had been illustrated, both the Procreate® file and the reference photo were imported into Microsoft Powerpoint. The LBTP Fossil Lab regularly uses Powerpoint in the development of image-heavy documents such as posters. All reference images retained their scale bar and collection number. The photos were set to the desired size, one per slide, with their corresponding illustrations beside them. The illustrations were set to 50% opacity and laid over the photos by selecting "bring to front" in the Arrange option dropdown menu and dragging them to overlap the photos. The illustrations were then resized to perfectly overlay the photo. At this stage, no appreciable difference in size or shape existed between the illustrations and the photos. The illustration transparency was set to 0% and the illustrations were moved so that the photos were displayed with the scale bar between them and the illustrations. The slides were labeled to denote diagnostic and important features by using the Textbox tool (Figure 2).

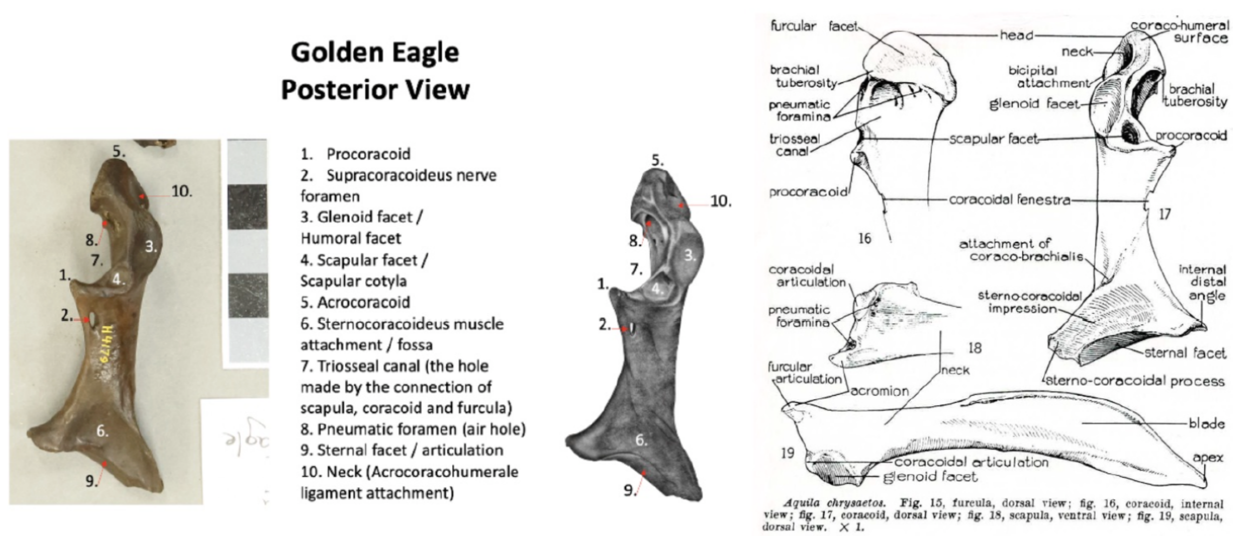

Figure 2: (left) Avian skeletal reference guide layout showing a photographed Aquila chrysaetos *LACM H4179 coracoid with numerical labels corresponding to listed terms with the illustration on the right; (right) Schematic style illustrations of* Aquila chrysaetos.

The Powerpoint file was uploaded to the LBTP Google Drive and shared with the second author for corrections, ensuring that every effort was made for accurate representation of the most important features of each skeletal element.

While identification of avian fossils remains a complex endeavor, the staff and volunteers at LBTP are becoming increasingly expert at bird bone preparation and are open to sharing information with our peers. This project is another step in an ongoing effort to improve the knowledge and preparation practices in the LBTP Fossil Lab. Generating this reference guide and sharing it as a supplement to the second author's presentations with the volunteer cohort has been noticeably advantageous by increasing their knowledge and independence during fossil preparation. Even though this document was generated for the LBTP volunteer cohort, it may prove useful to anyone seeking to increase their skills in the preparation of avian osteology. The value of a trained scientific illustrator cannot be overstated. However, it is also possible to create accurate digital images for reference using the methods presented here.

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LIMPING ALONG: CONSERVATION OF A PATHOLOGICAL *SMILODON FATALIS* PELVIS AND FEMUR FOR EXHIBITION FROM RANCHO LA BREA, CALIFORNIA

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Rancho La Brea (RLB) in Los Angeles, California is a Late Pleistocene fossil locality. Development of an exhibit required conserving fossils of a pathological *Smilodon fatalis* pelvis (LACMHC 131) and femur (LACMHC 6963) and a non-pathological pelvis (LACMHC 41396) and femur (LACMK 3378). Lacking preparation data, observations and general knowledge of historical practices were used to guide conservation.

Morphology was obscured by asphaltic matrix on LACMHC 131 and LACMHC 6963. Both fossils were dehydrated, with friable cortical diaphysis on LACMHC 6963. LACMHC 41396 and LACMK 3378 required only superficial conservation. To identify adhesives, 1cm^2 test patches on LACMHC 131 and LACMHC 6963 were treated with acetone, then with hot tap water.

For all fossils, a degreasing solvent, Novec 73DE, was applied to surface asphaltic matrix with foam tip applicators (FTAs) and short bristle nylon paintbrushes. Surface glyptal was removed with acetone and FTAs, then hot tap water and cotton swabs for white glue and non-asphaltic matrix. Paraloid B72 in acetone (1:5 w/v) was used for consolidation and small crack repair. Cracks >1mm wide were filled with Paraloid B72 and thin Kozo paper. RLB uses Hon Mino Gami, a type of archival Japanese tissue paper made of Nasu Kozo (mulberry), purchased through Talas (12 gsm: TPB077001; 15 gsm: TPB076001). Excess adhesive was removed with acetone.

LACMHC 131 required additional conservation. A metal rod inserted into drilled holes had loosened from a degraded adhesive. This fossil also had two gaps filled with white glue, plaster and glyptal. These were wrapped with thick Kozo paper and Paraloid B72 during initial conservation to prevent damage. Kozo paper was removed in sections and the fillers treated with hot tap water applied with nylon and boar bristle brushes. The fillers were then removed with dental tools and tweezers. Each section cleared of old fillers was air dried, then filled by layering torn pieces of thin Kozo paper and Paraloid B72. These pieces of paper were applied with tweezers and a nylon bristle brush dipped in acetone. A layer of medium Kozo paper was placed over the thin Kozo paper for additional support. All excess adhesive was removed with acetone on FTAs.

The conservation was recorded in written documentation and with time-lapse videos, and weekly assessment photos. Assessment methods and data about plaster and white glue use were saved for reference. It is desirable to determine quantitative testing methods to decrease uncertainties when drafting conservation plans.

All conservation of the specimens was performed at a ventilated station, while wearing safety glasses and neoprene gloves, as appropriate for working with acetone and Novec 73DE.

KOOBI FORA RESEARCH PROJECT: FIELD PROTOCOLS FOR DOCUMENTATION AND COLLECTION OF FOSSILS IN TURKANA BASIN

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The fossil rich sites of Turkana basin in Northern Kenya, have been very important for prospecting for vertebrate fossils remains for over a decade. The richness of this locality for survey of fossil remains has been attributed to the Rift Valley systems. The Rift Valley was formed by gradual breaking of the Earth's crust during the last 17 million years. As the crust was pulled apart, two or more long cracks, or faults formed and the land between sank. The Kenyan Rift Valley runs 3,000 km from Mozambique, through Ethiopia and into the Red Sea. The Great Rift Valley is the key to exposure of buried fossil-rich sediments.

The Koobi Fora Research Project (KRFP) has been prospecting for vertebrate fossils in this area since the year 1968. This survey has yielded very many vertebrate fossils, among which very important hominid finds such as Turkana Boy, *Kenyanthropus platyops*, and many others, that have enlightened us on understanding our human origins.

Through time, KFRP project under the leadership of the late Dr. Richard Leakey, and now Dr. Meave Leakey and Dr. Louise Leakey, have developed protocols for documenting and collecting the paleontological specimens in the field.

These protocols are designed to provide a consistent and detailed record of all the fossils that are found. Because the vertebrate fossil collection from the Pliocene and Pleistocene deposits of the Omo-Turkana Basin are now very comprehensive, it is unnecessary to collect all the specimens discovered. Collection of all specimens removes important surface evidence and hampers future investigations. Thus, although almost all the diagnostic specimens found are documented, the majority are not collected. Instead, the documentation includes GPS co-ordinates, descriptions, digital images and taxonomic details so that the specimens can be referred to or collected at a future time. Only those specimens that represent rare taxa or rare elements of more common taxa, or that are unusually complete, are collected. There is the risk of these being left in the field, where they would be in danger of being lost or damaged, and importantly the study of such specimens may provide significant new information. The database thus documents all specimens found and includes those collected as well as those remaining in the field.

Because KFRP is composed of a large group of people working in the field, the health and safety of the team is paramount. Proper field gear (e.g., boots, knee pads, camel bags for water, hats, etc.) are provided. A first aid kit including medicines is always available, and AMREF evacuation insurance is purchased for everyone.

A collecting team is composed of three kinds of members: surveyors, documenters, and collectors. The surveyors look for the fossils and when they find something that is identifiable or of potential interest, they report their find to the documenters. The documenters record all the details of the fossil. Finally, if the specimen is deemed suitable for collection, the collectors decide how best the specimen should be collected, make the final records, and remove the specimen using the appropriate methods. Because serving as a documenter or collector is a position of responsibility, these people have years of experience in the field.

Field Protocols

Most of the field crew is comprised of surveyors, and they generally work in teams and there is a documenter for each team. The surveyors locate fossils suitable for documentation and immediately advise the field documenters of their finds. They are instructed not to try to excavate or remove fossils from the place and position in which they are originally located, and they are encouraged to always ask if they are unsure of the identification or importance of any fossil that they find. All fossils that can be identified and that are reasonably complete are shown to the documenters and are recorded including all postcranial specimens.

The members of each team keep relatively close together so that any fossils discovered can be readily checked by a documenter. Specimens are less likely to be missed or forgotten if the documenter can immediately record each specimen with digital images, GPS coordinates and a computer record. The use of an IPAD with a customized FileMaker Go app, contains the field template which allows recording of the geology and geography, and all specimen details, including field photos and taxonomy, as is currently used by KFRP.

The positions of specimens discovered are marked according to the area in which they are found. In the Koobi Fora area, which is in Sibiloi National Park, specimens are indicated by a cairn constructed one meter to the west of the fossil. Specimens found in the Ileret area where they are subjected to considerable danger of interference from the local people and damage by livestock, are marked by a line of stones oriented in an east west direction and ending 1 meter from the fossil. Any specimens found on slopes are protected from being washed away by a solid line of stones placed just below the fossil. Small specimens are surrounded by a circle of stones, this greatly enhances the ability of the collectors to relocate a specimen later and prevents the specimen from being lost.

Protocol for Documenters and Collectors

The FileMaker Go database is a template with drop down values, which enhances consistence and time management. The GPS coordinates are taken with a Garmin. As additional backup, e.g., a field computer is unavailable or malfunctions, NMK field slips are used instead, and the data is recorded manually into the main data base in camp each evening. Digital images of the specimen are taken to record exactly how various parts of the specimen were distributed and the specimen's condition and situation when it was initially discovered. These are taken in the IPAD template, so that the records exported from the IPAD are accompanied by the images. For the database documentation, a unique serial number is given, and each documenter is allocated an individual set of numbers, e.g., F001 to F499, F500 to F999 etc.

Field Catalog Components

Field ID number
- Date and Year of Discovery
- Discoverer

Geology and Geography
- Study Area
- Collecting Area
- Locality
- Site
- Epoch
- Formation
- Member
- Stratigraphic Unit
- Level
- Latitude
- Longitude
- Altitude

Specimen Details
- Body Element
- Part Description
- Condition
- # of Fragments
- Matrix

Taxonomy
- Class
- Order
- Family
- Subfamily
- Tribe
- Genus
- Species

Field Photos
- Field Photo 1 & 2
- Context Photo
- Context Direction

Collector details
- Action
- Collector
- Date Collected

Recovery method

Field Comments

Specimen images taken in the field.
To identify the specimens subsequently, a small number is written on the bone with archival ink, and the number is protected with a thin layer of consolidant (ratio to start 100 g PVA B-15 to 500 mL of acetone, and then when in solution add another 500 mL of acetone). A larger number is also written on a stone placed next to the specimen, and a scale mounted on a compass is placed beside the specimen for a field photograph. The numbers last in this condition for a considerable amount of time, but as backup the specimen can also be relocated using GPS, along with field and context images, and an Avenza map screenshot derived from low-flying aerial surveys. GPS coordinates are accurate within 3m. Individual specimens found in close proximity are not distinguishable from each other, but this feature allows us to see where clusters of bones are occurring. In circumstances where a specimen is at risk of washing away, such as one recovered inside a river channel, the specimen is documented and then moved to a safer location nearby and this is noted in the catalog.

Multiple photographs are taken. The first image shows the specimen as it was originally found, and additional images show the specimen from views that illustrate the most significant details. For some specimens, e.g., isolated teeth or tooth rows of bovids, equids and pigs, two photographs showing both lateral and occlusal views are taken to illustrate the most diagnostic features and the degree of preservation of the fossil.

Before a specimen is collected, an image is taken recording its depositional environment. This "context image" is taken from the direction that best shows the geological context, and the direction is recorded as a compass bearing. A colored flag is placed where the specimen was found to make its position clear in the context shot. If multiple parts of the same specimen are found scattered some distance apart (>10m) a different colored flag is used for each of the major parts, and the color association is noted by the collector. 10-20 m, using the wide-angle lens setting of the camera provides a good compromise between showing sufficient surroundings, and being able to detect the specimen flag in the image.

<u>Fossils excavation and Plastering Protocols</u>
Some specimens need to be excavated and/or plastered. In these instances, first survey the area where the specimen is located, and uncover just enough to see the edges of the bone *in situ.* Take the image of the specimen with the compass North arrow and scale, and record its GPS reading in the IPAD. Pick up and wrap all individual surface elements and loose associated fragments. Excavate completely around the specimen, to pedestal it, making sure that there is sufficient room to work on all sides, and keeping an eye out for any plant fossils and impressions. Next, wrap the specimen with a layer of metallic foil, before applying damp tissue paper, and tightly wrap it with hessian cloth bandages, soaked in plaster. After the first side dries completely, the specimen can be flipped over, the excess matrix can be removed, and the process is repeated on the other side. Images of the flipped side are taken in the field, with its numbered field label inside. The field number is then written on the plaster using archival ink.

These field protocols have ensured the safe and efficient collecting of fossils by the KFRP team for two generations. To date the KFRP has contributed to the recovery of over 40,000 specimens housed at the National Museums of Kenya and the Turkana Basin Institute. These protocols are also currently being used to train the next generation of scientists.

VALDUGGIA FOSSIL LEAVES:
EXTRACTION, CONSOLIDATION, AND PREPARATION

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The Project

Plant macrofossils were observed in abundance at an outcrop close to the Valduggia village, in the province of Vercelli (Piedmont, Italy). The sediments, predominantly sandy and often fossiliferous, are attributed to a Pliocene marine palaeoenvironment (Fantoni et al., 2005), in which leaves that drifted in from a terrestrial environment were buried. Fossil terrestrial plant remains are regularly destroyed by natural causes due to flooding events of a little brook at the "Crabbia site" (Caleca & Martinetto-under submission). In 2023, the University of Turin decided to try saving some specimens. There are several conservation problems associated with these specimens, which are compressed layers of leaves saturated with water. The exposed fossil leaves, which often retain most of their original organic material, appear to be very well preserved if they are saturated with water, but sunlight can destroy them in a few hours in summer or after some days in the archives. Degradation is caused by the evaporation of water. This event causes shrinkage of the matrix and the fragmentation of the leaf, delamination, exfoliation of the fossil, until its final disappearance(Cimino et al. 2016). The focus of this study is to identify the correct tactics for collecting leaves in the field, consolidating them until they arrive at the laboratory, and allowing successive preparation and safe storage in the collections. In this case, some specimens will be conserved in the collection of the Museo di Geologia e Paleontologia of the Turin University, while others will be conserved in the Museo Paleontologico Territoriale dell'Astigiano.

Health and Safety

Safety equipment was used during excavation: gloves, safety helmet, safety shoes and safety goggles. During leaf preparation, gloves and goggles were used when removing excess matrix, and a mask and gloves were used when preparing samples under the optical binocular microscope.

Procedures/Results

Some leaf specimens have been recovered almost entire and the most common types have been preliminarily identified on a macromorphological basis as Lauraceae, *Platanus leucophylla, Quercus drymeja* and *Trigonobalanopsis rhamnoides.* Other leaf remains were recovered still embedded in sediment or in a fragmentary state and were considered very useful for this preliminary study of preparation techniques. Thus, 15 specimens in different conditions were used: Completely covered leaf remains (visible in section), partially covered leaves, leaves split into two plates, and impressions with parts of the cuticle. To satisfy all conditions of hydration of the leaf, comparisons of the best consolidation techniques were made on numerous samples. Vinavil diluted in water (5-10%) was used for field extraction. Once extracted, the leaves were wrapped in moistened newspaper and transported to the laboratory. At the laboratory, having photographed the fossil with a Canon EOS1200D reflex prior to preparation, and after the inventory of the items and their assignment to a provisional catalogue number, it was decided to do some consolidation tests and proceed with the preparation of the leaves.

Two methods of consolidation were tested on matrix on which no fossil leaves were seen or which had previously been treated with Vinavil: the acrylic resin Paraloid B-72 (in concentrations of 2-4-8% w/w) diluted in pure acetone and Vinavil diluted in water (20-40-80% w/w). A clearly visible difference between the use of Paraloid and Vinavil is the ability of the solidifying agent to penetrate the matrix: not only does the solution in water take longer to dry (and thus solidify the matrix), but it also remains slightly darker even after the matrix is completely dry. The penetration of the consolidant is also different, whereas Paraloid (at any concentration) penetrates the matrix,

Vinavil (at any concentration, but mainly at 40-80%) tends to remain superficial. This is a problem especially in preparation: by consolidating only the superficial part, the fossil is not effectively consolidated to the matrix and tends to 'detach' the more apical part from the rest of the specimen.

The work was carried out using 4% w/w Paraloid B-72 as a consolidating agent. The first problem encountered was with partially exposed leaves: in this case, a part of the leaf had been pre-treated with the solution of Vinavil and water described above, both in the field and when the fossils arrived at the laboratory (knowing that the test and the preparation could not take place the next day, but only in the following weeks). This solution is difficult to remove as it does not penetrate well into the matrix. During preparation, the attempt to remove the contact sediment between 'exposed leaf - unexposed leaf' tends to tear a part of the consolidated material (this happens both using steel needle and air scribe). As a result, the contact zone between the two leaves shows a clear fracture, which affects the fossil. For studying the fossil itself, this does not result in a great loss of information, but visually the effect is important. An attempt was also made to reverse the consolidant, which had now become solid, with additional cold or hot water, but this did not seem to have any effect.

For the preparation itself, several tests were carried out: manual preparation with steel needle; pneumatic preparation with an air scribe pen like the 'Chicago' model-PU001; pneumatic preparation with air engraving pen-W224.These trials showed gentle manual preparation did not produce good results. Pneumatic preparation produced better results with the pneumatic pen using fewer impact per minute (13.500 instead of 36.000 impacts/min).

Even though, as a consolidation agent, it was found that the best result was obtained with Paraloid B-72 diluted to 4% w/w, in cases where the specimen was badly damaged it was preferable to use Paraloid B-72 concentrated to 8% w/w. Visually, Vinavil diluted in water gives a higher gloss than Paraloid B-72, but the main function of a consolidant is to consolidate, and for the reasons given above, Vinavil does not achieve a very good effect.

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LARGE-SCALE PROJECT MANAGEMENT FIT FOR A JURASSIC GIANT

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Background

The Denver Museum of Nature & Science (DMNS) has collected vertebrate fossils from the Upper Jurassic Morrison Formation for the last century and a half, and as a result, hosts one of the largest Morrison dinosaur collections in the western United States. Specimens from this collection (e.g., *Stegosaurus*, *Diplodocus*, *Apatosaurus*, *Allosaurus*) have been the subject of numerous publications, provided training for dozens of students, interns, and entry-level scientists, and have offered invaluable community science opportunities through authentic, research-based paleontological experiences. However, the Morrison Fm fossil collection consists of logistically challenging, complex, heavy, large (1m+) dinosaur fossils that make accessing them for research, education, and exhibition a difficult task. Additionally, the majority (90%<) of the fossils are in need of preparation, repair, stabilization, and archival housing using modern conservation materials and methods. By integrating 3D scanning technology into our workflow, DMNS is able to make its Morrison Fm collection safe, stable, accessible, and engaging for external audiences. This proposal will provide an overview of how to manage and develop a workflow for a large-scale preparation and collections project, and the ways in which DMNS has made iconic Jurassic dinosaurs more engaging for both the scientific and local community.

Managing a Project on a Large Scale

Phase 1. Identify critical need and highest priorities
The Morrison Fm collection at DMNS consists of thousands of objects, but to make the project feel less overwhelming, we opted to focus efforts on those specimens in greatest need of repair, stabilization, and proper housing. We identified three sub-collections from the Morrison Fm; 1) US Forest Service sauropods, 2) Kaycee, WY quarries, 3) DeWeese *Diplodocus*.

Phase 2. Preparation workflow
The Morrison Fm Project is unique in that it requires both the re-preparation and re-stabilization of fossils already housed in the collections, and also initial preparation from field jackets collected in the last decade. We were able to tackle both preparation endeavors by 1) hiring a staff person dedicated to this project, 2) hiring an intern dedicated to this project, 3) recruiting and training new volunteers who are dedicated to this project, and 4) using the existing volunteer core to complete lab work for the Morrison Fm Project. Preparation was

completed using pneumatic tools such as air scribes, air hammers, air abrading units, and various hand tools (scalpels, dental tools, tweezers, etc). The specimens were stabilized using varying concentrations of B-72 consolidant and the cyanoacrylate PaleoBond 100x. Through volunteer efforts alone, 400 fossils were prepared, stabilized, or re-prepared from field jackets in 9 months. The preparation work also included building 216 archival cradles or cavity mounts completed by volunteers) to ensure the fossils are stored safely and securely for years to come. The archival cradles were constructed using polyester felt, sheets of fiberglass weave, Hydrocal FGR-95 plaster, and fiberglass veil. Volunteers, staff, and interns wore the appropriate personal protection equipment including N95 masks, safety glasses, and noise protection throughout the entire course of preparation.

Phase 3. Tracking preparation
We created a spreadsheet that includes preparation status and collections storage, as well as scanning, processing, and uploading status. This data has proven instrumental in monitoring the overall progress and informing our priorities for lab work, collections work, and digital surface scanning (see Phase 4). We sorted the data by field locality to set an organizational standard moving forward.

Phase 4. Digital surface scan and processing
The final step of the workflow is 3D surface scanning, which is captured using the wireless handheld 3D scanner Artec Leo. We use the Leo to scan one side of the bone at a time, rotating the bone until enough scans have been generated to create an accurate, detailed 3D model. Models are created by transferring data to Artec Studio 17 Professional (3D, 2022) where background noise is deleted and the individual scans are stitched together to create a final mesh file. This mesh file is then uploaded to the open access website, Morphosource, where all the scans are available to view and manipulate.

<u>Broader Impacts</u>
The project promotes access to museum and collections by significantly increasing use of large and unwieldy Museum specimens by completing specimen preparation and organization, and by making digital surface scans of each object available. Museum collections are a vast resource that remain widely untapped for scientific research because many specimens are delicate and require on-site visits. This is especially true for sauropod fossils like those from the Morrison Formation, which can measure over 1m and can weigh well over 150kg. By creating an established workflow, we successfully optimized data entry and storage for specimens originating from high producing field localities. This enabled us to create 3D models available to researchers on Morphosource (Tamez-Galvan et al., 2023), which has increased specimen access without extreme cost to our institution or detriment to the specimens.

Additionally, the project makes objects normally stored out of view accessible to the public through a variety of tangible products and efforts to communicate project activities and success. Specimens were prepared and repaired in the window of the highly-visible Schlessman Family Earth Sciences Preparation Laboratory within the popular Prehistoric Journey permanent exhibition at DMNS, visited by many of the (typically) more than 1.5 million guests who visit DMNS each year. Specimens and project activities are regularly highlighted during special Museum-wide events (Science on the Spot, Girls and Science, Educator Night, etc), which allows project interns and support staff to interact directly with members of the public using project objects. The successful "Scientists in Action" program at DMNS communicates project activities and collections directly to school-aged audiences around the country (and world) during live broadcasts to their classrooms. Additionally, the collection and the work surrounding it is highlighted on the DMNS webpage and current work is featured via social media posts on the project's Instagram account (@JurassicGiantz).

Furthermore, this Morrison Fm Project works to engage with students from traditionally underrepresented groups in science through a variety of local programs within DMNS, and in collaboration with external partners. These programs include 1) the Teen Science Scholars Program at DMNS which involves a partnership with local high schools to increase representation in the sciences, 2) Arrupe Jesuit High School's Corporate Work Study Program which connects its students with corporate partners to provide entry-level career training, and 3) Earth Sciences Fossil Preparation Internships that provide undergraduates and recent college graduates the opportunity to learn appropriate materials and methods in fossil preparation. All of the aforementioned efforts combined have allowed DMNS to provide access to researchers, students, collaborators, and public audiences while successfully training and engaging with the next generation of STEM scientists.

Conclusion

The development and implementation of a workflow has allowed us to manage a large-scale preparation and collections project simultaneously, and work with material collected over the past century in an effective and efficient way. We successfully improved the storage of a large scale collection of Jurassic fossils, which is intended to increase the longevity of the specimens for future research. The workflow includes creation of digital models of the Morrison Fm collection despite the challenges associated with moving and scanning large fossils. These efforts successfully promote the wider dissemination of the collections and its significance to local and regional communities (where many of the fossils originated) and offer the opportunity to deepen connections and appreciation for local fossil resources. This project resulted in an improved ability to share the Morrison Fm collection with the community in a variety of ways; the fossils were showcased 1) in-person during many on-site Museum events and in the Earth Sciences Prep Lab viewing window in the Prehistoric Journey Exhibit, 2) digitally through MorphoSource, and 3) virtually via social media, the project's webpage, and live broadcasts. It is hoped that the repairs, stabilization, and rehousing will last for decades or longer, making the specimens in the Morrison collection accessible to researchers and the public indefinitely. It is anticipated that the project-supported surface scanning of large and delicate fossil objects will become a model for making similar collections more accessible to scholarly and public audiences.

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THE 2003 FORD EXPLODER INCIDENT: THE DANGER OF FIELD VEHICLES AND THEIR HOT EXHAUST SYSTEMS, PRAIRIE FIRE AND MITIGATION RECOMMENDATIONS

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Fossiliferous outcrops are often located in remote places dominated by prairie grass ecosystems. These grasses usually grow vigorously in the spring and early summer, seed and then die, "browning off" and drying in the later summer. Dry grass is fuel for natural and manmade fires. Wang et al. (2021), conducting experimental burns in southern Alberta in dry mixed prairie vegetation, showed that fall fires "…tend to be more intense than spring fires because there is greater fuel mass". Accessing fossil sites involves driving vehicles and ATVs on roads, trails and sometimes onto the grass itself. Doing so under high fuel mass conditions creates a potential fire hazard with hot vehicle parts contacting dead grass or the grass being entrapped in undercarriage infrastructure and igniting later. Fire departments in remote areas are typically small, have volunteer/paid-on-call crews, and located far away. Volunteer crews have to be mustered and then get to the fire, all the while consuming valuable time. On arrival, the fire, especially if it is wind-driven, may prove very difficult to manage (Pyne, 2007; Murphy et al., 2015). Lightning-induced fires are a natural part of prairie ecosystems, anthropogenic fire are not. The issue is exacerbated by climate change (e.g. Withen, 2017), with some areas having longer, hotter and drier summers. As field workers, it's up to us to make the best attempt at preventing the fire from happening in the first place. A major tenet of the Royal Tyrrell Museum (TMP) carrying firefighting equipment in the field is not to use it to fight a fire (though they can), but use it to prevent fires from happening. Four hundred eighty USA wildland firefighters died on the job between 2007-2016 (NWCG, 2017), so let's try to keep them, and ourselves, safe in the field.

In 2003, a non-TMP paleontology team were operating a sport utility vehicle (SUV) in a prairie grazing lease in southernmost Alberta, driving across dry grass when suddenly there was a fire. Large flames emerged from the undersides of the vehicle and the two occupants narrowly escaped. The vehicle, erroneously believed to be a Ford Explorer, was later nicknamed by others the "Ford Exploder" was destroyed. The fire melted the vehicle's aluminum parts; which has a melting point of 660°C (1220°F). Inside was camping and field gear, and personal effects including a rumored computer with an unfinished thesis with no backup. Thousands of acres of prime winter grazing grass were also destroyed. The relationship between the professional Albertan paleontological community and the grazing lease custodians was seriously damaged. Two close calls with TMP vehicles involving burning or smouldering plant material in the undercarriage necessitated a careful re-examination of the problem. Hazard assessments were drawn up, a new section added to the staff training manual, and mitigation procedures, including equipping field vehicles with H_20 sprayers (hereinafter just "sprayer(s)"; Figure 1a) were emplaced in 2003. Information regarding field vehicles and the fire danger they pose and recommendations are shared here.

A vehicle's exhaust system can get very hot. Benes and Alkantree (2021: Figure 4) show that, for a variety of vehicles, temperatures can range from 380-620°C (716-1120°F) for the exhaust pipe, 320-560°C (608-1040°F) for the catalytic converter, and 190-480°C (374-896°F) for mufflers. Temperatures can fluctuate, but will increase if the vehicle is driven a long time or working under load. The hot exhaust train will start a grass fire. In a New Zealand (South Island) thesis study, motor vehicles accounted for 8% of wildfires there, and a literature review showed dry grass would ignite when exposed to temperatures at or lower than those noted above (Wakelin, 2010). Fires can start by dry grass contacting hot parts, grass becoming entrapped between protective skid plates/heat shields and hot exhaust parts, or tailpipe sparks.

The TMP uses portable sprayers carried by hand or on the back. Filled sprayers, given their tall and narrow shape, tend to fall over and leak in a vehicle, ruining materials like plaster. Rubber bungee cords held them in place but sprayers could work themselves free, fall over, and leak. Finally, in 2022, the lead author had the TMP's carpenters construct durable plywood holder boxes (Figure 1b). These were clamped inside the vehicle near the rear doors/tailgate. When these are opened, the box side facing out is open for unhindered sprayer retrieval. When the sprayer is returned, the vehicles' closed doors/tailgate block the sprayer's egress.

The TMP field procedure for the sprayers is as follows: 1. Each vehicle carries 1 or 2 units. They are filled and tested before field use. 2. Everyone is trained on how they operate. 3. Once the vehicle goes onto roads with grass close by, we stop, and the hot exhaust train underneath is sprayed with water and cooled down. 4. When parking on natural grass, priority is given to the least grassed areas. Hot undersides are sprayed again and the grass underneath. Visual inspection for entrapped grass is made. A repurposed long broom handle, with a bent nail duct-taped to the end is useful for removal of grass. We park on the same spot for the duration of the project. Consider clearing a vehicle-sized dirt pad(s) for parking, perhaps with some gravel for sites to be revisited annually. A cordless rechargeable or gas-powered weed whip or a manual weed whacker can create a safer parking spot. Rake the cut vegetation off to the sides. 5. The sprayer is positioned in a stable upright position ~23 metres (75 foot) upwind from the vehicle, and a broom for stamping out flames rests against the sprayer. This protects the sprayer in case of wind-driven fire. Placing them where easily visible shows passing land owners/custodians that we practise fire safety diligence. The sprayer can also be used by others in case of our absence. Sprayers/brooms placed outside might invite vandalism or theft but we've had no issues after two decades, even in publicly accessible areas. Winds can shift, so when the two sprayers/brooms are positioned, one is placed upwind, the other downwind, the logic being one unit is available if one tank is damaged/destroyed or access is barred by flames.

Spraying twice on hot parts uses much water, so the author brings two large repurposed 8 litre (~2 gallon) plastic kitty litter jugs) to refill the sprayers after use each morning.

Other considerations: 1. Should you even fight the fire? Never put yourself or crew in danger if you feel uncomfortable. Some fire safety websites recommend doing nothing if you are not a trained firefighter in a grass fire situation, except alerting the proper authorities, then keep well back (preferably upwind) and stay safe. First Aid for burns, smoke inhalation, or heart attack (NWCG, 2017; via physical exertion/rapidly developing tense situation) may be required. Professional firefighters wear fire proof or fire-resistant clothing, paleo field workers don't, so consider that if you decide to fight a grass fire. Again, work from upwind if you can. Burnt sections will reveal tripping hazards. Paleo fieldworkers will likely also lack proper PPE, especially masks to counter smoke inhalation, so care will have to be taken. Vehicles have plastic parts derived from petroleum which burn rapidly/intensely and give off extremely toxic fumes and smoke. At Dinosaur National Monument, staff are instructed to phone emergency services to report a vehicle fire and not to approach it or retrieve items inside because of this danger (D. Chure, pers. comm., 2023). TMP has a similar recommendation in their staff training manual.

2. Test the sprayer before fieldwork. Check the tank and hose for cracks and leaks. Rubber gaskets can dry out/crack between field seasons. The rubber gasket between the tank and top cap can degrade. Water in the sprayer will slosh around in a moving vehicle leading to leaks. A new gasket can be made from a piece of an old car inner tube. The rubber hose can be damaged by age, UV light, extreme temperature fluctuations or rubbing against field gear. The metal piston can seize up, so be sure it is lubricated as per manufacturers recommendations.

3. Freezing weather. H_2O can become slushy or freeze solid, rendering the sprayer useless. Frozen water expands, cracking and irreparably damaging the water tank or damaging internal parts. Ensure sprayers are empty and pumped until dry for outside winter storage.

4. Before venturing onto dry grass, check local websites on drought conditions and wildfire danger. In Alberta, Alberta Wildfire (2023), Alberta Wildfire Status Dashboard (2023), and Wildfire Status (2023) can be consulted; there should be similar organizations covering your field area. Check for any fire advisories or off-road vehicle restrictions. Local firefighting services might also have helpful suggestions. Municipal or government bans on off road driving may be enacted to reduce risks. One may have to park well away from the site and walk in or reschedule work until better conditions permit.

5. Be careful with the disposal of smoking materials and campfires where there is dry tinder and especially wind. A sprayer would be useful to have in camp.

6. Water in the sprayer(s) is limited so use it carefully, perhaps hard to remember in a high stress situation. On July 22, 2021, the TMP initially assisted at a strong wind-driven prairie firefighting effort. Ironically, the fire was started by a farmer's large mowing tractor cutting grass near oilfield infrastructure to mitigate against fire. The TMP's water supply ran out quickly but the fire brooms were useful for swatting down and smothering flames that were 30 cm (~1 foot) high, but less so for flames up to 92 cm (~3 foot) high. The mowing tractor, its towed accessory, and nearly 5,000 acres (20 km^2 or 7.8 $miles^2$) of grass were lost.

7. When driving, regularly check the side mirrors to ensure burning grass clumps are not dropping out of the bottom and being left behind. If you see smoke or smell scorched or burning grass, an underside inspection with sprayer(s) close by for instant use needs to be conducted immediately.

8. There may be steel skid plates straddling the frame rails on the underside of the vehicle chassis. While these plates help protect exposed and sensitive parts from rock strikes, they can also serve as shelves, collecting and progressively building up dry grass and twigs that can catch fire.

9. Tall dry grass should never be driven on. Driving across harvested farmers' fields with the upright base of the plant stems in life position (stubble) can also be dangerous if a stubble fire ensues.

10. The vehicle should never sit and idle on grass unless it is green, wet, or snow-covered.

11. Plan an escape route (via foot/vehicle) and safety zone as needed. Badlands, denuded of grass should be safe if nearby. Sparks, embers, and burning grass can become airborne and

start fires behind you. Burnt sections can reignite; in the 2021 fire noted above, cow patties continued to smoulder. Thick, choking smoke may blind and disorient you.

12. Supplement your fire-fighting capabilities with an ABC-type fire extinguisher mounted inside the vehicle where it is easily accessible. One was needed in a TMP incident where burning grass dropped out underneath a recently parked truck onto a paved road. Local fire companies or fire extinguisher suppliers may offer training courses on how to use these fire extinguishers correctly. They are a worthy safety training investment.

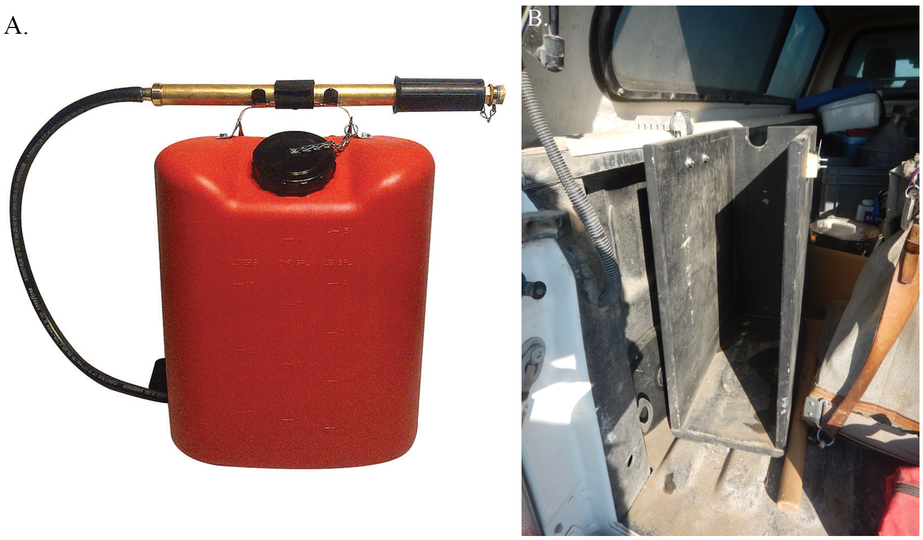

Figure 1a-b. a) An Ottawa Brass Ltd. Model #20 backpack-type water sprayer. The rugged plastic tank holds about 19 litres (5 gallons) of water. The empty unit weighs 4.3 kg (9.5 lbs); filled 23.3 kg (51.5 lbs). These sprayers cost about $300.00 CDN each. Plastic tanks are more durable than metal ones, resisting dents and punctures. Image from: https://www.grainger.ca/en/product/PUMP-TANK-FORESTRY-POLYETHYLNE/p/OTB20 *Product name here is not an endorsement by the TMP or the Alberta Government. It's provided for educational and illustrative purposes only. b) The left rear corner of a TMP pickup truck box showing installed sprayer storage box, sprayer removed.*

13. Proper off road vehicles have 4X4 capability and high clearance, reducing contact between grass and hot parts. These should not be conflated with SUVs, which are essentially cars with 4X4 capability, and much lower ground clearance, increasing contact between grass and hot undersides and potentially trapping more flammable grass.

14. In Alberta, there are two particularly dangerous prairie grasses that can lead to fires. Needlegrass or Thread-and-Needle Grass *Stipa (Hesperostipa) comata* and Speargrass *Heteropogon contortus*, ranging from northern Canada to Mexico so they live in many paleontological field areas. Fieldworkers encountering them know them well as their seeds stick into socks and painfully poke into the skin. The seeds bear a long tail or awn that, dependent on humidity, can be straight or twisted. Twisted awns of these species can become intertwined in large numbers underneath vehicles, gradually building up with dry plant material of other species (Figure 2).

Figure 2. Amateur fossil collector Hope Johnson (1916-2010) in southern Alberta, undated. Dry, matted and flammable plant material is seen stuck to the car's grille. From Tanke (2019:126). The car is a basic model 1956 Chevrolet 150 4-door sedan.

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MANAGING FOSSIL PREPARATION THROUGH ERGONOMIC EFFICIENCY

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When taking over a space as an incoming lab manager or setting up a brand-new space, it is essential to have a plan on how to organize projects, specimens, and tools that will meet the needs of both the space and the program participants. This plan will become the standard practice for your laboratory and be critical to maintaining a clean, clear, organized, and safety compliant space. Here we present practices essential to ensuring that preparation can be accomplished efficiently with minimal time spent searching for supplies or broken pieces of specimens that have disappeared among rock detritus.

Basic lab setup must include labeled storage for all preparation tools, chemicals, and associated paperwork. Personal Protective Equipment (PPE) and Safety Data Sheets (SDS) are placed in a clearly labeled, easy to access location. All lab personnel are trained in safety standards of working in the lab. The laboratory specimen storage system should comply with standard collections management protocols. This includes always documenting specimen locations within the lab. Specimens must always have an identifying field or collection tag with them. All equipment, tools, solvents, or specimens not currently needed should be in their respective labeled spaces. This will set-up the workspace for clean, uncluttered, successful preparation. During active preparation only the current project is on the work surface with appropriate labeling. The same protocol is applied to molding, casting, and specimens in a sandbox.

Regular cleaning of all work surfaces (tabletops, floors, storage drawers, shelves, and sinks) is critical to mitigating errant chemicals, broken fossil pieces, and dust accumulation. To control creating airborne dust, cleaning is best accomplished with a HEPA filter vacuum. Well maintained tools reduce the risk of injuries.

By maintaining the lab daily, there is always a clean microscope station for anyone to use. Time is saved knowing exactly where tools and equipment are stored. These protocols will save time for preparators and researchers waiting for a specimen to be finished or locating a specimen for study. Having a clean, clutter-free lab sends a visual message to lab visitors that the specimens are well cared for and are to be handled carefully while working with them.

THE WELL DRESSED ELEPHANT: JACKETING A MASSIVE SKULL AT A REMOTE SITE IN KENYA

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In 2013 the Koobi Fora Research Project discovered and excavated an immense cranium of *Loxodonta adaurora* (KNM-ER 63642), a Pliocene elephant (4.3 Ma) in northern Kenya. The specimen was transported to and prepared at the Turkana Basin Institute's Ileret field campus off the eastern shore of Lake Turkana. The specimen was described by Sanders, et al. in 2021. In 2016 an attempt was made to create a clamshell storage jacket for this prize specimen, one that would allow technicians to flip the skull over with minimal effort. But the materials used proved inadequate to the task, then the COVID 19 pandemic further delayed the project.

In early 2023 discussions began between William Sanders, Alan Zdinak, Louise Leakey, and Martin Kiriinya on a renewed effort to house the fossil. Leakey was determined that the materials employed should be sourced in Kenya. This would enable TBI staff to continue to apply the technique economically going forward. The materials Sanders and Zdinak were accustomed to working with in North America were not available in Kenya, but they insisted on using the most archival-grade analogs that could be found locally. Locally meant Nairobi, over 600 km (400 miles) from Ileret by small plane or nearly 1000 km (600 miles) by truck. Polyethylene foam was located at a construction supplier where it was sold for insulation. Two candidate plasters were acquired from Laborama, Ltd., Nairobi. Chopped strand fiberglass and polyester felt were also purchased, as well as tools such as a hot melt glue gun and sabre-saw.

Zdinak and Sanders arrived at the Ileret facility in late September with a plan to execute the jacket over a 10 day schedule. They were aided in this effort by Kiriinya and over a dozen TBI staffers who were to be trained in the clamshell jacketing technique. First, the supplies were inventoried: the felt provided was too thin to use on such a heavy specimen, so polyethylene foam was chosen for the liner material. The two plasters were tested. The one designated "medical" plaster set too quickly and too soft. The other plaster, listed as "laboratory grade" set harder and more slowly, so was the clear choice for the shell. This plaster was labeled P.O.P., the abbreviation for Plaster of Paris.

The specimen, weighing at least half a ton, had been sitting outside the collections building under a metal shed over the intervening years. The shed was removed, shade tarps erected, and the team built a scaffold of plywood and cardboard around the skull to establish the midline. They discovered hot melt glue takes much longer to harden when the ambient temperature is 38C (100F). The facility's plumber had a large heat gun, so that was used to weld the 6mm (1/4") polyethylene foam liner. 24mm (1") foam pads were added to weight-bearing areas. Since the plaster set in 20 minutes, the team was divided into four units, each at a corner of the specimen, to apply the plaster and fiberglass. It still took three batches of plaster to complete the eight layers of the first side of the jacket. The chopped strand fiberglass fell apart on dipping in the plaster, so panels were laid on the jacket and the plaster massaged in. PVC pipe from TBI's carpentry shop was used to reinforce the jacket and stabilize the rockers. Rockers were constructed of four layers of 24mm foam around a 24mm plywood core. To mitigate wear and tear on the rockers from such a heavy load, recycled motorcycle tires were cut to fit over the rockers and screwed into the plywood core.

N95 dust masks and nitrile gloves were worn when handling plaster and fiberglass. Work gloves, dust masks, and goggles were worn when cutting lumber or trimming the jacket.

Once the dorsal side of the jacket was complete, the specimen needed to be flipped over in it to expose the ventral side. Four large straps were arranged under the specimen, which was sitting on the remnants of the earlier jacketing attempt. Slots were cut in the flange through which the straps were threaded to conform more securely to the jacket. A single block and tackle hung from TBI's homemade gantry were used to lever the front end of the package up until the rockers engaged, and many hands helped to settle the jacket to the ground. The right zygomatic arch suffered some fracturing and was repaired with polyvinyl acetate (Black Hills Institute PVA B-15). The ventral half of the jacket was then executed. An angle grinder was used to trim the flange, then the jacket was consolidated with PVA B-15 in acetone.

The last challenge was to get the specimen into the collections building. TBI's resident engineer welded a custom dolly to fit under the jacketed specimen. The team then rolled the specimen halfway around the building on a plywood track to a spot where it could be lifted inside.

The project required adapting the clamshell jacket technique, in wide adoption in North America, to the conditions and available materials of rural Kenya. It also sparked several innovations -- the tires covering the rockers, the strap slots in the flange, the use of PVC to reinforce the jacket – which contributed to the final result: the successful housing of this exceptional, and massive fossil.

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Third time's a charm!

The 2025 AMMP Annual Meeting will be hosted by East Tennessee State University in Johnson City, Tennessee.

Details coming soon to www.paleomethods.org!

The Association for Materials and Methods in Paleontology (AMMP) values the diversity of views, expertise, opinions, backgrounds, and experiences reflected within our community and is committed to providing a safe, productive, and welcoming environment for all participants. This Code of Conduct (COC) is important for promoting diversity and creating an inclusive, supportive, and collaborative environment for all people and cultures.

All event participants—including, but not limited to attendees, speakers, volunteers, exhibitors, personnel, members of the media, and service providers—are expected to abide by this COC.

We expect everyone to respect the following list of behaviors:

Expected Behavior

- Treat everyone with kindness, respect, and consideration, valuing a diversity of views and opinions (including those you may not share).
- Exhibit professional behavior at all times.
- Communicate openly, with respect for others, critiquing ideas rather than individuals.
- Be mindful of your surroundings and those of others. Alert event staff if you notice a dangerous situation or someone in distress.
- Make space for new people to join in your conversations.

Unacceptable Behavior

- Harassment, intimidation, or discrimination in any form including, but not limited to:
    - Written or verbal abuse
    - Exclusionary behavior and microaggressions related to age, physical appearance or body size, employment or military status, ethnicity, gender identity and expression, individual lifestyle, marital status, national origin, physical or cognitive ability, political affiliation, sexual orientation, race, or religion
    - Unwanted sexual attention
    - Use of sexual or discriminatory images or language
    - Deliberate intimidation, stalking, or following
    - Sustained disruption of talks, workshops, or other events
    - Bullying behavior, including intentional microaggressions
    - Retaliation for reporting unacceptable behavior
- Unacceptable behavior intended in a joking manner still constitutes unacceptable behavior.
    - Avoid jokes about a specific group (like "undergrads").
    - Avoid making derogatory comments toward a specific individual.
- The recording or transmission of any sessions, presentations, demos, videos, or content in any format is strictly prohibited unless documented permission by AMMP is granted in advance.
- Disruption of presentations during sessions is strictly prohibited. All participants must comply with the instructions of the moderator(s) and any event staff.
- Participants should not copy or take screenshots of presentations if the author posts an icon prohibiting such action on the title page or other pages of the presentation, or if

the author verbally announces such an action is prohibited during the course of their presentation.

Note About Differences of Opinion and Offense

The primary benefit of a collaborative professional event is the unhindered involvement and contribution of all participants. In order to achieve the objectives of an event within the limited time provided (with the universal benefit of all participants being fully engaged) discussions should be focused on the meeting topic at hand. All participants must be welcome and able to equitably and effectively participate.

Articulations

It is not a violation of the AMMP COC to express an opinion, raise research questions, or describe an experience (i.e. an "articulation") that is at odds with the opinions of or is found offensive by others. An articulation must be part of an on-point discussion of the AMMP event topic at hand and offered in a manner that does not interfere with others' reasonable ability and welcome to fully participate. Debate is an integral part of professional collaboration and it is important that differing positions be expressed with respect and consideration for all. Doing so in a manner that reflects intellectual rigor and is demonstrably mindful of minimizing, as reasonably possible, its potential adverse effect on others' ability to participate is considerate and professional. (Offering an advance warning of the potential for impact on others is one way to demonstrate such respect and consideration for all.) This includes avoiding dominating a discussion, expressing an articulation that is reasonably expected to cause offense gratuitously (i.e., unrelated to or unnecessary for the work on that topic), and voicing articulations as personal attacks (ad hominem) or put-downs of an individual.

It is important to show consideration for anyone who appears distressed by promptly halting the cause and demonstrating caring while still pursuing a way to share pertinent information with the event moderator's assistance if needed.

Reporting Incidents

If you feel that you are the subject of unacceptable behavior, have witnessed any such behavior, or have other concerns, **report the incident to the email address below as soon as possible**. AMMP will work with you to resolve the situation.

AMMP will treat all reports seriously and will work to understand the situation through prompt investigation, including conversations with relevant individuals and witnesses before determining an appropriate course of action. AMMP will exercise strict confidentiality with the identities of the reporting individual(s) and involved parties; however, if identification is necessary for resolution of incidents with higher authorities, AMMP will comply with information requests.

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Consequences

- Anyone requested to stop a behavior by AMMP is expected to comply immediately.
- AMMP may take any action deemed necessary and appropriate, including immediate removal from the event without warning or refund.
- AMMP reserves the right to prohibit attendance at any future event, virtually or in person.
- Further action may be deemed necessary to address egregious acts.

1. Critical Thinking

The judgments and actions of the qualified preparator are guided by a methodology that places a priority on enhancing, not diminishing the scientific value of the specimen. Critical thinking allows the application of the knowledge, skill, and experience of the preparator to assess the specimen, the task at hand and the desired end product before commencing preparation and during every stage of preparation. The preparator must be able to continually monitor the immediate physical impacts upon the specimen by treatments, handling, examination, and consider the long-term effects of the materials and techniques applied to the specimen. The qualified preparator has the ability to conceptualize, think creatively and evaluate information in a systematic, purposeful, efficient manner. The preparator also has an appreciation for their own limits and knows when and where to seek guidance.

2. Aptitude for Fossils as Materials

Competent preparation requires an intrinsic sensitivity and feel for fossils as physical, often fragile material. The preparator combines this innate aptitude with an understanding of the scientific value of fossils, and a lack of competency in this area cannot be offset by knowledge of preparation and conservation theory.

3. Understanding of Fossils as Biological Materials and Data

The qualified preparator has the ability to exercise good judgment when interpreting the distinction between biological remains and matrix, and is guided by a fundamental knowledge of vertebrate anatomy, physiology and evolution. The preparator can recognize that fossil specimens are the physical representations of primary paleontological data. A preparator has a basic understanding of fossils as an individual's remains and the biological data contained therein. A qualified preparator uses correct anatomical terminology to document preparation and communicate with researchers.

4. Understanding of Fossils as Geological Materials and Data

A qualified preparator should have an understanding of fossils and matrices as the products of geological processes and as geological data. This should include knowledge of taphonomy, basic geological principles, and different modes of preservation. Preparation usually requires removal of matrix from bone, and some fossil evidence such as trace fossils, root-casts, phytoliths and soil structure are contained within the matrix. Therefore, the preparator should have an awareness of data contained within the matrix and understands that any modification of matrix is a potential loss of data.

5. Participation in the Science of Paleontology

A qualified preparator is conversant in the specialized vocabulary, terminology, and research goals of paleontology, and can alert researchers to evidence and assist in its interpretation. The preparator understands the pertinent scientific references, and is able to share and receive relevant information with other subject matter experts.

6. Understanding of Conservation Principles and Ethics

The preparator is also a conservator and makes every effort to ensure that the prepared specimen will resist deterioration for as long as possible. The qualified preparator recognizes the agents of deterioration and understands the principles of preventive and remedial conservation. The preparator is familiar with the current literature, principles, ethics, and specialized vocabulary of conservation.

7. Documentation and Record Keeping

The qualified preparator understands that preparation is part of the scientific process and ensures that all data generated within the laboratory, including identifications, photographs, preparation records, and housing materials are documented and archived. The preparator keeps identifying numbers in association with specimens throughout the preparation process. The preparator keeps records of all tools, techniques, and materials used to prepare or house the specimen that might impact physical or chemical interpretation, or that might have to be removed in the future. The qualified preparator is able to create publishable documentation of materials and methods for inclusion in scientific descriptions of the specimen.

8. Understanding and Aptitude in the Use of Preparation Tools and Techniques

The qualified preparator can select the most appropriate tools and techniques to skillfully reveal scientific information, and safeguard the long-term well being of the specimen. The preparator should be proficient in the preparation of common modes of vertebrate fossil preservation and in challenging situations should be able to seek further guidance in the preparation and conservation literature. The preparator augments this knowledge through professional conferences and communication with colleagues.

9. Understanding and Use of Adhesives

The qualified preparator is familiar with the range of adhesives available and is able to select the most appropriate adhesive for a given task. The preparator has knowledge of the physical and chemical properties, uses of various adhesives, the setting mechanism and reversibility of adhesives, their solvents, and the advantages and disadvantages conveyed by each kind of adhesive. The preparator should also be familiar with the ethical implications of using adhesives on museum objects and the kinds of scientific data that may be obscured, lost or destroyed by the use of adhesives. A qualified preparator is conversant in adhesives terminology and nomenclature and is able to justify decisions and correctly document adhesives used on specimens in preparation records and reports for publication. The preparator is able to mitigate and manage the potential health risks associated with the use of adhesives and solvents.

10. Understanding and Use of Molding and Casting Materials and Techniques

The qualified preparator is familiar with the ethical implications of using molding compounds on museum specimens and the kinds of scientific data that may be obscured, lost or destroyed during the molding process. The preparator is able to determine the suitability of the fossil for molding and type of mold produced based on its fragility, morphology, and other physical properties. The preparator is familiar with the physical properties and uses of various gap fillers, separators, molding and casting compounds commonly used in paleontology, is adept in their use and also trained in the management of potential health risks associated with molding and casting.

11. Use of Archival Labeling, Housings and Storage Environment

The preparator is aware that an essential step in the long-term conservation of fossil material is the use of archival labeling, housing, and proper storage environment. The qualified preparator incorporates specially designed archival housings into their preparation strategy, in collaboration with collection management staff. The preparator is knowledgeable about archival materials and proper storage environments and can recognize deterioration due to improper materials or storage conditions. As the understanding of storage materials evolves, the preparator is able to evaluate and modify storage materials and methods to ensure the long-term stability of the specimen.

12. Ethics of the Use of Specimens

The preparator is able to mitigate the risk of damage from research and education as much as possible without compromising the scientific value of a fossil specimen. The preparator is able to evaluate whether the specimen would be subject to undue or unnecessary risk by sampling, handling, loan, or display. A qualified preparator understands exhibition as a form of specialized specimen storage, and can evaluate exhibitions and their accompanying furniture, lighting, and other materials to ensure their compatibility with sound conservation practices.

13. Understanding Fieldwork

The preparator is aware that specimens should be collected with the goal of obtaining a stable specimen while ensuring that the greatest amount of geological and biological information is preserved, and understands that no fossil should be collected without comprehensive documentation. The preparator ensures that specimens are collected in a manner that facilitates preparation in the laboratory. The preparator knows and practices proper health and safety procedures while working out of doors in varying climatic conditions.

14. Health and Safety

The qualified preparator has the training to ensure their own safety and the safety of their coworkers and visitors by determining and mitigating physical and chemical hazards in the paleontology laboratory. The preparator should be able to comprehend Material Safety Data Sheets and select appropriate personal protective equipment and environmental controls, and have basic knowledge of emergency response and first aid.

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