AMMP 2023

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Patty Ralrick, Abstracts Subcommittee Chair
Jennifer Cavin
James Preston
Darren Tanke
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Shane Tucker

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Paige Wilson Deibel
Greg Wilson Mantilla

Land Acknowledgement:

The Burke Museum stands on the lands of the Coast Salish Peoples, whose ancestors resided here since time immemorial. Many Indigenous peoples thrive in this place—alive and strong.

#AMMP2023

Follow us on:

Association for Materials and Methods in Paleontology

@AMMPaleo

ammpaleo

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

Our website: www.paleomethods.org

Purchase 2023 apparel, drinkware, and other products from the newly created AMMP Store. All proceeds will help fund the McCarty Student Travel Grant.

Cite abstracts as: Doe, J. 2023. Abstract title. Abstracts of the 2023 Annual Meeting of the Association for Materials and Methods in Paleontology. Seattle, WA, April 4 – 8, 2023. p. X.

Table of Contents

Welcome!

As we gather together here (finally!), I'd like you to think about how incredibly special our profession is, and how lucky we are to be a part of it. To be entrusted with the care of such unique, irreplaceable, and scientifically valuable objects is an extraordinary honor. The people that comprise our preparators' community are extremely diverse in many ways, but we all share two common characters…we are all perfectionists and we all subscribe to the Hippocratic principle of *primum non nocere* – "first, do no harm". But being perfectionists does not mean that we are, or ever will be, perfect. Recognizing this is why, 15 years ago, Matt Brown planned and hosted at Petrified Forest National Park the first Fossil Preparation and Collections Symposium (FPCS). This was never a formal organization, but rather a series of independently hosted annual get togethers. At what would become one of the final FPCS meetings, a small group of folks, some possibly a bit under the influence of post-meeting adult beverages, sat down to brainstorm the creation of a formal organization to oversee future meetings. By the time the group parted that evening, we had a name, mission statement, embryonic bylaws and incorporation documents, and a few officers. AMMP was born.

Putting on the annual meeting has become a huge undertaking with a nearly infinite number of moving parts to juggle. The 2019 meeting at the Sternberg Museum, Hays, Kansas, was AMMP members' last opportunity to get together, at least physically, until today. The proposed 2020 meeting at East Tennessee State University (ETSU) fell victim to the rapidly intensifying Covid pandemic after most of the planning had already been completed. Early in the planning stages for a 2021 redo at ETSU, the decision was made to meet 100% virtually…again, thanks to Covid. This was a new and interesting adventure for the Annual Meeting and Host Committees but defying all odds and a few technical glitches, it was quite successful. Virtual, however, cannot provide the same experiences and opportunities as an in-person meeting. With improvement on the Covid front, in 2022 the University of Washington's Burke Museum of Natural History and Culture was chosen to host the long-awaited first "real" meeting since 2019. Well into the planning stages, a perfect storm of administrative and procedural issues delayed the planning process long enough that the meeting had to be cancelled despite the best efforts of all parties.

Just as preparators are not perfect at preparation, preparators are even less perfect at running a professional organization. Mistakes have been made and will be made. As in preparation, we learn from mistakes and strive to get better. It's a process. It's a goal. We need to improve the professional standards of our members as well as those of our organization. Please be patient with us (on both tasks). If not patient, at least be understanding and know that we are fully committed to our mission.

This year we have put in place a Memorandum of Understanding giving the host institution more responsibility in negotiating contracts in a more efficient manner and in the process, providing AMMP with considerable financial savings. We have created a new standing committee, chaired by Anthony Maltese, to oversee abstracts, presentations, and other content to ensure that they depict and promote appropriate safety standards. Review of abstracts has also been enhanced to determine if materials and methods presented adhere to best practices; not an easy determination to make from abstracts alone, but we hope to improve that oversight in the future. Matthew Mille is heading up an *ad hoc* committee examining the ByLaws to recommend critically important changes that will better serve our organization and its members. In addition, the committee will be reviewing and improving policies and procedural guidelines for the Board and committees to ensure that responsibilities, duties, and authorities are clear and comprehensive. AMMP is not the Board's organization, it is yours. We need, welcome and value members' constructive input, be it complimentary or critical. Most of all, we need your participation.

So here we are, 2023, in Seattle! Join me in thanking the University of Washington, the Burke Museum, the Annual Meeting Committee (Chair Conni O'Connor, Patrick Wilson, Patty Ralrick, Darren Tanke, Marilyn Fox, Shane Tucker, Cinda Timperley, James Preston, Jennifer Cavin) and the Host Committee (Chair Kelsie Abrams, Christian Sidor, Caroline Strömberg, Zoe Kulik, Eddy Armstrong, Ron Eng, Paige Wilson Deibel, Greg Wilson Mantilla, Katie Anderson) for their perseverance, dedication and the many, many hours of hard work required to bring us here together finally! I also want to thank current and previous members of the AMMP Board for facing and resolving issues that have hampered us in the past. As we move into the future, I hope that all of you will continue to support AMMP and our mission to improve our profession, our lives, and the new lives we give to our long-dead fossils! Welcome to Seattle and the Burke…it's really good to see you all again!

Gregory Brown
AMMP President 2023


The Graduate
BROOKLYN AVE NE
4518
N28
N29
N27
4545
15TH AVE NE
17TH AVE NE
20TH AVE NE
22ND AVE NE
TO FRATERNITY AND SORORITY HOUSING
NE 45TH ST
UW Tower
O
T
C
S
1415
University Bookstore
UDistrict Station
Burke Museum
JACOBSEN OBSERVATORY
N5
N4
CLALLAM LANE
Hughes
Archery Field
KLICKITAT LANE
Hansee
McCarty
Kincaid Ravine
Madrona
Denny Field
Willow
North Physics Lab
NE 43RD ST
William H. Gates
Law Library
MEMORIAL WAY
PACCAR
BAEEC
Dempsey
Hutchinson
Oak
Haggett
N9-11
N12
N3
Lewis
N6
WHITMAN COURT
CENPA Instr. Shop
N2
Mackenzie
STEVENS WAY
Denny
Chelan Lane
Art
McMahon
N13-15
Russell
NE 42ND ST
Eagleson
Parrington Lawn
Denny Yard
Intellectual House
Raitt
Music
Clark
PEND OREILLE RD
< Enter Garage
MASON RD
BROOKLYN AVE NE
UNIVERSITY WAY NE "THE AVE"
Social Work
Parrington
Savery
THE QUAD
Miller
Cunningham
SKAGIT LANE
Communications
Padelford
Padelford Garage N16 - N21
NE 41ST ST
Enter Garage
Elm
Poplar
Playhouse
Schmitz
Henry Art
Odegaard
Kane
SPOKANE LANE
Smith
Thomson
Transp. Svcs.
OVERPASS
Gowen
Grieg Garden
N22
WAHKIAKUM LANE
N24
OLYMPIC
VISTA
RED SQUARE
Hall Health
Lander
Alder
Commodore Duchess Apt.
Central Plaza Garage (Underground) C1 - C6
Suzzallo
HUB Yard
Fluke
George Washington Lane
Meany
Husky Union Building "HUB"
UW Club
W8
NE 40TH ST
Gerberding
Allen
C19
N24
Enter Garage
Child Ctr. WC
Ethnic Cltr Cntr
ECC Theatre
CDC
Scene Shop
Gould
GRANT LANE
C9
GRANT LANE
Mary Gates
Sieg
Facilities Admin.
Univ. Facilities
3902
3903
3935
W13
W11
W12
3917
W12
UW Police
CONSTRUCTION AREA
Population Health
Architecture
ASOTIN PL
Nano ES
Johnson
Mol. ES
Gug. Anx
Guggenheim
Kirsten
C17
C17
Aerospace
Aerodyn. Lab
Engr. Libr.
UF Anxs.
PO Anxs.
JEFFERSON RD
Loew
Plant Ops.
B
C
W29
WCUP
C7
Guthrie
Chemistry Library
Atmos. Sci. Geophysics
Drumheller Fountain
BENTON LANE
Mechanical Engineering
Engr. Annex
C15
Power Plant
NE PACIFIC ST
WRS
Physics/ Astronomy
STEVENS WAY
Okanogan Ln
Bagley
Elec & Comp Engineering
Paul G Allen Ctr for CSE
JEFFERSON RD
C14
E98
Tower
E97
W35
Wallace
Portage Bay Garage
W27
Child Cntr. PB
Auditorium
C7
Benson
Chemistry
RAINIER
Sylvan Grove
Bill & Melinda Gates Ctr for CSE
OVERPASS
Kincaid
Marine Studies
Ocean Rsch.
W28
3716
3710
W24
15TH AVE NE
Foege Bioeng.
ARCF
Medicinal Herb Garden
Life Sciences
More
C12
Roberts Annex
Alaska Hec Ed
Greenhouse
Mueller
Roberts
C12
Wilcox
C12
Foege Genome
SKAMANIA LANE
Hitchcock
OVERPASS
Burke-Gilman Trail
VISTA
MONTLAKE BLVD NE
Anderson
MASON RD
Sakuma Viewpoint
1303
NE PACIFIC ST
Winkenwerder
Wilson Annex
Wilson Ceramic Lab
E17
C10
Ocean Sciences
K
J
I
T
Bloedel
C10
C10
OVERPASS
NE BOAT ST
N

FIRST FLOOR

Heritage: Arts & Cultures

Culture is Living Gallery

Northwest Native Art Gallery

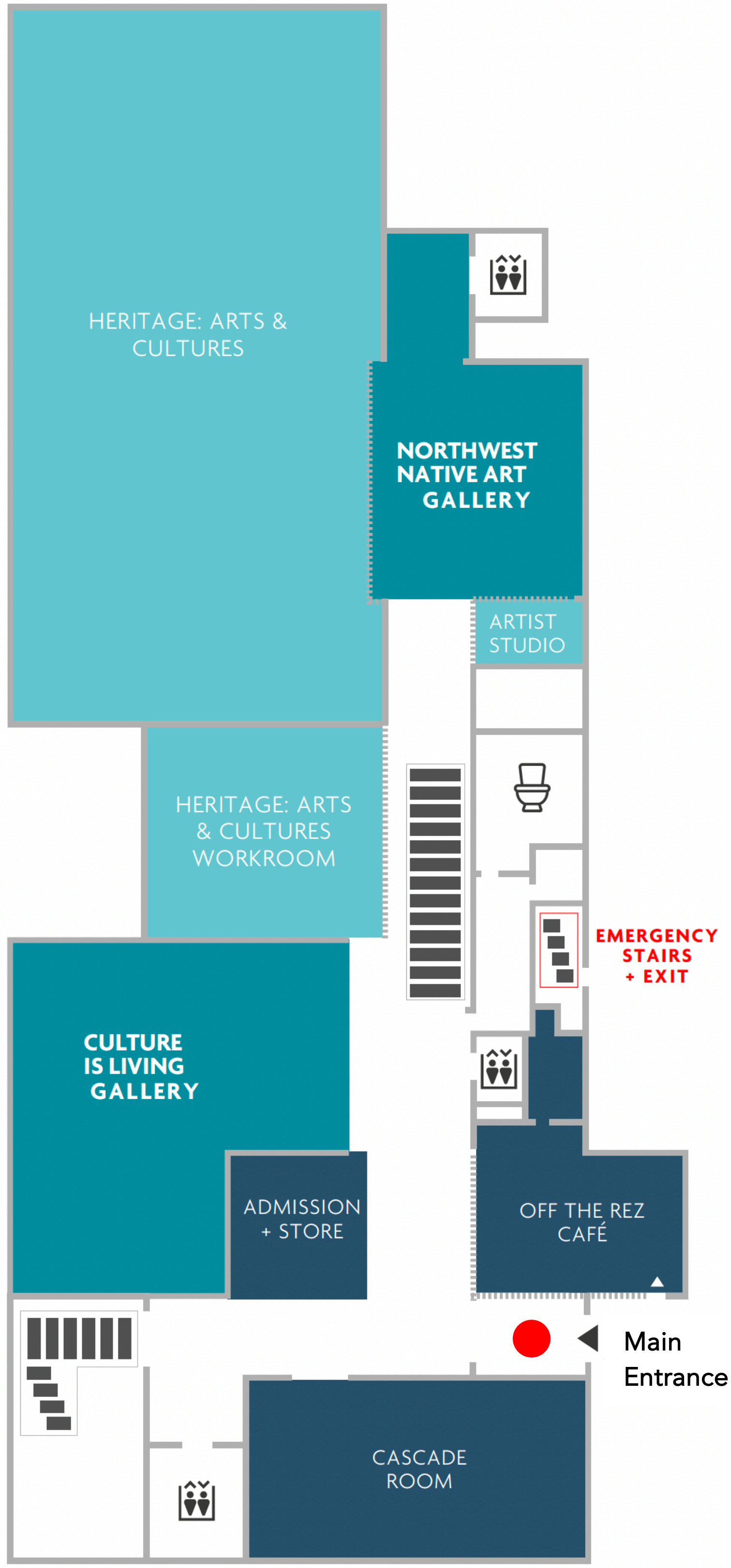
Main Lobby

Accessible Restrooms + Changing Tables

See-Through Locations

Elevator

Meeting Place



SECOND FLOOR

Biology

Amazing Life Gallery

Special Exhibit Gallery

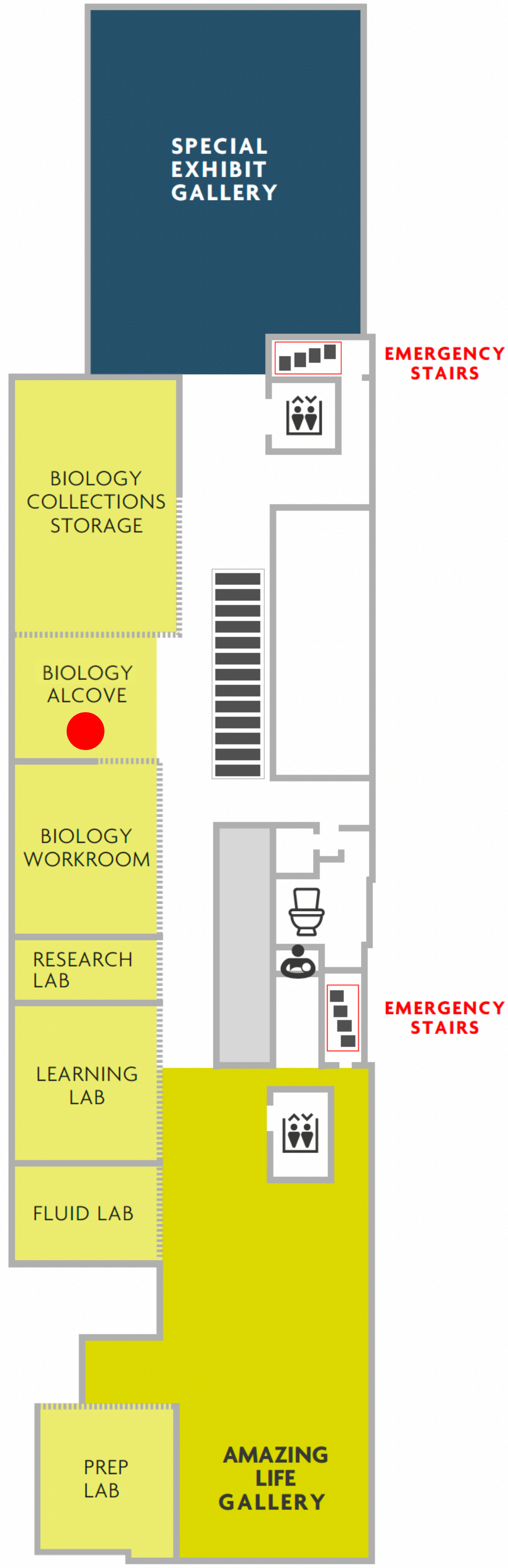
Accessible Restrooms + Changing Tables

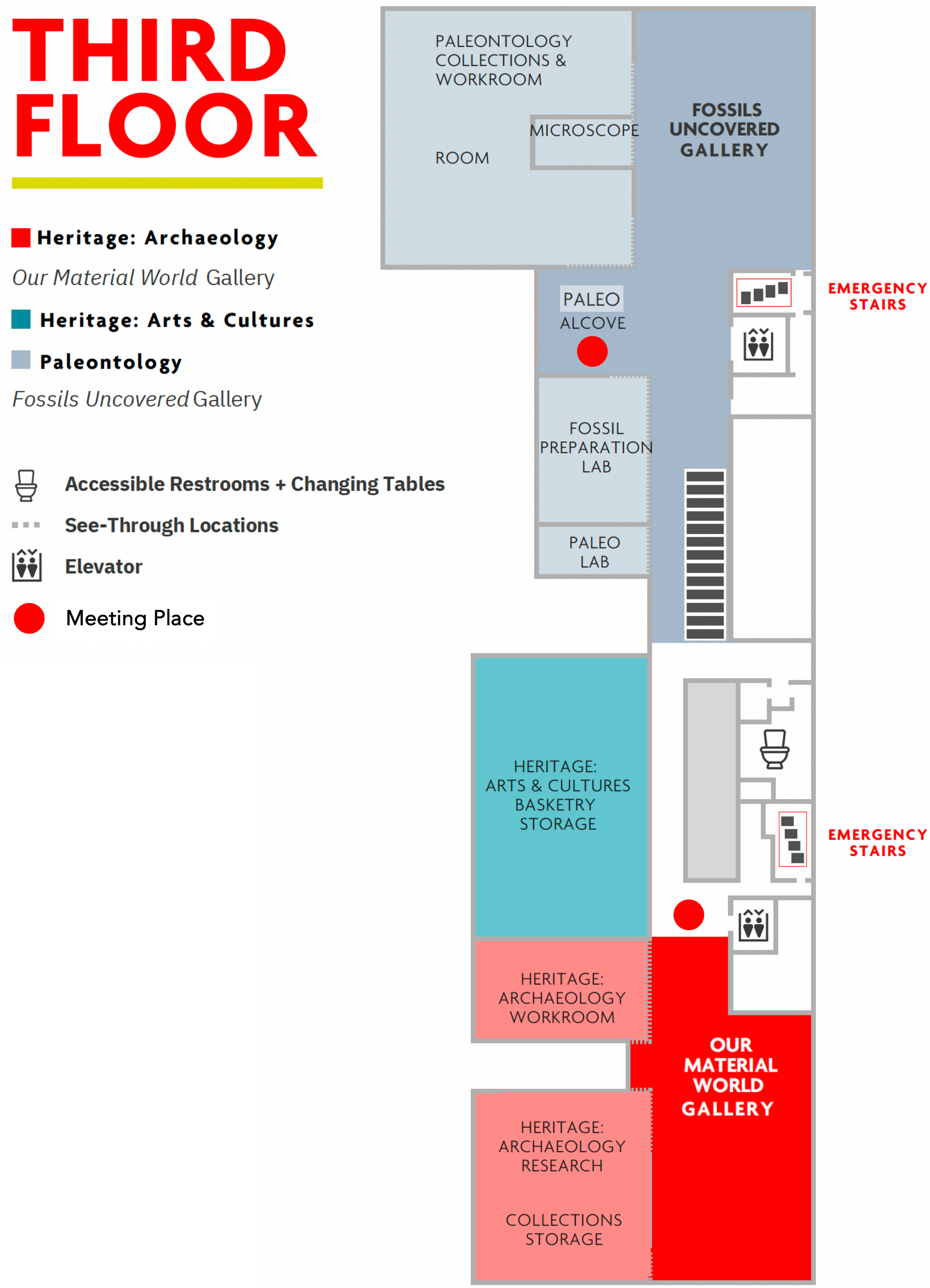
Lactation Room

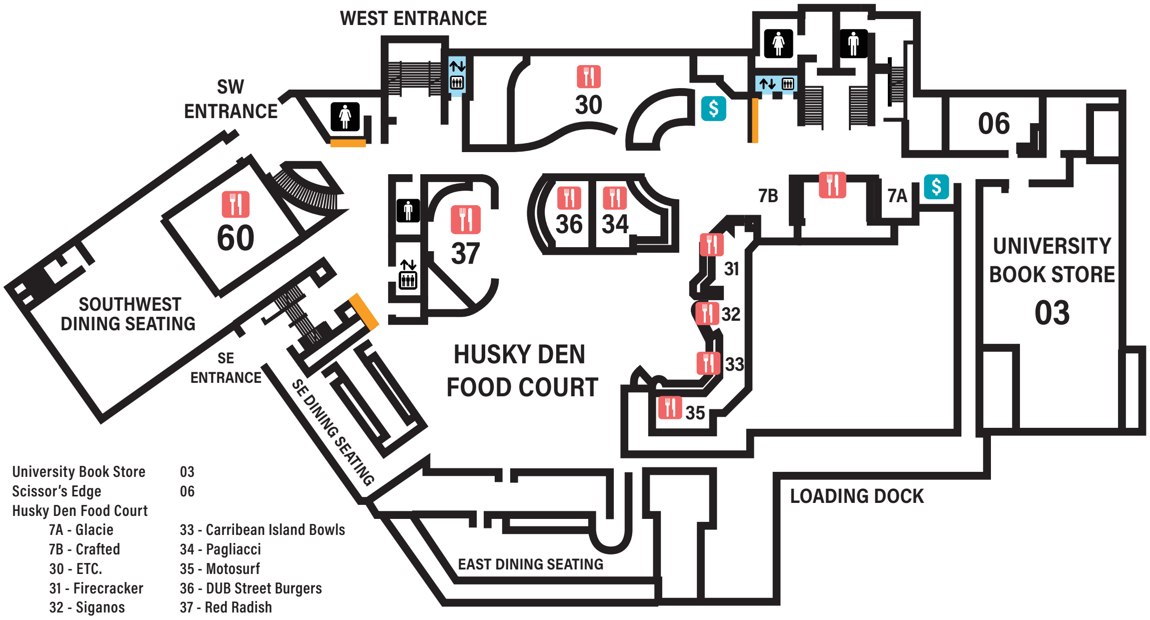
See-Through Locations

Elevator

Meeting Place



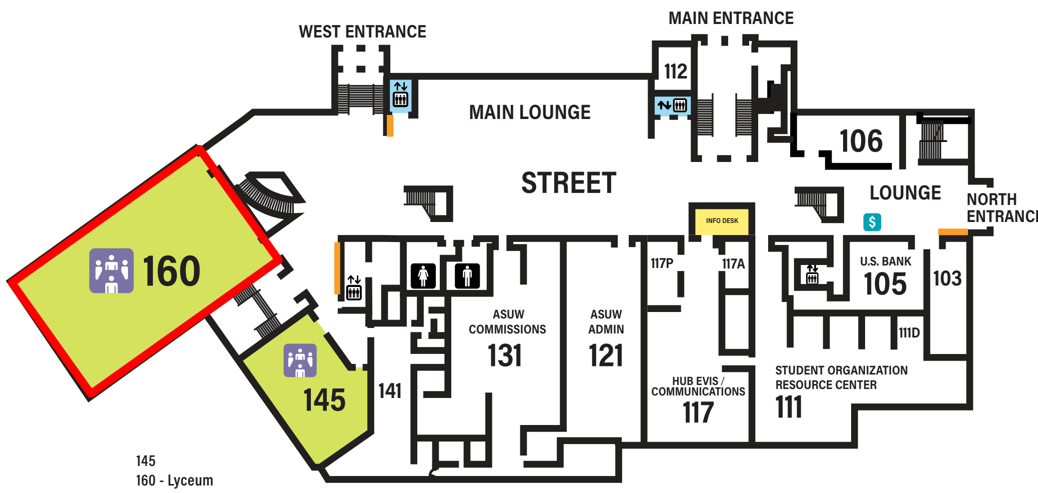

THIRD FLOOR
Heritage: Archaeology
Our Material World Gallery
Heritage: Arts & Cultures
Paleontology
Fossils Uncovered Gallery
Accessible Restrooms + Changing Tables
See-Through Locations
Elevator
Meeting Place
PALEONTOLOGY COLLECTIONS & WORKROOM
MICROSCOPE ROOM
FOSSILS UNCOVERED GALLERY
PALEO ALCOVE
EMERGENCY STAIRS
FOSSIL PREPARATION LAB
PALEO LAB
HERITAGE: ARTS & CULTURES BASKETRY STORAGE
EMERGENCY STAIRS
HERITAGE: ARCHAEOLOGY WORKROOM
OUR MATERIAL WORLD GALLERY
HERITAGE: ARCHAEOLOGY RESEARCH
COLLECTIONS STORAGE



University Book Store	03
Scissor's Edge	06
Husky Den Food Court	
7A - Glacie	33 - Carribean Island Bowls
7B - Crafted	34 - Pagliacci
30 - ETC.	35 - Motosurf
31 - Firecracker	36 - DUB Street Burgers
32 - Siganos	37 - Red Radish
Starbucks	60

Bulletin Board
Public Elevator
ATM

GROUND FLOOR



Meeting Room	145
Event Spaces	160 - Lyceum
ASUW Bike Shop	103
U.S. Bank	105
Welcome Center	106
Student Organization Resource Center	111
Tech Loan Program	111D
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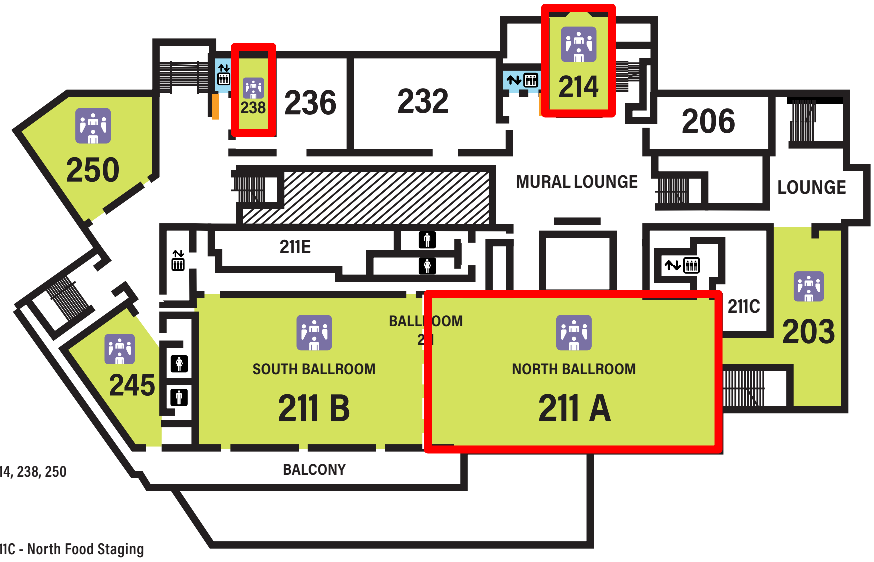
UWPD SubStation	117A
HUB Cashier's Office	117P
ASUW Admin / Commissions	121 / 131
Commuter & Transfer Commons	141

ATM
Bulletin Board
Public Elevator

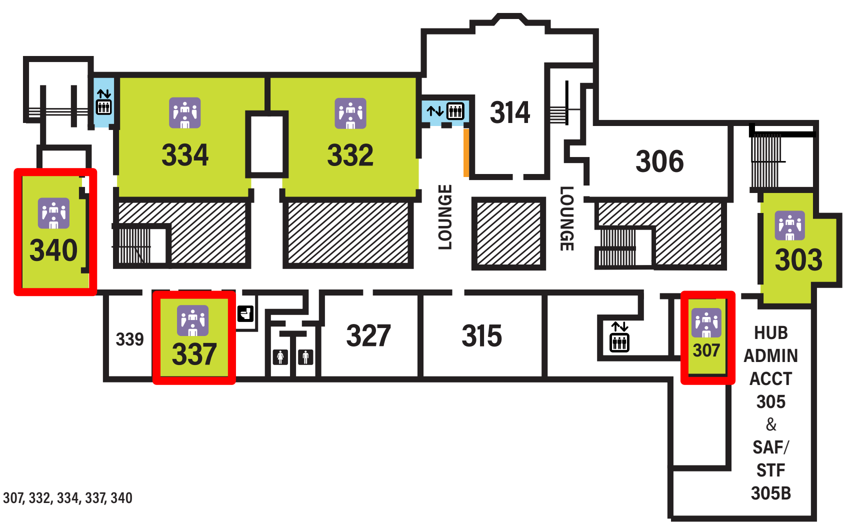
FIRST FLOOR



Meeting Rooms	214, 238, 250
Event Spaces	
211 - Ballroom	
(North: 211A) (South: 211B)	
203 - North Prefunction	211C - North Food Staging
245 - South Prefunction	211E - South Food Staging
Student Veteran Life	206
Student Activities Office	232
Office of Fraternity & Sorority Life	236

Bulletin Board — Public Elevator

SECOND FLOOR



Meeting Rooms	303, 307, 332, 334, 337, 340
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D Center	327
Office of the Ombud	339

Bulletin Board — Public Elevator

THIRD FLOOR

Mountaineers Club (Top of Graduate)

Off the Rez (Burke Cafe)

Arepas Venezuela
Agua Verde
Big Time Brewery and Alehouse
Byrek and Baguette
Cedars
Guanaco's Tacos Pupuseria
Just Burgers
Kitanda Espresso and Acai
Meraki Tea Bar
MOD Pizza
Morsel
My Favorite Deli
Pho Shizzle
Portage Bay Cafe
Schultzy's Bar
Shawarma King
Sizzle and Crunch
Sweet Alchemy Ice Cream
Taste of India
Thai Tom
Xi'an Noodles

Higher End Restaurants and Shopping down the hill from the Burke at the University Village (bus lines run there, and it's a 15-20 minute walk):
Bamboo Sushi
Din Tai Fung
Hokkaido Ramen Santouka
Homegrown
Mas Veggies Vegan Taqueria

Schedule of Events ~ Overview

Monday – April 3	US Pacific Time (UTC)	Location
Registration	19:00–22:00 (02:00–05:00)	Graduate-Quimby Room
Tuesday – April 4		
Workshops and Field Trips-Morning	Various Times	Various Venues
Workshops and Field Trips-Afternoon	Various Times	Various Venues
Registration	19:00–22:00 (02:00-05:00)	Graduate-Quimby Room
Wednesday – April 5		
Registration	07:00–08:00 (14:00-15:00)	HUB-Lyceum
Symposium	07:55–17:00 (14:55-00:00)	HUB-Lyceum
Opening Reception	18:30–21:30 (01:30-04:30)	Burke
Thursday – April 6		
Workshops-Session 1	08:30–10:00 (15:30-17:00)	Various Venues
Break	10:00–10:30 (17:00-17:30)	On your own
Workshops-Session 2	10:30–12:00 (17:30-19:00)	Various Venues
Lunch	12:00–13:30 (19:00-20:30)	On your own
Workshops-Session 3	13:30–15:00 (20:30-22:00)	Various Venues
Break	15:00–15:30 (22:00-22:30)	On your own
Workshops-Session 4	15:30–17:00 (22:30-00:00)	Various Venues
Poster Session	18:00–20:00 (01:00-03:00)	Graduate-Wright Ballroom
Trivia	20:00–22:00 (03:00-05:00)	Graduate-Wright Ballroom
Friday – April 7		
Oral Presentations	08:55–16:30 (15:55-23:30)	HUB-Lyceum
Business Meeting	16:30–17:00 (23:30-24:00)	HUB-Lyceum
Closing Banquet	18:00–22:00 (01:00-05:00)	HUB-North Ballroom
Saturday – April 8		
Field Trips	Various Times	Various Venues

GatherTown is our virtual conference space. This year's oral presentations, posters, and a select number of workshops in addition to all of the platform presentation pre-recordings and poster files from 2021 and this year for you to view.2021 virtual meeting content can be found on GatherTown. The space is available to **all** paid registrants April 3 through May 2. 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.

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

Be-leaf-able Plant Preparation

Classroom:
Workshop leaders will present case studies on plant fossil collection and preparation methods and techniques from five very different plant fossil sites: Florissant Formation in Colorado, Emerald Creek Lagerstätte in Idaho, Hell Creek area in Montana, Jose Creek in New Mexico, and the Clear Fork Formation in Texas. Our presentation will cover the entire journey of plant fossil collection including excavation and field prep, lab preparation (i.e., removal of matrix by air scribe and pin vise, adhesives and consolidants, labeling, etc.), and concluding with storage environment and housing. This workshop is aimed at all levels, especially beginners to plant preparation and fossil preparation, in general. There will be ample time for discussion during the classroom session and sharing of lessons learned and best practices.

Hands-on Demonstration:
Our workshop will also include some hands-on demonstration of plant fossil preparation. This portion of the workshop will include demonstrations and hands-on application of adhesives and consolidants along with different methods of matrix removal. There will be opportunity for further discussion during this portion of the session, depending on time and interest.

We will provide examples of plant fossils from a few different lithologies for demonstration and practice. We will provide materials, equipment, and PPE (borrowed from the Burke Museum) but ask that participants wear closed-toed shoes and long pants for this portion of the workshop.

Roundtable:
This last session of the workshop will entail a roundtable discussion where participants are welcome to bring their questions or issues concerning preparation of plant fossils. We will discuss best practices and lessons learned and hope to share community knowledge.

Facilitators:

Alex Lowe
Burke Museum
Seattle, Washington, USA

Mariah Slovacek
Perot Museum
Dallas, Texas, USA

Conni O'Connor
Florissant Fossil Beds National Monument
Florissant, Colorado, USA

Paige Wilson Diebel
Burke Museum
Seattle, Washington, USA

08:30–12:00 PT (15:30-19:00 UTC)	Burke Museum – Paleo Alcove (3rd Fl)	Hybrid
13:30–17:00 PT	Burke Museum – Paleo Alcove (3rd Fl)	In-Person Only

Fossil Preparation 101

This workshop will cover the basic concepts of fossil preparation including, basic explanation of what preparation is, basic discussion of the agents of deterioration, a brief history of preparation and conservation, 14 essential competencies of preparation, and basic health and safety considerations for any preparation lab.

Facilitator:
Patrick Wilson
South Dakota School of Mines and Technology
Rapid City, South Dakota, USA

08:30–12:00 PT (15:30-19:00 UTC)	Graduate – Quimby Room	Hybrid
13:30–17:00 PT (20:30-00:00 UTC)	Graduate – Quimby Room	Hybrid

Paleohistology

This workshop teaches hands-on skills on how to make thin sections of fossilized hard tissues. The processes of embedding bones into epoxy, sectioning on a precision saw, mounting specimens onto slides, and grinding slides on a lapidary wheel to optical clarity will be covered. This workshop is an introduction to the machinery needed to start a histology lab and help troubleshoot the specific challenges that different fossils present (e.g., heavily permineralized material, dark vs. light fossils, porous or fractured specimens, etc.). Fossil specimens will be provided.

Facilitator:
Zoe Kulik
Burke Museum
Seattle, Washington, USA

08:30–17:00 PT	Depart from Burke Main Entrance at 08:15	In-Person Only

Polyethylene Glycol and Its Uses in Fossil Preparation and Conservation

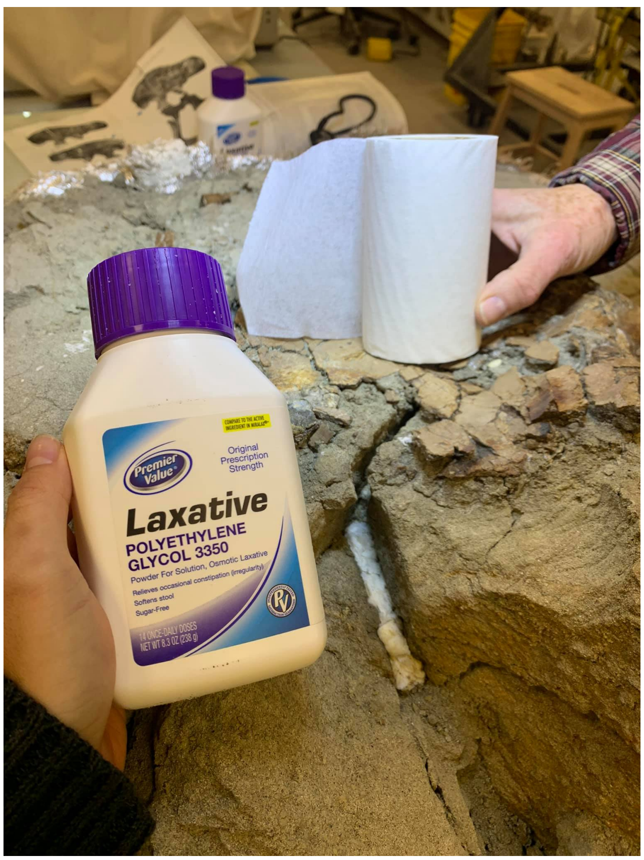
Polyethylene Glycol (PEG, also known by the trade name Carbowax) is a common substance used to consolidate and support fossils during preparation. It is safe to handle, easily accessible and affordable, reversible, and when used correctly allows for preparation of very fragile or small fossils. However, poorly thought through use of PEG can result in disastrous consequences for fossils. This workshop will cover where and how to purchase PEG, the grades of PEG available and their properties, various application methods and uses of PEG, and how to safely remove it from fossils. There will be additional time to practice safe embedding and removal of specimens.

Facilitators:

Kelsie Abrams
Burke Museum
Seattle, Washington, USA

JP Cavigelli
Tate Museum
Casper, Wyoming, USA

08:30–12:00 PT	Burke Museum – Paleo Alcove (3rd Fl)	In-Person Only
13:30–17:00 PT	Burke Museum – Paleo Alcove (3rd Fl)	In-Person Only



Schedule of Events – Tuesday, April 4

Pre-Meeting Field Trips

University of Washington Libraries Conservation Center

Take a behind-the-scenes look at the UW Libraries state-of-the-art Conservation Center. Conservation staff will lead a tour and show examples of the rare books, manuscripts, prints and drawings that they are working to preserve, including examples of unusual boxes and housing solutions.

In 2016 UW Libraries completed construction of a new conservation facility to provide care for book and paper materials throughout the 9-million item collection. The 4,000 square foot facility has a wet lab equipped for chemical treatments, washing, humidification and light bleaching, photo documentation and examination equipment, custom storage, and more. The result is an inspiring amalgam of traditional and contemporary equipment for the conservation and preservation work that provides stewardship and access across the Libraries' diverse collections.

Transportation: Walking through the UW campus to Suzzallo Library. The Conservation Center is on the 5th floor of Suzzallo Library. Use the main entrance off of Red Square and go to the bank of elevators just past the grand staircase, go up to the 5th floor, the conservation center is room 560. Fifteen minute walk from the hotel to the Library.

Depart Graduate Hotel Lobby at 10:30 PT, 15 minute walk
Tour: 11:00 – 12:00 PT

Seattle Art Museum (SAM)

The SAM collections include thousands of works of art from a spectacular range of ancient, historical, and modern cultures. SAM conservators ensure that the museum provides an appropriate environment for these works and perform treatment when necessary. Participants will be able to see the behind-the-scenes Conservation Lab at the SAM. Conservators work on a variety of projects at the SAM and AMMP participants will be able to get an understanding of the materials and considerations taken when working on various historical and modern objects.

Info on SAM Conservation Lab: https://www.seattleartmuseum.org/collections/conservation

Transportation: Participants will take a train ($2.75 one way, $5.50 round trip per person) to SAM. Includes six minutes of walking to train stations, 20 minute commute one way. Transportation to be paid individually by each participant.

Directions To SAM: Walk from Graduate Hotel to the U District Light Rail Train station (1 block). Take the 1-Line Angle Lake train, it runs every 10 minutes. Four stops later, get off at the University Street Station. Walk 440 feet to the SAM.
Return: Walk from the SAM to the University Street Station. Get on the 1-Line Northgate train. Four stops later, get off at the U District Station. Walk 1 block to the Graduate.

Morning:
Depart Graduate Hotel Lobby at 09:15 PT
Tour: 10:00 – 11:00 PT

Afternoon:
Depart Graduate Hotel Lobby at 12:15 PT
Tour: 13:00 – 14:00 PT

SAM SEATTLE ART MUSEUM

Schedule of Events – Wednesday, April 5

Symposium ~ HUB – Lyceum

07:00 – 08:00 PT	REGISTRATION
08:00 PT (15:00 UTC)	WELCOME/ANNOUNCEMENTS
08:30 PT (15:30 UTC)	Different Ways of Knowing to Enhance Science Collaboration Polly Olsen
09:00 PT (16:00 UTC)	Demystifying Decolonization and Paleontology Aaron McCanna
09:30 PT (16:30 UTC)	How to Create a Field Work Environment that is Welcoming and Safe for Female Presenting Participants Hillary McLean and Marilyn Fox
10:00 PT (17:00 UTC)	BREAK
10:30 PT (17:30 UTC)	Changing How We View Conservation Efforts while Making Palaeontological Field Experiences More Sustainable and Inclusive along the Bay of Fundy Danielle Serratos
11:00 PT (18:00 UTC)	Before the Pharaohs: Breaking New Ground in the Study of Egypt's Ancient Prehistory Sanaa El-Sayed
11:30 PT (18:30 UTC)	Collaborative Fieldwork in the Global South: Building Relationships, Avoiding 'Parachute Science', and Preserving Natural History Resources Christopher Griffin
12:00 PT (19:00 UTC)	LUNCH
13:30 PT (20:30 UTC)	Science with a Social Conscience and the Mahajanga Basin Project: Finding Dinosaurs and other Late Cretaceous Vertebrate Fossils, Building Paleontological Infrastructure, Training Graduate Students, Engaging the Public, and Helping Kids in Madagascar David W. Krause* and Patrick M. O'Connor
14:00 PT (21:00 UTC)	Collecting Fossils at the Bottom of the World: Vertebrate Paleontology in Antarctica Christian Sidor
14:30 PT (21:30 UTC)	Collecting Late Cenozoic Mammals in Himalaya: Challenges in High Elevation and Extreme Environment Xiaoming Wang
15:00 PT (22:00 UTC)	BREAK
15:30 PT (22:30 UTC)	PANEL Q&A DISCUSSION

*Presenting Author

Fieldwork Challenges and Global Perspectives: Diversity, Equity, Access, Inclusion (DEAI) and Decolonization in Paleontology

Diversity, equity, access, inclusion, and decolonization permeate both museum and field experiences in paleontology. This symposium seeks presentations that discuss the unique challenges of developing DEAI practices in museums, different perspectives and field experiences from around the globe, and "teachable moments." Field experiences worldwide have unique access challenges and special experimental techniques developed for different regions, whether in physically removing specimens from the ground or supporting and collaborating with local communities. Museum experiences may highlight the development of anti-hate speech policies, how diversity is being increased among staff, and how paleontology can respect and incorporate indigenous ways of knowing.

DIFFERENT WAYS OF KNOWING TO ENHANCE SCIENCE COLLABORATION

Polly Olsen
University of Washington Burke Museum, Seattle, Washington, United States of America
polly@uw.edu

This presentation will be a guided framework on decolonization. We will explore the concepts of community relationships, storytelling, and dissemination of information. We will take a learning adventure to identify who is missing from the conversation and why. How can we invoke collectivism and co-create in the field of Paleontology? This talk will introduce topics to open up conversation on how to collaborate with local communities and understand the necessity of engaging in tribal consultation. There will be an accompanying facilitated roundtable to continue discussing these concepts.

DEMYSTIFYING DECOLONIZATION AND PALEONTOLOGY

Aaron McCanna
University of Washington Burke Museum, Seattle, Washington, United States of America
amccanna@uw.edu

Decolonization as a term is used in many fields and areas, and in many ways. Specifically in regards to paleontology, many might struggle to see how the concept is relevant to the field of paleontology, and to the everyday lives of those who work in the field. This talk will briefly describe how Aaron McCanna (Decolonization Coordinator at the Burke Museum) conceptualizes the term, why it is applicable to the field of paleontology, and provide some simple ways to begin the generations-long journey of decolonization in a way that benefits everyone.

Some of the primary questions this talk will address are: What is decolonization, actually? How does it apply to paleontology? How can someone start this process?

HOW TO CREATE A FIELD WORK ENVIRONMENT THAT IS WELCOMING AND SAFE FOR FEMALE PRESENTING PARTICIPANTS

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In Paleontology, fieldwork is a massive component and for many people represents a large portion of their career experiences. In the last 20 years, women or female presenting paleontologists have grown as participants in fieldwork programs. However, the majority of field crews have a minority of women participants, and an even smaller number of these field crews are actually run by women. It is an unfortunate fact that a lot of backcountry or small rural towns do present a real and hostile danger to woman participants. Therefore, it is imperative that anybody doing any sort of paleontology fieldwork, whether identifying as male or female, be actively engaged in educating themselves on the hurdles that women face in the field and how to create a safe and welcoming environment for all field work participants

A major concern, especially to inexperienced female participants, is how to take care of bodily needs while out in the field. This can include bathroom needs, bathing, and how to safely and comfortably menstruate. For example, leaders need to know what sort of menstrual products should be present as a regular part of a field first aid kit, how debilitating period cramps can be, and proper procedures of used sanitary product disposal. Leaders should have a frank discussion of bathroom protocols, such as 'pack it in, pack it out' and other good Leave No Trace backcountry habits. Suggestions and tips about handling any of these subjects from more experienced members are welcomed by those who are less experienced. It is extremely important when creating a field work environment that welcomes a diverse group of people to be knowledgeable about, and to openly and clearly discuss sensitive subjects prior to leaving for the field. These discussions can go a long way toward making all participants feel welcomed and ready for the field experience.

Another major concern of female participants with fieldwork also includes feeling uninvited, excluded, bullied, or talked over. This sort of experience can be greatly reduced or removed from camp culture by having strong and clear guidelines with emphasis on anti-bullying, anti-harassment, and deliberate acknowledgement of other voices being heard. It is important for field leaders to recognize differing physical strengths and capabilities; these should never be used to make participants feel less able or less valuable.

Although no one would want to experience being attacked or assaulted while participating in fieldwork, a hard truth is that these events do happen. A strong and precise plan should be developed and discussed with the entire crew beforehand and maintained when such events occur. Thorough documentation helps to prevent future issues and allows all participants to continue to feel safe and welcome in field camp experiences.

Through examples and discussion, this talk aims to make the fieldwork experience safer for all and easier to plan by camp leaders while including all participants regardless of their gender, origin or level of experience.

CHANGING HOW WE VIEW CONSERVATION EFFORTS WHILE MAKING PALAEONTOLOGICAL FIELD EXPERIENCES MORE SUSTAINABLE AND INCLUSIVE ALONG THE BAY OF FUNDY

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Smaller rural science museums often struggle with gathering the needed resources each year to have a successful field season. Lack of adequate funding affects the ability to secure the necessary staff and equipment needed to conduct research, while museums in remote locations often lack amenities desirable to a potential workforce. The Fundy Geo Museum is a small, provincial government museum in Nova Scotia that is two hours from city amenities but sits along the coast of the world-famous Bay of Fundy, home to the world's highest tides. Field sites all along the shoreline surrounding the Fundy Geo Museum are where Canada's oldest dinosaurs are found and the flora, fauna, and ichnofauna of the Triassic-Jurassic boundary are stunningly preserved. Unfortunately, due to the tidal nature of these areas, field sites are inaccessible for six hours, twice per day, every day. The cliffs that make up the shoreline along the Bay of Fundy are under constant erosion, which is a double-edged sword as they regularly expose new fossil material which are then subject to the tides, cliff collapse, and storms along the coast. This raises the question, how does an underfunded museum in a remote location manage to collect and conserve this steady supply of fossil materials before they are lost to the sea? The Fundy Geo Museum has attempted to increase our observation and collection of fossils by engaging citizen scientists to collaborate with our efforts in numerous ways, including paid opportunities, volunteer efforts, and hands-on educational programming. The most unique experience we offer is the Fossils on Horseback half-day excursion, where guests ride to and from the field site on horseback and spend hours sieving through McCoy Brook Sandstone for 200-million-year-old dinosaur and reptile fossil remains. Other programs that guests pay to participate in include weekly walking trips to active field sites that are open to the public as well as private group tours. Local community members and research collaborators often assist in summer field activities as well, but the grade-school outreach field excursions that target underrepresented students in STEM are by far the most impactful and meaningful field work we accomplish each year. All these efforts combined have increased the amount of time spent assessing and excavating fossil materials at our field sites while maintaining rigorous standards and utilizing best practices for fossil collecting. This has resulted in numerous finds and publications of life that lived prior to the End Triassic Mass Extinction as well as fauna that started the explosion of diversity that is characteristic of the Age of Dinosaurs. They also provide a substantial amount of revenue for the Museum, community goodwill in terms of promoting local tourism, and create increased opportunities for the public to contribute to modern scientific discoveries.

BEFORE THE PHARAOHS: BREAKING NEW GROUND IN THE STUDY OF EGYPT'S ANCIENT PREHISTORY

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Mansoura University Vertebrate Paleontology center (MUVP) is a research unit within the Department of Geology at Mansoura University. It was created in 2010 to be a pioneer center in the Egyptian universities and institutions. Since its foundation, MUVP has become a center for the study of fossil vertebrates where students and researchers can exchange ideas and collaborate on projects that build upon Egypt's fascinating geological past. Before the establishment of the MUVP, vertebrate paleontological research took place in Egypt at scattered institutions, but there was not a broader community of Egyptian paleontologists working in collaboration with each other to explore Egypt's vertebrate fossil record. MUVP has made extraordinary contributions to scientific understanding of the vertebrate paleontology of Egypt in a series of publications led by Egyptian students, and indeed, the entire Middle East region as a whole. These publications have been diverse in scope, ranging from Late Cretaceous dinosaurs to Oligocene mammals, with other groups (e.g. fishes) or questions (e.g. stratigraphy) sprinkled in between. Furthermore, MUVP has attracted a large group of enthusiastic postgraduate Egyptian students, both men and women, who are eager to make new paleontological discoveries and participate in the analysis and description of those discoveries.

MUVP center has had great success engaging young Egyptian students and volunteers in paleontological research related to the different projects outlined above as part of its international scientific collaborations. MUVP has been teaching classes in vertebrate paleontology to undergraduate and postgraduate students at four different Egyptian universities and also directly advising numerous projects for senior undergraduate students. Seven Egyptian postgraduate students have engaged in MUVP projects primarily under supervision of Dr. Sallam; four of them are currently Assistant Lecturers at Mansoura University, Assiut University, Alexandria University, and Banha University. These MUVP-trained scientists will go on to deliver their specialized knowledge at several Egyptian universities.

Another critical aspect of MUVP work is its public outreach through social media. Previously, there were no highly trained vertebrate paleontologists who were able to explain new discoveries — in Arabic — to interested students in the Middle East and North Africa. MUVP has come to play a pivotal role in helping to raise awareness of paleontological stories that are circulating in the media, and explaining those advances in Arabic, free of the jargon that can serve as a major impediment to learning and comprehension. Moreover, MUVP has served as a consultant for the Jebel Qatrani open air museum and Wadi Hitan Fossil and Climate Change Museum in collaboration with the Egyptian Environmental Affairs Agency (EEAA) and the United Nations Development Program (UNDP).

COLLABORATIVE FIELDWORK IN THE GLOBAL SOUTH: BUILDING RELATIONSHIPS, AVOIDING 'PARACHUTE SCIENCE', AND PRESERVING NATURAL HISTORY RESOURCES

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Paleontology has often been an extractive colonial science, with foreign researchers from more resource-rich countries (often, but not always, western Europe and the USA) advancing their country's scientific output with fossils permanently removed from resource-limited countries. This often occurs with little to no input from or interaction with local populations, nor are resources provided to help these populations pursue their own independent research and curation programs. Every country and situation is different, and there are rarely any set rules that fit every context; however, the principles of open communication, scientific honesty, and the ideal of creating a truly global science can help to guide conduct. For this presentation, I will reference my own experience conducting fieldwork in Zimbabwe in collaboration with the Natural History Museum of Zimbabwe. I will speak about how this collaboration began, and how we have continued to work on scientific research, capacity building for the Museum, and Zimbabwean student education, highlighting the things I have learned and mistakes I have made along the way. I will also speak about the challenges we have had in conducting fieldwork in Zimbabwe, and how we have overcome these challenges. Not only were my Zimbabwean colleagues' knowledge and expertise critical to the scientific outcomes we have seen thus far, but learning from them has been both personally and professionally enriching. Building relationships with scientists from around the world and contributing to institutional capacity building helps to make paleontology more global and equitable, and is an important but often overlooked part of our collective scientific legacy.

THE MAHAJANGA BASIN PROJECT: FINDING DINOSAURS AND OTHER LATE CRETACEOUS VERTEBRATES AND PARTNERING TO DEVELOP PALEONTOLOGICAL INFRASTRUCTURE, TRAIN GRADUATE STUDENTS, ENGAGE THE PUBLIC, AND HELP COMMUNITIES IN MADAGASCAR

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The Mahajanga Basin Project (MBP), focused on the discovery and analysis of fossil vertebrates from the Late Cretaceous of northwestern Madagascar, was initiated three decades ago. The resulting assemblage of vertebrate fossils, collected over the course of 13 expeditions, consists of ~25,000 specimens, many of them exquisitely preserved skulls and skeletons. In some cases, soft tissues are even preserved (e.g., ossified tendons, keratin on claw sheaths, feather shafts, costal cartilages). The sample includes some of the most complete and best-preserved specimens for entire clades of vertebrates from the southern supercontinent of Gondwana. Almost all major terrestrial and freshwater vertebrate groups living on southern landmasses at the time are represented: cartilaginous, lobe-finned, and ray-finned fishes, frogs, turtles, lizards, snakes, crocodyliforms, sauropod and non-avian theropod dinosaurs, birds, and mammals.

The MBP continues to have as its major scientific goals:

1. To discover, collect, conserve, curate, and document a well-dated series of Late Cretaceous vertebrates from the Mahajanga Basin;
2. To describe and study the paleobiology of vertebrate taxa in the fauna and the paleoecology of the fauna as a whole;
3. To conduct rigorous phylogenetic analyses of the taxa we have discovered, and to use those analyses in tests of biogeographic and plate tectonic hypotheses, as they relate to the fragmentation of Gondwana in general and the isolation of Madagascar in particular; and
4. To elucidate and refine the stratigraphy, sedimentology, and taphonomy of Upper Cretaceous strata of the Mahajanga Basin and to reconstruct the paleoenvironments represented in the various rock units.

To date, one family, 20 new genera, and 21 new species of fossil vertebrates from the Late Cretaceous of the Mahajanga Basin have been named and described, many of which exhibit uniquely bizarre adaptations hypothesized to be the result of lineage evolution in isolation on Madagascar for tens of millions of years. A faunal list is provided in Krause et al. (2020: table 2). Several more new taxa (e.g., one fish, two crocodyliforms, two birds) are currently being described. The sample of fossil vertebrates has resulted in substantial scientific output — 118 peer-reviewed scientific articles, four monographic volumes, and 169 conference presentations. Specimens in this collection have been or are currently on display in 36 institutions in Madagascar, North America, Europe, and Asia. Recent overviews of the research resulting from the MBP are provided in Krause et al. (2019, 2022).

Concurrently, the MBP has also undertaken several education and outreach initiatives and continues to have as its major science-adjacent goals:

1. To develop and maintain a robust, transparent, and mutually beneficial collaborative framework with various Malagasy governmental agencies, institutions of higher education, and individual researchers;
2. To enhance in-country research infrastructure and promote human resource skills development in research methods, technical expertise, and natural history collections care;
3. To collaborate with scientists and educators to advance general public knowledge and science literacy on the deep-time natural history of Madagascar; and
4. To work with local organizations and international partners on best practices for, and the implementation of, healthcare and educational efforts in rural, underserved areas of Madagascar.

The MBP could not address its multi-pronged science and science-adjacent goals without developing strong collaborations with various Malagasy entities including national, regional, and local governments, the University of Antananarivo, and local communities. Collaboration has taken several forms, as detailed below.

<u>Collaboration Agreements</u>

A series of collaboration agreements with the University of Antananarivo (UA) and various ministries of the Malagasy government have many components but they stipulate that all specimens can be exported from the country in order to prepare them out of the rock, for which Madagascar does not currently have the preparation laboratories, specialized equipment, and trained personnel. It also stipulates that all holotype specimens and one-half of the remaining specimens must be returned to Madagascar upon completion of study, with the other half reposited in U.S. institutions. We regard this as an academic partnership with our Malagasy colleagues, and we aspire to have it serve as a model for collaborative collection sharing between developed and developing countries, to facilitate access for scientific study both in Madagascar and the U.S., and by researchers around the world. We have sought earnest and sustained engagement and robust, mutually beneficial collaboration across national and economic boundaries in the context of both late 20th and early 21st Century expeditionary science (e.g., Raja et al., 2022).

The MBP was recently awarded a collections grant from the Division of Biological Infrastructure of the National Science Foundation (NSF). Because Stony Brook University, where the project was initiated, does not have an accredited museum, the

Field Museum (Chicago, IL) was selected as the U.S.-based repository (between 1993–2015) for representative specimens from the project—this was chosen as one of us (DWK) was (and still is) a Research Associate at the Field Museum. Coincident with the beginning of DWK's employment at the Denver Museum of Nature & Science (DMNS) in 2016, specimens are now being divided between UA and DMNS. The objectives of the NSF grant are to prepare, conserve, rehouse, and catalog all specimens, whether reposited at UA, the Field Museum, or DMNS, to modern museum standards, to the point that they can be maintained in perpetuity by collections management personnel. We endeavor to make the specimens more accessible to current and future generations of researchers (including colleagues and students in Madagascar), as well as for educational and public engagement opportunities. Digital datasets derived from CT scans, μCT scans, and surface scans, will be (and have been) made available via the NSF-supported repository MorphoSource and specimen records will be exported to data aggregators such as the Integrated Digitized Biocollections (iDigBio) and the Global Biodiversity Information Facility (GBIF).

Building Paleontological Infrastructure in Madagascar

To enhance the prospects that the specimens to be returned to Madagascar will be conserved in perpetuity, we have built a two-room collections facility, as well as a classroom and a collections manager's office, at the University of Antananarivo (UA). This was funded by Stony Brook University and inaugurated in 2015. In 2016, the Denver Museum of Nature & Science (DMNS) donated 80 gently used Steelcase specimen cabinets to the facility as well as to the Ministry of Mines. Specimens have been and will be returned to Madagascar in a state in which our Malagasy colleagues and students, and any visiting scientists, can further study them. After various delays, including COVID-mediated travel restrictions, historic MBP collections that were already returned to Madagascar were transferred into the collections facility in autumn 2022.

In addition, because scanning equipment is currently unavailable in Madagascar, it is important that 3D digital data (via surface or CT/μCT scans) of the most significant UA specimens be obtained, especially the holotypes, prior to their return, so that digital dataset access can be provided to colleagues both in Madagascar and the U.S., and researchers world-wide, through on-line repositories such as MorphoSource. Surface scanning resolution has improved to a point that, for most specimens, it is a desirable replacement for more labor- and materials-intensive molding/casting, a process that places specimens at relatively high risk of damage. Previous U.S.-based work by technician J. Groenke resulted in molds and casts of 200 of the more robust UA specimens. We now have plans to surface scan several hundred more and to CT- or μCT-scan approximately 30 specimens preserving critically important internal morphology (e.g., endocranial cavities, inner ears, nasal cavities).

Training Opportunities and Collaborative Involvement

The MBP has provided, and continues to provide, undergraduate and graduate students, as well as young professionals, formal and informal training opportunities. In particular, we are strongly involved with our colleagues at the University of Antananarivo in providing training to Malagasy graduate students. This has been accomplished through participation in field work (including training in field methods), by serving on student committees, bringing students to the United States, and providing seminars and workshops in Madagascar. To date, 32 Malagasy graduate students and young professionals have participated in field expeditions (nine of them multiple times) and received extensive training in paleontological field techniques. Significantly, seven Master's theses and three Ph.D. dissertations have also been completed by Malagasy graduate students as part of the MBP and under the direct supervision of project scientists. Finally, our Malagasy colleagues and students have participated in a broad range of research projects, resulting in co-authorship on 34 peer-reviewed papers; we fully expect this number to rise as more students receive training.

Moreover, with funding from the David B. Jones Foundation we are now fully engaged in providing collections management and fossil preparation training for Malagasy colleagues and students here at the DMNS. Two individuals completed two months of collections management training in late 2022 and one individual is spending all of 2023 learning fossil preparation techniques at the DMNS.

Public Engagement in Madagascar

Public engagement is a key component of the MBP. Our Malagasy colleagues and we feel that it is essential for the Malagasy public to become more aware of their rich natural heritage. We are also on record concerning the importance of keeping the island's vertebrate fossils in the public domain by curtailing the illegal collection and trade of such fossils (Krause et al., 2006). Public engagement has taken several forms. We have:

1. Erected informational roadside displays about our discoveries in our primary field area along Route Nationale 4, a major thoroughfare between the capital city of Antananarivo and the coastal city of Mahajanga.
2. Donated casts of skulls and mounted skeletons. These casts are, or have been, on display at the University of Antananarivo, the University of Mahajanga, the Ministry of Mines, and the Presidential Palace (there is no national natural history museum in Madagascar).
3. Published an 8-page, glossy, color booklet entitled "The Dinosaurs of Berivotra", which is translated into Malagasy ("Ny Dinaozaaoro ao Berivotra") and distributed for free in Madagascar.
4. Given numerous public talks at universities and various other organizations in Madagascar.
5. Provided countless interviews to the Malagasy media (television, radio, newspapers, magazines, internet).

Helping Local Communities in Field Areas

We have engaged with local communities in our field study areas, most of which are in very remote regions where education and healthcare are sparse to non-existent. To assist in these endeavors, in 1996 we established the Madagascar Ankizy Fund ("ankizy" means "children" in the Malagasy language), a not-for-profit 501(c)3 organization whose mission is to provide education and healthcare for children living in remote field research areas. The organization is administered through the Stony Brook Foundation of Stony Brook University.

To date, the Madagascar Ankizy Fund (www.ankizy.org) has built six schools, five elementary and one secondary. Although two schools have been donated to other entities, we continue to maintain and operate four of them, which currently serve approximately 1,000 students. We also support high-achieving students to continue their education in high school and university in the nearest major city, Mahajanga, with food, lodging, supervision, and supplemental tutoring. Several students from the village in our primary field area, in which no children were receiving an education when we began working there in 1993, have now graduated with university degrees. Recently, the Madagascar Ankizy Fund has supported sustainability projects initiated by university graduates. In particular, it has provided seed funding for a women's permaculture association and also is funding the specialized training for one of the university graduates who will establish a fish farm in the primary field area surrounding the village of Berivotra.

The Madagascar Ankizy Fund has also sponsored monthly medical clinics staffed by Malagasy physicians and annual dental clinics staffed by faculty and students from Stony Brook University; the latter was suspended during the COVID-19 pandemic. These efforts have saved many lives. Other healthcare initiatives included a solar water disinfection system that provides clean water for a region with about 24,000 people. Providing clean water in such areas has the ability to reduce deaths from diarrheal disease in children five and under by one-half. We have also distributed mosquito netting to curb malarial infections, provided pre-natal vitamins to expectant mothers, and renovated an orphanage.

Long-term Prospects and Goals

Madagascar is a developing country, one of the very poorest in the world. As such, sustainability represents the most critical issue for MBP initiatives. This includes the development of in-country expertise for continuing and expanding scientific and educational efforts while also stewarding natural history collections (Miller et al., 2020) developed over the course of the project. We will therefore continue to work with our Malagasy partners to further develop paleontological infrastructure in Madagascar, assist with graduate student training, engage the public about the island's rich natural heritage, and help the ankizy in our field areas with both education and healthcare.

Acknowledgements

We are deeply grateful to the government of the Republic of Madagascar for the ability to conduct research on the island. We also thank our many colleagues, past and present, at the University of Antananarivo; the staff of the Madagascar Institute for the Conservation of Tropical Environments; and the villagers living near our study areas in the Mahajanga Basin for the last three decades of collaboration and logistical support; all expedition members for their hard work, long hours, and good humor in the field; and the National Science Foundation, the National Geographic Society, the Dinosaur Society, the David B. Jones Foundation, Stony Brook University, the Denver Museum of Nature & Science, and Ohio University for funding and other support.

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COLLECTING FOSSILS AT THE BOTTOM OF THE WORLD: VERTEBRATE PALEONTOLOGY IN ANTARCTICA

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Vertebrate fossils were first discovered in the Triassic Fremouw Formation of Antarctica in 1967. Since then, paleontologists have conducted nine seasons of fieldwork totaling approximately 58 weeks in the Transantarctic Mountains, with over 1300 Antarctic vertebrate fossils now cataloged. The austral summer, when fieldwork takes place, features 24 hours of daylight, but storms and fog are not uncommon and can hamper helicopter-assisted fieldwork. The most recent expedition investigating Fremouw strata took place in the Shackleton Glacier region during 2017–2018 and resulted in relocating old localities, as well as collecting some of the best preserved material collected to date, including the first identifiable fossils from the middle member of the Fremouw Formation.

Given the high latitude, high elevation, and consistently freezing conditions of Fremouw outcrops in the Transantarctic Mountains, a variety of techniques have been used to collect vertebrate fossils, with varying degrees of success. In this presentation I will discuss fieldwork logistics, successful collecting techniques, as well as the results of some recent preparation efforts on Fremouw fossils.

COLLECTING LATE CENOZOIC MAMMALS IN HIMALAYA: CHALLENGES IN HIGH ELEVATION AND EXTREME ENVIRONMENT

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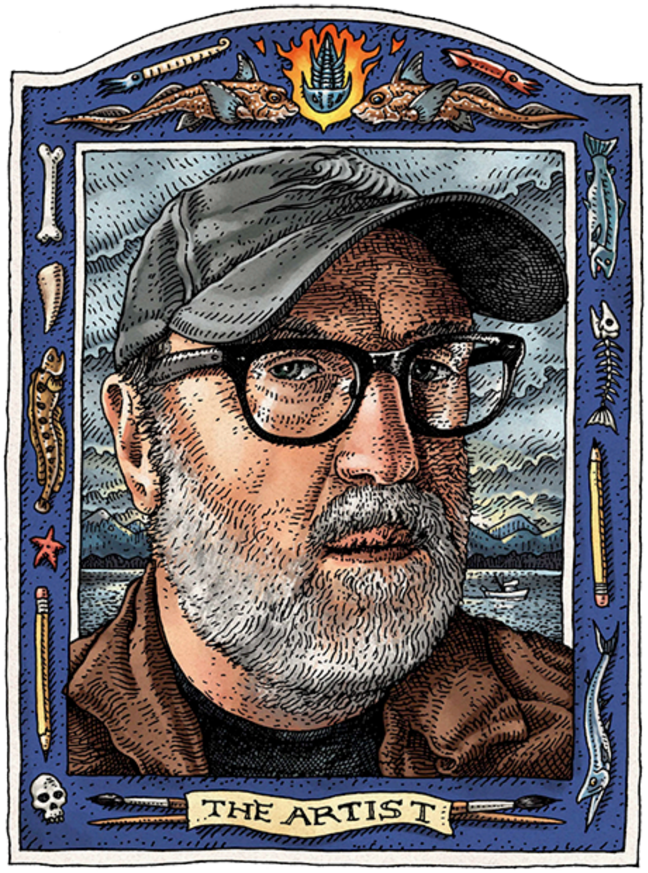
Led by the Natural History Museum of Los Angeles County and Institute of Vertebrate Paleontology and Paleoanthropology (IVPP, Chinese Academy of Sciences), a team of vertebrate paleontologists, geochemists, and supporting staff mounted four expeditions to Zanda Basin at the northern foothills of the Himalaya Mountains in 2006-2012. Our Sino-American expedition team were the first professional vertebrate paleontologists to work in this remote region of southwestern Tibetan Plateau. Zanda Basin was previously inaccessible due to its remoteness (~1,500 km from Lhasa) and lack of paved road, difficulty in obtaining permits, and prohibitive costs for small, independent teams. A window opened in the 2000s and early 2010s when infrastructure buildup, improvements in regulatory environment, and increase of science spending in China converged to make the Zanda expeditions possible.

At an elevation of 3,800-4,500 meters asl, Zanda Basin produces some of the highest-elevation mammals in Asia. At these altitudes, physical challenges in field work include low temperature (hypothermia), low oxygen (hypoxia), high UV radiation, and unpredictable weathers. Working in the warm summer season can (usually) mitigate cold weathers but hypoxia is a constant presence. Physical fitness of team members was essential and so was being prepared, such as bringing oxygen tanks in case of high-altitude sickness. We also adopted a regiment of gradual acclimatization, spending a week in relatively lower altitude Qaidam Basin (3,000 m asl) before moving to high elevations. In addition to the challenge of the physical environments, other logistical obstacles include obtaining work permits and field supplies in remote locations.

The above challenges came to the fore when we discovered a complete skull and lower jaw (later became holotype) of an ancestral woolly rhinoceros, *Coelodonta thibetana*, near the end of the 2007 field season. Excavating and jacketing this specimen within a few days required overcoming shortages of plasters and cotton gauze (burlap being not available), while juggling with illness (and hospitalization) of our Tibetan driver. The jacket was made extra difficult due to the fact that it must survive a 5,000+ km journey back to lab in Beijing, often along bad (or no) road (local materials were used for reinforcements, including bamboo chopsticks). Overall, we had been cautious in our approach to our expeditions and monitored personal health conditions. We also make plans for emergency evacuation such that we can drive to nearest health facility within one day or a few hours if possible.

18:30 – 21:30 PT OPENING RECEPTION



Spend an evening at the Burke Museum of Natural History and Culture, featuring Executive Director Dr. Gaby Chavarria and guest speaker Ray Troll. Tour the galleries of the new Burke, visit the gift shop, and hear Ray speak on “Fostering Fossil Fascination: Living the Paleo Nerd Life.” Heavy hors d’oeuvres and beverages (two tickets per person) will be provided.

08:30 – 10:00 PT (15:30 – 17:00 UTC)	SESSION 1

3D Scanning and Printing
Leader: Michael Holland
Location: Burke Museum – Paleo Alcove (3rd Fl)

Biology Collections Tour
Leaders: Sharon Birks and Melissa Frey
Location: Burke Museum – Biology Alcove (2nd Fl)

Custom Box Making
Leaders: Siri Linz and Laura Phillips
Location: Burke Museum – World Gallery (3rd Fl)

Field Courtesy
Leaders: Anthony Maltese and Alaina Fike
Location: HUB – Room 337

GIS for Field Paleontology
Leader: Melissa Macias
Location: HUB – Room 238

Introduction to Microsorting
Leader: Patrick Wilson
Location: Burke Museum – Paleo Alcove (3rd Fl)

Paleontology Preparation Training Manual
Leaders: Stephany Potze, Cornelia Clarke, and Stevie Morley
Location: HUB – Room 307

Polyethylene Glycol and its Uses in Fossil Preparation and Conservation
Leaders: Kelsie Abrams and JP Cavigelli
Location: Burke Museum – Paleo Alcove (3rd Fl)

10:00 – 10:30 PT (17:00 – 17:30 UTC)	BREAK

10:30 – 12:00 PT (17:30 – 19:00 UTC)	SESSION 2

3D Scanning and Printing (continued)
Leader: Michael Holland
Location: Burke Museum – Paleo Alcove (3rd Fl)

A Beginner's Guide to Paleontology Fieldwork: What You Need to Know Before You Go
Leader: Hillary McLean
Location: HUB – Room 307

Field Courtesy (continued)
Leaders: Anthony Maltese and Alaina Fike
Location: HUB – Room 337

GIS for Field Paleontology (continued)
Leader: Melissa Macias
Location: HUB – Room 238

10:30 – 12:00 PT (17:30 – 19:00 UTC) SESSION 2 (continued)

Introduction to Microsorting (continued)
Leader: Patrick Wilson
Location: Burke Museum – Paleo Alcove (3rd Fl)

Paleontology Collections Tour
Leaders: Ron Eng and Katie Anderson
Location: Burke Museum – Paleo Alcove (3rd Fl)

Polyethylene Glycol and its Uses in Fossil Preparation and Conservation
Leaders: Kelsie Abrams and JP Cavigelli
Location: Burke Museum – Paleo Alcove (3rd Fl)

Tribal Government to Government Roundtable
Leader: Polly Olsen
Location: HUB – Room 214

UW Special Labs Tour
Leaders: Elliot Armour-Smith and Paige Wilson Deibel
Location: Burke Museum – Main Entrance (departs at 10:15)

12:00 – 13:30 PT (19:00 – 20:30 UTC) LUNCH

13:30 – 15:00 PT (20:30 – 22:00 UTC) SESSION 3

3D Scanning and Printing
Leader: Michael Holland
Location: Burke Museum – Paleo Alcove (3rd Fl)

Archeology Collections Tour
Leader: Laura Phillips
Location: Burke Museum – World Gallery (3rd Fl)

A Beginner's Guide to Paleontology Fieldwork: What You Need to Know Before You Go
Leader: Hillary McLean
Location: HUB – Room 307

Creating and Implementing Dual Anatomy/Inventory Workflow Guides
Leader: Jess Miller-Camp
Location: HUB – Room 238

Field Courtesy
Leaders: Anthony Maltese and Alaina Fike
Location: HUB – Room 337

Illustrating Fossils
Leader: Crystal Shin
Location: Burke Museum – Paleo Alcove (3rd Fl)

Paleontology Collections Tour
Leaders: Ron Eng and Katie Anderson
Location: Burke Museum – Paleo Alcove (3rd Fl)

13:30 – 15:00 PT (20:30 – 22:00 UTC) SESSION 3 (continued)

Standardizing Fossil Preparation Lab Protocols
Leader: Shyla Davison
Location: HUB – Room 340

Tribal Government to Government Roundtable
Leader: Polly Olsen
Location: HUB – Room 214

15:00 – 15:30 PT (22:00 – 22:30 UTC) BREAK

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

3D Scanning and Printing
Leader: Michael Holland
Location: Burke Museum – Paleo Alcove (3rd Fl)

Beyond Airscribes
Leader: Alan Zdinak
Location: Burke Museum – Paleo Alcove (3rd Fl)

Biology Collections Tour
Leaders: Sharon Birks and Melissa Frey
Location: Burke Museum – Biology Alcove (2nd Fl)

Creating and Implementing Dual Anatomy/Inventory Workflow Guides
Leader: Jess Miller-Camp
Location: HUB – Room 238

Destructive Sampling Working Group
Leader: Marilyn Fox
Location: HUB – Room 214

Field Courtesy
Leaders: Anthony Maltese and Alaina Fike
Location: HUB – Room 337

Illustrating Fossils
Leader: Crystal Shin
Location: Burke Museum – Paleo Alcove (3rd Fl)

Standardizing Fossil Preparation Lab Protocols
Leader: Shyla Davison
Location: HUB – Room 340

UW Special Labs Tour
Leaders: Elliot Armour-Smith and Paige Wilson Deibel
Location: Burke Museum – Main Entrance (departs at 15:15)

Poster Session ~ Graduate – Wright Ballroom

18:00 – 20:00 PT (01:00 – 03:00 UTC)	POSTER SESSION

Christina J. Byrd*, Josue Guerrero, Caitlin Spind, and Eva Biedron
NON-ENGLISH LANGUAGE DOCUMENT DIGITIZATION AND CONSERVATION DURING A PANDEMIC

Gregory Carr
THE 2022 RECOVERY AND PREPARATION OF 11 NEW SPECIMENS OF *ONCHORHYNCHUS RASTROSUS*, THE GIANT MIOCENE SALMON

Vicen Carrió
A CACHE OF FRAGILE FOSSIL BIRDS WITH PYRITE DECAY—HOW TO SAVE THEM?

Nicole D. Dzenowski
CASE STUDY: CONSERVATION OF A WATERLOGGED MAMMOTH TUSK

Heather C. Finlayson
AN ABUNDANCE OF BISON: PRESERVING NON-PERMINERALIZED BONES OF *BISON OCCIDENTALIS*

Tabatha Gabay
THE "TUNA CAN" FIELD JACKETING METHOD

Alex C. Gardner
THE APPLICATION OF A SOLVENT GEL TO FIX THE MAMMOTH SITE'S GLYPTAL CONUNDRUM

Juliet A. Hook* and James S.C. Preston
HOME IS WHERE THE FOSSIL IS: NAVIGATING A WORK FROM HOME INITIATIVE DURING A GLOBAL PANDEMIC

Marilyn C. Laframboise
A NEW FACE—THE LAST CHAPTER IN THE HISTORY OF *ALBERTOSAURUS SARCOPHAGUS* TMP1981.010.0001

Alex Landwehr*, Laura E. Wilson, Shyla Davison, Kaiden O'Dell, and Aly Baumgartner
OF PROTOCOLS AND PERISSODACTYLS: BUILDING ON PAST EXPERIENCES FOR SMOOTH TRANSITIONS TO NEW PROJECTS

Fátima Marcos-Fernández*, Elena Fernández Fernández, Javier Fernández Martínez, Elisabete Malafaia, and Pedro Mocho
PALAEONTOLOGICAL HERITAGE 3D CONSERVATION TECHNIQUES IN THE SERVICE OF MUSEOGRAPHY AND CONSERVATION

Stevie L. Morley
ACRYLIC FILMS & COB WEBS: INVESTIGATING PARALOID B-72 AND BUTVAR B-76 IN ACETONE AND 95% ETHANOL FOR TRANSPARENT VOID FILLS

*Presenting author

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Francisco Ortega*, Fátima Marcos-Fernández, Elena Fernández Fernández, Javier Fernández Martínez, Zaira Villa Alonso
BONDING AND PAPERING FOR CONSERVATION OF PALAEONTOLOGICAL MATERIAL: EVALUATION OF THE RESISTANCE OF THE MATERIALS CLOSEST TO THE FOSSIL

Stephany Potze*, Stevie L. Morley, and Cornelia A. Clarke
IMPROVED PREPARATION METHODS FOR ASPHALT-PRESERVED FOSSILS FROM RANCHO LA BREA, CALIFORNIA

Darren Tanke
RAPID AND SAFE RECOVERY OF MEGAVERTEBRATE FOSSILS FROM OPEN PIT AMMOLITE MINES IN SOUTHERN ALBERTA, CANADA

Vicki L. Yarborough* and Geno Iannaccone
CASE STUDY: MAKING TWO INTERIOR SUPPORT JACKETS WITHIN A MOTHER JACKET TO MAINTAIN TAPHONOMIC ARTICULATION OF PHYTOSAUR TRUNK VERTEBRAE

***Presenting author**

GatherTown Q&A		
18:00 PT (01:00 UTC)	Heather C. Finlayson	Marilyn C. Laframboise
18:15 PT (01:15 UTC)	Christina J. Byrd	Alex Landwehr
18:30 PT (01:30 UTC)	Gregory Carr	Stevie L. Morley
18:45 PT (01:45 UTC)	Vicen Carrió	Stephany Potze
19:00 PT (02:00 UTC)	Nicole D. Dzenowski	Juliet A. Hook
19:15 PT (02:15 UTC)	Tabatha Gabay	Darren Tanke
19:30 PT (02:30 UTC)	Alex C. Gardner	Vicki L. Yarborough
19:45 PT (02:45 UTC)	Fátima Marcos-Fernández	Francisco Ortega

*All poster presenters will report to their poster in GatherTown at their designated time to answer questions with virtual attendees.
*Two computer stations will be provided for in-person presenters to access GatherTown.

20:00 – 22:00 PT (03:00 – 05:00 UTC) TRIVIA

Join us for a fun trivia challenge featuring questions by Burke Museum Fossil Lab Manager and Host Committee Chair Kelsie Abrams.

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Schedule of Events – Friday, April 7

Platform Presentations ~ HUB – Lyceum

08:55 – 09:00 PT (15:55 – 16:00 UTC)	WELCOME/ANNOUNCEMENTS

09:00 PT (16:00 UTC)

Hillary R. McLean

PHOTOGRAPHING AND REHOUSING THE EXTENSIVE FOSSIL COLLECTION AT FLORISSANT FOSSIL BEDS NATIONAL MONUMENT

09:15 PT (16:15 UTC)

Cinzia Ragni* and Magnani Fabio

CASE STUDIES: RESTORATION AND PYRITE DECAY ON BOLCA'S FOSSIL PALM

09:30 PT (16:30 UTC)

Alan Zdinak

LA UNDERWATER: A DEEP DIVE

09:45 PT (16:45 UTC)

Jared R. Heuck

USING ACCESSIBLE GIS SOFTWARE TO IMPROVE DATA COLLECTION AND WORKFLOWS

10:00 – 10:30 PT (17:00 – 17:30 UTC)	BREAK

10:30 PT (17:30 UTC)

Ian P. MacDonald

USING THE EPOXY EPO-TEK 301™ AS A CONSOLIDANT AND ADHESIVE/GAP-FILLER IN THE PREPARATION OF A LARGE HORNED DINOSAUR SKULL

10:45 PT (17:45 UTC)

Adam D.B. Behlke

THE USE OF SODIUM POLYTUNGSTATE TO ACCELERATE THE PICKING OF VERTEBRATE MICROFOSSILS; A CASE STUDY FROM THE ELLISDALE FOSSIL SITE

11:00 PT (18:00 UTC)

Kieran Miles* and Timothy A. M. Ewin

CHEMICAL PREPARATION OF EXCEPTIONALLY PRESERVED ECHINODERMS FROM THE MIDDLE JURASSIC OF WILTSHIRE, UK, USING THE SURFACTANT REWOQUAT

11:15 PT (18:15 UTC)

Catherine G. Cooper* and Conni O'Connor

COMPARATIVE ANALYSIS OF CONSOLIDANT PERFORMANCE AND AGING ON PAPER SHALE FOSSILS

*Presenting author

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11:30 PT (18:30 UTC)

Kaiden O'Dell*, Laura E. Wilson, Kale Link, and Todd Moore

ASSESSING AND IMPROVING SCIENCE STUDENT #SCICOMM SKILLS

11:45 PT (18:45 UTC)

Dawson T. Lambert*, Brendon Slaney, Samantha J. Nicol, and Rylee Maxwell

MASSIVE OVERBURDEN REMOVAL ON A STEEP HILL USING A FALL PROTECTION SYSTEM IN DINOSAUR PROVINCIAL PARK, ALBERTA, CANADA

12:00 – 13:30 PT (19:00 – 20:30 UTC)	LUNCH

13:30 PT (20:30 UTC)

Leya D. Collins*, Brett S. Dooley, and Robert L. Evander

HOW AIR SCRIBES AFFECT YOUR HEARING ON DIFFERENT SURFACES

13:45 PT (20:45 UTC)

Anthony E. Gordon

COMPARISON OF TENSILE STRENGTH FOR COMMON PLASTER JACKETING MATERIALS IN PALEONTOLOGY

14:00 PT (21:00 UTC)

Alaina A. Fike*, Anthony Maltese, Mike Triebold, and Cassandra Knight

BASIC FIELD JACKETING TECHNIQUES – A CASE STUDY OF METHODS USED IN THE NIOBRARA FORMATION OF KANSAS

14:15 PT (21:15 UTC)

Akiko Shinya*, Constance Van Beek, and Peter J. Makovicky

PLASTER FIELD JACKETS USING AIR FILTER MEDIA: AN ALTERNATIVE TO TRADITIONAL BURLAP AND PLASTER JACKETS

14:30 PT (21:30 UTC)

Michelle M. Pinsdorf*, Adam Behlke, Steve Jabo, and Pete Kroehler

STABILIZATION AND CRATING FOR TRANSPORT OF A LOANED HOLOTYPE *TRICERATOPS* SKULL

14:45 PT (21:45 UTC)

Sandra Dunn*, Lynn Gratz, Bronson Kozdas, and Aimie Botelho

FORGING FOSSIL MOUNTS WITH FOSSIL FUEL: AN ANCIENT CONVERSATION

15:00 – 15:30 PT (22:00 – 22:30 UTC)	BREAK

*Presenting author

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15:00 – 15:30 PT (22:00 – 22:30 UTC)	BREAK

15:30 PT (22:00 UTC)

Cyrus Green* and Jessica Cundiff

LIFT WITH YOUR COMPUTER, NOT WITH YOUR BACK: VIRTUAL RECONSTRUCTION OF A 450-MILLION-YEAR-OLD JIGSAW PUZZLE

15:45 PT (22:45 UTC)

Amy L. Kowalchuk* and Daniel N. Spivak

DIGITAL DOCUMENTATION OF THE GRANDE CACHE DINOSAUR TRACKSITE – A POTENTIAL LONG-TERM CONSERVATION STRATEGY

16:00 PT (23:00 UTC)

Robert Gay*, Brandon R. Peecook, Evelyn Vollmer, and Timothy W. Gomes

HANDS-ON! BREAKING OUT OF THE OUTREACH TRADEOFFS BETWEEN FOSSIL SPECIMENS AND TRADITIONAL REPLICAS BY UTILIZING 3D PRINTING

16:15 PT (23:15 UTC)

Joel P. Crothers*, Andrew B. Heckert, Marta Toran, and Luke Joseph Rose

WHAT NO EYE HAS SEEN: DIGITIZATION, 3D PRINTING, AND CUSTOMIZATION AS AN INEXPENSIVE MEANS OF RECONSTRUCTING FOSSIL SPECIMENS FOR EXHIBITIONS AND OUTREACH

*Presenting author

16:30 – 17:00 PT (23:30 – 00:00 UTC)	BUSINESS MEETING

Please join us to learn more about AMMP and how you can become involved in shaping the Association. We exist because of you and we want your feedback! Feel free to raise any questions or suggestions during the open forum after the Officer Reports.

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18:00 – 19:00 SILENT AUCTION

19:00 – 22:00 CLOSING BANQUET

AWARD PRESENTATIONS
(AMARAL LEGACY AWARD, AMMP SERVICE AWARD, MCCARTY STUDENT TRAVEL GRANT)

ELECTION RESULTS

FUTURE PLANS/CLOSING REMARKS – GREGORY BROWN, AMMP PRESIDENT

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

2019 Closing Banquet in Hays, Kansas. Musical entertainment provided by René Hernández and Conni O'Connor assisting with puppets.

Stories in Stone Walking Tour

Leader: David B. Williams

David B. Williams is an author, naturalist, and tour guide whose award-winning book, *Homewaters: A Human and Natural History of Puget Sound* is a deep exploration of the stories of this beautiful waterway. He is also the author of the award-winning book *Too High and Too Steep: Reshaping Seattle's Topography*, as well as *Seattle Walks: Discovering History and Nature in the City.* Williams is a Curatorial Associate at the Burke Museum and writes a free weekly newsletter, the Street Smart Naturalist.

Most people do not think of looking for geology from the sidewalks they travel, but for the intrepid geologist any good rock can tell a fascinating story. All one has to do is look at building stone in any large city to find a range of rocks equal to any assembled by plate tectonics. Furthermore, building stones provide the foundation for constructing stories about cultural as well as natural history. In this 1.5-mile-long walk, *Stories in Stone* (which was a finalist for the Washington State Book Award) David will explore stone ranging from 3.5-billion years old to 120,000 years old, the most commonly used building stone in the country, and rock used by the Romans to build the Colosseum.

Transportation: Participants will take the train ($2.75 one way, $5.50 round trip) to a stop near downtown, which is an 8-minute walk from the meeting place. 25 minute commute total. Transportation to be paid individually by each participant.

Directions: Walk from Graduate Hotel to the U District Station (1 block). Take the 1-Line Angle Lake train, it runs every 10 minutes. Four stops later, get off the train at the University Street Station. Walk roughly three blocks to the SE corner of Madison St and 1st Ave to meet David.

Return: Walk to the University Street Station. Get on the 1-Line Northgate train. Four stops later, get off the train at the U District Station. Walk 1 block to the Graduate.

<u>Morning tour: Depart Graduate Hotel Lobby at 09:00 PT</u>
Tour time: 10:00 – 11:30 PT
Return by approximately 12:00 PT

Museum of Pop Culture (MoPop)

The Museum of Pop Culture's mission is to make creative expression a life-changing force by offering experiences that inspire and connect our communities. MoPOP's permanent collection — much of which is stored in a physical "vault" — spans the breadth of the pop culture canon and also features one of the finest assemblages of popular music-related artifacts in existence. This rich archive provides the foundation for exhibitions and programs that explore themes tied to popular culture. Participants will see the behind-the-scenes conservation and exhibit fabrication spaces of MoPop. The care and housing of film props is very different from the care of geological specimens. Film props are not produced with materials meant to last forever, and often contain volatile materials. Storing and displaying volatile materials, and conserving delicate textiles worn by movie and music stars, is an exciting challenge. Guests will also be able to see the world-class exhibits of MoPop, and enjoy the unique architecture of the building.

**Guests will be split from 20 into two groups: one group will tour behind-the-scenes while the other attends the galleries, then the groups will switch. Total time recommended at the museum is 2 hours, with 1.5 hours included in the two 45 minute tour slots, and half an hour at the end to reconvene and finish seeing galleries. Including travel time, this trip will take just a little over 3 hours. Adding time for lunch downtown, the tour could be 4-4.5 hours.

Transportation: Participants will take 1-Line Angle Lake Train ($2.75 one way, $5.50 round trip) to Westlake Station, then walk to Monorail. Participants will then ride the historic Monorail ($3.75 one way, $7.50 roundtrip) to MoPop. Total roundtrip cost is $13 per person and it is a 33-minute commute. Transportation to be paid individually by each participant.

Directions: Walk from Graduate Hotel to the U District Station (1 block). Take the 1-Line Angle Lake train, it runs every 10 minutes. Three stops later, get off at the Westlake Station. Walk 3 minutes to the Seattle Center Monorail station. Get on the monorail (runs a small loop). Get off at MoPop.

Return: Walk to the Seattle Center Monorail station, get on the monorail. Get off at the other end. Walk 3 minutes to the Westlake Train station. Take the 1-Line Northgate train. Three stops later get off at the U District Station.

<u>Depart Graduate Hotel Lobby: 12:00 PT</u>
Depart MoPop at 15:00 PT

Extended Burke Paleontology Tour

Extended behind-the-scenes tour of the Burke Museum's Geology and Paleontology spaces by Kelsie Abrams. The tour will cover both laboratory spaces and fossil collections. The Geology and Paleontology collections include the West Coast's second largest paleobotanical collection and the Burke has extensive laboratories dedicated to pollen and phytolith recovery. The Vertebrate collections showcase several holotype reptile, amphibian, and therapsid fossils from Africa and Antarctica. This tour will be a treat for anyone wishing to see the diversity of the Permo-Triassic fossil record and plant nerds alike.

Meet at Paleo Alcove (3rd Fl) 5 minutes ahead of tour.

Morning Tour: 10:00 – 11:00 PT
Afternoon Tour: 13:00 – 14:00 PT

3D Scanning & 3D Printing in Paleontology

Level: Basic

Leader: Michael Holland

This workshop will offer both demonstration of and active participation in the 3D scanning process using the 3D imaging system available in the Burke Museum Paleontology department. Methods and tips for a successful 3D capture will be offered, including:

- proper specimen orientation
- movement of scanner vs. movement of specimen
- understanding image overlap during capture
- use of supplemental objects for tracking/registration
- selection of 3D reconstruction software parameters
- creating physical models from scans with 3D printing

While the workshop will utilize one specific brand of scanner and software (Artec), the concepts demonstrated apply to 3D surface scanning in general and are useful with any 3D scanner. Observing the operation of the 3D reconstruction software will enable participants to develop greater understanding of how a 3D image is made, and thus understand what the scanner user can do to achieve the most useful outcomes.

During the workshop participants will be given an opportunity to operate the scanner and software themselves for experiential learning. Examples of end uses (information/data sharing, exhibit production, educational aids, fossil restoration, etc.) will be discussed, as the intended end use can have influence on decisions made during scanning. A completed 3D model created by the group during the workshop will be started on a 3D printer at the end of the workshop, completing the transition from virtual to physical object. (As the printing can take several hours, workshop participants will see the finished 3D printed model later during the conference.)

A Beginner's Guide to Paleontology Fieldwork: What You Need To Know Before You Go

Level: Basic

Leader: Hillary McLean

In this "back to basics" style workshop, participants will get the opportunity to learn various tips and tricks for roughing it long term during paleontology field work. In this career, one is usually expected to spend 2+ weeks out in backcountry areas like Montana or Utah where access to resources are severely limited. This lecture style workshop will have a presentation given by the workshop leader on recommended gear, how to deal with various weather conditions, heat and cold safety, some basic wilderness first aid, and a general discussion of various prospecting, quarrying, and jacketing techniques. The workshop leader will also provide examples of gear from their own personal items for participants to see. There will be roundtable discussions towards the end of the class for brainstorming and opportunities for participants to present their own experiences or suggestions. This workshop is intended for beginners to field work only.

Beyond Airscribes

Level: Intermediate

Leader: Alan Zdinak

Preparators tend to rely on airscribes as the primary tool of fossil preparation. But they are not the only class of tools useful for fossil prep, nor always the appropriate one.

This workshop will explore the use of rotary tools – Dremels, Foredoms and the like – as an essential component of any prep lab. A mainstay of jewelers and woodworkers, rotary tools offer a seemingly endless array of tips, bits, and burrs to accomplish a wide variety of tasks. They are an efficient method of sharpening pin vises and airscribes, of opening and trimming small jackets, and of grinding away matrix, plaster or resin. Rotary tools can often remove hard matrix from soft bone, or reduce gross matrix on particularly hard concretions bound for acid prep, better than airscribes. All without need of a compressor (though dust management is even more critical). Attendees will be introduced to a wide variety of applications, plus health and safety protocols.

Creating and Implementing Dual Anatomy/Inventory Workflow Guides

Level: Basic

Leader: Jess Miller-Camp

Inventories are awesome, but anatomy is a lot. Let's work with a guide to make both things easier at the same time. Participants will learn about good workflow and inventory design, then work through a sample element inventory of turtle skeletal material using provided documents and specimens. The provided example will be for turtle osteology, but this process can be adapted to other groups and projects (e.g., bird osteology, Mazon Creek Fm pteridophyte leaves).

Many collections rely heavily on volunteers or previously-untrained hourly employees to complete tasks that take less experience or field-specific knowledge to fulfill, such as inventories. Having specific, explicit inventory workflows is one way to minimize the intentional and unintentional process modification often made workers during the course of their time on a task.

Specimen inventories are common in collections, but detailed element inventories? Not so much. They can be incredibly useful, but require much more specific anatomical knowledge than your average person has. Gaining a good understanding of anatomy is a lengthy process, which becomes a problem when a supervisor has to devote too much of their time to training new, ephemeral workers.

By combining pictoral and verbal guides of anatomical possibilities with the element inventory workflow itself, mistakes should be minimized and efficiency increased. Workers should have relevant process and material information in front of them at all times without needing to search for it except in unusual cases. Workers doing quality control of inventories will similarly have immediate access to information that will make some mistakes more obvious, such as a count of one type of element beyond what would be present in a single specimen.

Custom Box Making

Level: Basic

Leader: Siri Linz and Laura Phillips

Archaeology collections managers share box-making tips while providing hands-on instruction to participants who will each create an archival box for a selected Burke Paleontology fossil.

Destructive Sampling Protocols

Level: Advanced

Leader: Marilyn Fox

Many museums receive requests for destructive sampling of their specimens. "Destructive sampling" includes any procedure that causes a permanent change to a specimen, such as sampling of subfossil tissues for molecular studies, sectioning of specimens for histology, or drilling of tooth enamel for isotopic studies. The knowledge thus gained may outweigh the cost in damage to the specimen.

However, to ensure that damage is not excessive and that the work is not done wastefully, a museum should develop guidelines that require researchers seeking permission to sample specimens to address the following:

- Do they have the requisite skills to collect and analyze the sample while minimizing damage to the specimen?

- What changes will occur to the specimen?
- How will changes to the specimen be documented?
- Can they get the desired results from the collected sample?
- Will they publish the results in a timely manner?

This working group will compare guidelines from several museums (participants are encouraged to bring their own) with the end goal of developing a template that can be published, shared widely and adapted as needed. Having a well-known standard set of protocols would help museums minimize unnecessary damage to specimens and gather data. It would further help to educate researchers as to the need to document changes to specimens and encourage them to think of specimens as a non-renewable resource that should be maintained while still enabling research.

Field Courtesy: Addressing Safety and Ethics While Conducting Fieldwork

Level: Basic

Leader: Anthony Maltese and Alaina Fike

Instructors will roleplay with participants in a hypothetical scenario. The participants will be asked to approach the scenario as a field worker responsible for taking an inexperienced crew to a remote area to conduct reconnaissance, research and excavation. Instructors will work through the various steps including safety and ethical concerns for each part of the work. Topics included will be securing permissions to dig, how to gain access when crossing private lands, work goals and boundaries, environmental concerns and values, maintaining good relationships with local residents, and personal safety. The goal of the workshop will be to instruct on concerns and best practices required to achieve the research goals all the while not aggravating tensions with landowners or residents in ways the participants may not even be aware of. We will address laws regarding trespassing, possible access fees, honestly interacting with people, environmental issues when in the field (weather and how field crews can make situations worse), and basic safety concerns.

GIS for Field Paleontology

Level: Basic

Leader: Melissa Macias

Accurate mapping of fossils is an important aspect in paleontological fieldwork. Using technological advances in GIS applications for desktop computers and mobile devices, combined with sub-meter accuracy GPS receivers, it is possible to precisely map fossils during surveys. These applications allow users in the field to plot points and gather data, while simultaneously analyzing the data back in the lab. With sub-centimeter accuracy, it is possible to plot the location and position of individual bones within a bone bed.

This workshop will focus on the ESRI suite of web and mobile applications for use in paleontological fieldwork. Participants will gain experience in:

- Creating maps in ArcGIS Pro desktop
- Uploading existing maps and data to Arc Online
- Creating dashboards to monitor data in real time
- Using ArcGIS Field Field Maps mobile application to gather data in the field
- Creating and using Survey123 forms

The workshop will be a combination of instruction and hands-on experience in each of these applications and participants will learn how to customize each to fit their needs. Participants will need to bring a laptop and mobile device, and have either an existing ESRI account or 21-day free trial version. Weather permitting, the second half of the workshop will be held outside to simulate field usage of the applications.

Introduction to Microsorting

Level: Basic

Leader: Patrick Wilson

Participants will learn the difference between tools and instruments used in microsorting and will evaluate their efficiency of microsorting via a hands-on exercise. This workshop will involve a brief lecture discussing how to wash and screen matrix prior to sorting, basic principles of microsorting, and health and safety considerations of using microscopes. Following the brief lecture, participants will be given a preset "fossil" medium that they will be able to sort under a microscope using tools such as tweezers and brushes. The participants can evaluate their efficiency of microsorting by analyzing the amount and type of material recovered from the "fossil" medium compared to the actual predetermined types and amounts.

Illustrating Fossil with Pencils

Level: Basic

Leader: Crystal Shin

Despite photography technology, scientific illustration still takes a very important role in the science world as an aid to convey scientific information. Whilst photos may provide many details, they can be visually confusing, and fail to guide understanding of the scientific information of the specimen.

Illustration can emphasize the parts that carry important scientific information of the specimen. It can also remove unnecessary information that is confusing to the actual specimen, such as cracks and discoloration. Well-rendered drawings can provide the viewer a clear and comprehensive understanding of the specimen. To create these drawings, illustrators often spend many hours under the microscope to complete the drawing, which leads to an extensive visual understanding of the specimen. Being able to draw the specimen will help your ability to see and perform your work in the field of paleontology better.

"*I would rather teach drawing that my pupils may learn to love nature, than teach the looking at nature that they many learn to draw.*" – John Ruskin

Beginners to drawing are welcomed. In this workshop, you will learn how to render the fossil specimen in graphite pencils. This will include the materials and the basics of graphite drawing techniques, such as seeing values, how to shade, what to pay attention to when you look at the specimens, and how to translate information to your drawing. There will be instructions, demonstrations, and examples to draw. Participants will benefit from hands-on guidance and feedback on their drawing.

Polyethylene Glycol and Its Uses in Fossil Preparation and Conservation

Level: Basic

Leaders: Kelsie Abrams and JP Cavigelli

Polyethylene Glycol (PEG, also known by the trade name Carbowax) is a common substance used to consolidate and support fossils during preparation. It is safe to handle, easily accessible and affordable, reversible, and when used correctly allows for preparation of very fragile or small fossils. However, poorly thought through use of PEG can result in disastrous consequences for fossils. This workshop will cover where and how to purchase PEG, the grades of PEG available and their properties, various application methods and uses of PEG, and how to safely remove it from fossils.

Paleontology Preparation Training Manual

Level: Intermediate

Leaders: Stephany Potze, Cornelia Clarke, and Stevie Morley

Paleontology preparation laboratories are frequently faced with training interns, students, volunteers, etc. on fossil preparation techniques. This requires comprehension of the technical terminology, tools and their application, correct PPE use and, in some instances, understanding of preparation chemicals. A great deal of instruction needs to be relayed to people with varied experience in a short time, which can lead to a sense of information overload by the trainees.

The La Brea Tar Pits and Museum Fossil Lab supports a large volunteer cohort (57 as of February 2020; pre-COVID 19) and is regularly tasked with quick-turnaround training, which includes seasonal volunteers, field school students, collaborating researchers, cross-departmental staff, and technicians from other institutions. Provision of a hard-copy training manual written by lab staff covering workspace orientation, health and safety, manual preparation techniques, and microfossil sorting had a positive impact. It was observed that providing a consultable reference that accompanied the physical training yielded greater information retention and success by the trainee. There was notable improvement in assurance with the techniques and application of tool use through manual solvent preparation and an increased accuracy when identifying microfossil taxa.

Individuals being instructed in solvent and adhesive preparation were given the manual highlighting health and safety requirements, including appropriate SDS, followed by a discussion to ensure the information was understood and questions addressed. Over-preparation through the unnecessary removal of internal matrix was a concern but, upon introduction of the training document, this practice reduced appreciably. Trainees learning to repair and conserve fossils with adhesive demonstrated greater levels of confidence and success than those trained without the manual. Using this three-pronged approach to training – physical, visual, and text – the overall quality of solvent and adhesive preparation increased.

During microfossil sorting (material measuring 1cm - 1mm), newly-trained individuals who were provided the manual to consult showed increased accuracy of between 85-100% in general microfossil identification on their first attempt of sorting a scoop of fossiliferous matrix (~30 grams), compared to 40-60% prior to the manual. From the various biological materials sorted, the most significant improvement was noticed in seed identification (including seed fragments). Previously over 50% of seeds were overlooked in the sediment by volunteers. Following consultation of the manual, no seeds were left unsorted and most were classified correctly as "plant" or placed in the "unknown" pile. The overall distinction between bone and wood also improved. The dependency on staff assistance throughout the sorting process decreased, allowing more time to amplify the learning experience of trainees and focus on other lab tasks.

This workshop will introduce the contents that can be considered when drafting a preparation laboratory training manual, with the La Brea Tar Pits Fossil Lab Training Manual serving as an example. Throughout, discussion is encouraged for interactive dialogue that can continue to enhance and support paleontological preparators in training techniques.

Standardizing Fossil Preparation Lab Protocols

Level: Intermediate

Leaders: Shyla Davison

The collection, archiving, and accessibility of data in fossil preparation labs is extremely important, and it allows preparators and collections managers to know the complete history of a fossil prior to long-term storage in collections or uses for research. Many institutions, regardless of size and resources, can improve fossil preparation data collection, transfer, and archiving protocols. By establishing a formal workflow and data collections protocols, institutions can ensure that the data collected in the preparation lab are archived properly to avoid confusion or data being lost.

In this workshop, we will focus on group discussions with the goal of constructing a protocol to standardize the process and ensure that data are collected, achieved, and made accessible to fossil collection managers, fossil prep lab managers, and researchers. This will be a collaboration between institutions to create a best practices protocol that can be implemented in fossil preparation labs and collections regardless of institution size and budget. The protocols developed during this workshop can be used to improve data management in institutions with fossil prep labs and provide suggestions for improving data transfer between labs and collections in, and between, other institutions.

NOTE: This workshop will be collecting data for research. Please read through the [Informed Consent](#) form for this workshop, which will also be sent to you after your registration.

Tribal Consultation: Perspectives from the Burke Museum

Level: Intermediate

Leaders: Polly Olsen and Native American Advisory Board members

Session attendees will hear from the Burke's Tribal Liaison (TL) and members of the Native American Advisory Board (NAAB), and will learn:

- How community voices—primarily via the NAAB—led to the creation of the TL role and defined its place within our organizational structure;
- What decolonization looks like at the Burke, and how it affects not only cultural practices but also scientific research; and
- Attendees will leave this session with a better understanding of how consultation with community advisory boards is essential to decolonization. At the Burke, our TL and NAAB collaborate with staff members in the development, communications, exhibits and visitors experience departments, as well as with our fundraising board and volunteers. These wide-ranging interactions deepen cohesion and collegiality within and among museum departments and stakeholder groups.

THE USE OF SODIUM POLYTUNGSTATE TO ACCELERATE THE PICKING OF VERTEBRATE MICROFOSSILS: A CASE STUDY FROM THE ELLISDALE FOSSIL SITE

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Sodium Polytungstate (SPT) is a non-carcinogenic salt combined with distilled water to create dense aqueous solutions (up to 3.1 g/ml) that can be used in a sink-float process to separate materials of different densities. Materials that are less dense than the solution float to the surface and denser materials sink to the bottom. The less dense material is removed from the surface. The denser material is retrieved from the bottom. Sodium Polytungstate has a long history in micropaleontology, mineralogy, and geology to segregate fossils, crystals, grains, and clasts by density.

The Ellisdale Fossil Site in New Jersey is significant for the diverse collection of Late Cretaceous vertebrate microfossils from eastern North America. In addition to the vertebrates, the site also contains significant quantities of charcoal that obscure microfossils when picking. The initial purpose for the SPT treatment of this site was float the charcoal and sink the fossil remains to make it easier and quicker to find the fossils. After some testing, the fossils were determined to be denser than 2.75 g/ml. For reference, quartz is 2.65 g/ml.

The vertebrate microfossil material was initially wet screened with 1mm and 0.425mm nested sieves. After each sample dried, about 50ml of screened material were added to a 250 ml beaker filled with 100ml SPT adjusted to 2.75 g/ml. The solution was gently stirred, filled the rest of the way with SPT, and left alone for ten minutes to let the contents settle. A small stream of SPT was then added to coax the less dense material to flow off into a collecting tray. Once the surface was clear, the contents of the beaker were poured through a 0.1mm sieve and allowed the drain. The same was done with the fluid in the tray in another 0.1mm sieve. Both sieves were rinsed three times with distilled water to recover the SPT. The rinsed solution was filtered to remove particles and left to evaporate. The density of the solution was checked as the water evaporated until it was at 2.75 g/ml and then poured into a storage bottle to be used again.

This process took about 4 man-hours over the course of two days to complete. It separated about 80 percent of the sample as float, leaving the last 20 percent as sink. The sink contained largely iron oxides, pyrite, glauconite, and clay aggregates. The fossils stand out among these minerals and were easily picked.

NON-ENGLISH LANGUAGE DOCUMENT DIGITIZATION AND CONSERVATION DURING A PANDEMIC

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For centuries, paleontologists have roamed far and wide, collecting evidence of our ancient Earth through fossils. Along with those fossils often comes correspondences and labels in the language of the country where they were collected. At the Museum of Comparative Zoology (MCZ) at Harvard University, there are collections in the Vertebrate Paleontology (VP) Department from Spanish-speaking countries. The documents associated with specimens acquired in the mid-1900s required conservation to protect fraying edges and digitization to capture the data within them. At a time when the pandemic had closed the museum to staff, digitizing and translating these documents became an ideal remote project. The initial task was to gather all known documents related to fossils from Spanish-speaking countries in the MCZ VP collection, which included handwritten letters and typed documents with handwritten annotations and figures. All documents were scanned on a flatbed scanner (Epson), stored in 4 mil 9x12" polypropylene plastic sleeves, and the digital files (PDFs)saved in a collaborative online platform (Microsoft SharePoint). To capture the data and make the document contents more accessible, a remote intern was hired to transcribe the documents. Each document was transcribed verbatim with annotations for sections where the text was illegible and when handwritten notes were present in the margins. When complete, transcription files were downloaded from SharePoint and archived on the MCZ server. Apart-time staff member fluent in Spanish was hired to translate the documents. To preserve the original context of the documents, text was translated as directly as possible. If inferences had to be made for clarity of the text, footnotes were added stating the original text, the literal translation, and a rationale for why the inference was made. A copy of each translation was digitally archived, while another was printed on archival paper and filed with the original Spanish documents. This work is critical to understanding the history of certain specimen collections within the MCZ VP Department. We will also use these newly uncovered histories to update accession records, catalog specimens, and appreciate the scientific contributions of past MCZ staff and collaborators.

PUBLIC-PRIVATE COLLABORATION IN THE 2022 RECOVERY AND PREPARATION OF 11 NEW SPECIMENS OF *ONCHORHYNCHUS RASTROSUS*, THE GIANT MIOCENE SALMON

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Onchorhynchus rastrosus was a large (2.5–3.5 meter, 150-250 kg) salmon that lived on the West coast of North America between 12 to 6 Mya (estimated). Although specimens have been found in California, Oregon and Washington, the most complete skulls and articulated vertebrae columns come from a private, inactive gravel quarry near the town of Madras in central Oregon. Prior to2022, four skulls have been recovered from that quarry since the type specimen was excavated in 1964. One was found in 1980, two others were found in 2011. In 2022another six complete and five partial skulls as well as significant amounts of post-cranial material were found. The specimens were recovered on a two-day weekend field trip by an enthusiastic group of amateurs of the North America Research Group. Three of these specimens remain in the quarry for excavation later in 2023.

The first group involved is, of course, the quarry owner –the Vibbert family of Madras. Sean Vibbert is an enthusiastic supporter of the recovery of these wonderful specimens, donating them to the Condon collection of the University of Oregon. Some member of the Vibbert family has owned this property since the 1880’s, and they have allowed collection of specimens since the first was collected in 1964.

A second group involved is the North America Research Group (NARG). A NARG member found evidence of the specimens during a routine scouting visit to the quarry in May 2022. The group was allowed controlled access to the quarry, and recovered a significant number of specimens during a weekend field trip in June 2022. They will be returning in 2023 to recover more known specimens.

The third group is the Oregon Museum of Science and Industry (OMSI). The actual preparation work on these fossils is done by volunteers in the Paleo lab. The OMSI lab has over one hundred thousand visitors a year. This is the most-visited paleontology lab in Oregon. In addition, the OMSI lab has flexible display opportunities, where the fossils can be stored and displayed for ready access by volunteers and visitors. The fossils are loaned to OMSI by the University of Oregon.

Ray Troll, an artist in Ketchikan Alaska has generously given some artwork about the giant salmon to enhance the Paleo lab at OMSI.

The last group is the Paleontology department of the University of Oregon (UO) in Eugene, Oregon. The specimens are all part of the Condon Collection of fossils. The specimens will eventually be curated and indexed by the collection manager, and most of the specimens will be relocated to Eugene when fossil storage becomes available. In addition, the UO professors (Ed Davis and Samantha Hopkins) will be coordinating and collaborating on a new paper, bringing in other experts in the field such as Brian Sidlauskas of Oregon State.

Preparation of the specimens was relatively straight-forward. The bones were removed from the quarry encased in blocks of matrix, which is a heterogenous mix of sand, pebbles and cobbles. Since the quarry was essentially a large vertical cliff of cemented gravel, the blocks were recovered by excavating around the top and sides of the blocks deep enough into the cliff to capture the bones, and then undercutting the block until they came loose. The blocks were packed into plastic crates and moved the short distance (about 20 feet) to a pickup for transfer to OMSI. Everything fit in one pickup load. All people working at the cliff face had hardhats, and used goggles if using hammer and chisels or power tools. Dust masks were available but optional. There was a watchperson assigned to monitor the cliff for falling rocks or larger cracking or shifting, though nothing major occurred. The Vibberts pointed out that some existing caves into the cliff face have been there essentially unchanged for at least 50 years, so the formation is stable in spite of its appearance.

<u>Preparation</u>

The matrix is lightly cemented sand and stream-rounded cobbles, requiring only hand tools to remove matrix from the bones. Exacto® knifes and/or small screw drivers were adequate. The sand was removed by a short bristle paintbrush. Most bones had a final cleaning in an air abrasive unit utilizing Sodium Bicarbonate at 30 PSIG or so. The bones are not mineralized so they are fragile. The larger skulls were supported on plaster cradles during preparation, and turned over into temporary transfer cradles. The smaller items such as vertebrae and fins, were handled as loose items and packed into cavity mounts. In some specimens the bones were 'wrapped around' larger cobbles since they were covered while still fresh and conformable. For these no attempt was made to separate the bones from the cobbles, and they are stored with the bones-up position. Some of the specimens retain soft-tissue casts where clay had infiltrated cracks left behind when the soft tissues decayed away. In particular there are the end of the fin rays and some of the body shapes. There is no small-scale texture nor scale preservation, however. After preparation the bones and sand lenses were coated with a thin solution of Vinac® to stabilize them and prevent dusting when moved. If breaks occurred, they were mended with a 2-stage gluing process. First, the broken edges were impregnated with a very thin Vinac solution, thin enough that it would soak in by capillary action to a depth about 5mm. After this dried, a thicker solution of Vinac (almost gelling, exact concentration unknown) was applied to the break surface and immediately reassembled. The wicking action caused the Vinac to gel, creating an appreciable bond in just a matter of minutes. The two-stage process was developed since if only the thick Vinac is used, the matrix was so weak that the glue joints invariably broke adjacent to the glue line. The skulls were mounted in custom-fitted chopped glass-reinforced cradles. The small items are mounted in cavity mounts of pink polystyrene foam lined with Tyvek fabric. Details available upon request.

A CACHE OF FRAGILE FOSSIL BIRDS WITH PYRITE DECAY-HOW TO SAVE THEM?

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More than 700 bird fossils from the Eocene (55 million years old) arrived at the National Museums of Scotland in the summer of 2021. They were discovered by Michael Daniels, an amateur palaeontologist, in the marine London Clay Formation at Walton-on-the-Naze in Essex (UK). Described as "one of the most important collections of its type in the world," the collection reveals the early stages of the evolution of modern birds. In the Eocene, the world was around 5-8 degrees centigrade warmer than today, probably tropical climatic conditions that prevailed in western Europe and the diversity of bird life was like that seen in the Amazonian rainforest today.

London Clay fossils are exceptionally preserved in three dimensions, and it has been argued that the deposits represent a Konzentrat-Lagerstätten (Allison, 1988).

The fossil bones show very little taphonomic distortion, thus they provide important information, particularly ecomorphological measurements. They are fragile, slow to prepare and generally small in size. Their matrix contains pyrite and concretions (calcareous or phosphatic) that penetrate the small cavities of the fossil bones as small grains and break the fossils from the inside out (Allison, 1988).

The matrix has a high sulphate concentration with minerals such as cobalt, nickel, zinc and aluminum with a very acidic pH of below 3. This acidic matrix is generated from the oxidation of pyrite ($FeS2$), whereby it absorbs moisture and converts to sulphuric acid, known as pyrite decay or pyrite disease, not only damaging the fossil but anything else in close contact.

During the fossilization process, the bones are in an anoxic environment and in this case, pyrite forms in the bones. When the bones are out of the matrix or excavated and moved to a non-anoxic environment, then the pyrite reacts. This process of decay is halted only by early diagenetic mineralization (Allison, 1988; Huggett, 1994).

The matrix in which the fossil collection is contained has oxidised pyrite in different forms: white, yellow and red grains, as well as different structural forms: grains, fibres, crystals and nodules.

The fossil collection arrived at the lab in a very poor condition. 40 years of fossil collection kept in a room without environmental conditions. The collection was in rusted metal boxes, deteriorated plastic boxes, oxidised paper, full of pyrite decay, etc... the collector was using everything available to separate the small bones.

After examination, we decided that the best way to save this collection was to extract the bones from the matrix to reduce the risk of pyrite decay.

Considering the significance of the collection, the researchers checked the whole collection and organised the bones according to their importance, the preparation started with the unique bones.

Action Plan

- All the contaminated housing materials had to be removed.
- New acid-free storage materials used, such as polyethylene boxes, plastazote and acid-free paper to replace old materials.
- All fossil bones removed from their matrix.
- In those cases where the pyrite is well established inside the bones, the fossil will be recorded photographically, perhaps CT-scanned and then an anoxic treatment will be carried out (NHM method).

Treatments

The bone surfaces were cleaned using brushes, puffers and quills with the purpose of not damaging them. In some specific cases, industrial methylated spirit (IMS) was used, although even the IMS was breaking the bones down and it had to be used fast in very small quantities to keep intact the anatomical structure of the bone.

Finally, the bones were repositioned and supported to allow all their anatomical details to be studied. In cases where the state of preservation or the pyrite density was too high, a meeting with the curator was organised, the bone was assessed, and prepared consequently. In some cases, a CT scan was the best option to be able to keep the whole information of the bone before its potential destruction.

The use of adhesives was necessary to consolidate the bones before extraction. The use of acrylic resin (Paraloid B72 at 5% concentration in acetone) was the most appropriate for this material. The adhesive was used by letting a drop go down a brush with only a couple of bristles. This technique allows more control and avoids the movement of the bone. Use of scalpel and wooden sticks were used to fix the bone during drying time. For a few big bones, a higher concentration of 20% was used to join their parts.

The bones were in some places broken due to:

- Collection in the field
- Use of poor storage materials
- Travel
- Internal efflorescence due to pyrite decay, that grew, expanded and destroyed the bones from the inside out

All preparation of the material was performed under a high magnification microscope to avoid breakages and to be able to see new bones appearing from inside the matrix.

Health and Safety

The collection was originally stored in an area that did not keep the environmental condition needed for this kind of collection.

Inside the boxes, rusty metal boxes, glass containers, mouse droppings, insect carcasses and pupae, rusty nails, cotton, and sulphur dioxide gas amongst others were found.

Consideration was given to how to approach the collection. After an overview of the collection, and considering the dangers seen when it was brought to the lab, gloves and extraction was made compulsory in all treatment.

The Future

Such an important collection has to be monitored over the long-term and with specific conditions of temperature (20-25°C) and humidity (35-45%). Treatments of those specimens with pyrite decay could be prepared from one of the well-known treatments described by Bannister (1933), Howie (1977), Newman (1998), Shinya and Bergwell (2007), or Larkin (2011), although there isn't a technique that gets rid of it completely.

The decision about which treatment should be taken has been not decided yet. As the main researcher of the collection is in Germany, progress in the research and the methodology is on hold, as some specimens will need CT scans before any treatment. So far, controlled environmental conditions of temperature and humidity are in place. Having a low humidity will either prevent the oxidation of the pyrite (which has been trigged) or it will slow down the reaction that has started. Both lab and collections stores are around 45% in RH, always less than 60% (Howie, 1992), and 20-25°C in temperature. Nevertheless, those specimens with hard pyritic nodules that cannot be removed without compromising the specimen, have been inserted in laminate film (that excludes moisture and oxygen) or have been placed in a lidded polyethylene container known as 'Stewart Boxes' (impermeable to moisture and oxygen).

The preparation of the collection has not been finished, but the most important specimens have been prepared and published. So far, a falcon-like bird, a diver, and a diurnal owl have been described as new species by Dr. G. Mayr and Dr. A. Kitchener (2022a, b and 2023) and there are more papers in preparation or in press.

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HOW AIR SCRIBES AFFECT YOUR HEARING ON DIFFERENT SURFACES

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Our initial hypotheses were that: a) thickness of fossil matrix can affect the decibel levels produced by air scribes, b) type of fossil matrix can affect the decibel levels produced by air scribes, and c) the type of tool used can affect the decibel levels produced by air scribes, and d) that these three in turn affect a preparator's hearing. In unpublished work, Dr. Robert Evander (retired preparator from the American Museum of Natural History) observed that when working on the large, flat neural spines of sauropod cervical vertebrae, at certain times the sounds that were registering as normal on both the A scale (for social environments) and the C scale (for machine environments) registered dangerously high in the max-hold mode as well as in the C scale of an audiometer. The OSHA standard for a safe work environment, a seven-hour average, tends to wash out the transient peaks of these high-decibel sounds. A reading of 70 decibels is considered safe, while prolonged exposure to 85 decibels can damage hearing. Per the Center for Disease Control, a 100-decibel environment is considered safe for only 15 minutes per day.

The C mode of the cell phone app Decibel X was used to collect data on the decibel levels produced while the air scribes were in use. This study shows that both tools produce higher and unsafe decibel levels when working against a thin plane versus a thicker one. Our data shows that matrix material (in this case mudstone and slate) was not a factor in the decibel level. For the final results we used the following air scribes: the HW65 and the HW322 from Stone Company (German-made tools), and the ME91 from Paleo Tools. There was a significant difference in the decibel levels produced by the HW65 and the HW322, but no other combinations were significant. While there was no statistical significance to the differences between other combinations of factors, unsafe decibel levels were experienced in all samples.

Figure 1. Very thin slate material from Poultney, VT being prepared by a HW65

Figure 2. Mudstone from Santa Ana, CA (3-5 mya) being prepared by a HW322

The first step to increasing hearing protection in your laboratory is to buy an audiometer or download an audiometer app. Then examine the soundscape of the environment in which you work. Once high-noise laboratory areas are identified, they may be partitioned off from other workers within the laboratory for maximum protection. If partitioning is not feasible, it is still essential to identify possible high-noise activities or areas to aid in a preparator's knowledge of their work environment. Personal hearing protection is inexpensive and unobtrusive in the form of ear muffs, and is cheaper and less obtrusive in the form of ear plugs. Hearing protection is a long-term commitment to safety, and one should keep in mind that you can do significant permanent damage to your hearing in as little as 15 minutes.

COMPARATIVE ANALYSIS OF CONSOLIDANT PERFORMANCE AND AGING ON PAPER SHALE FOSSILS

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Florissant Fossil Beds National Monument (FLFO) houses an important collection of paper shale fossils that are known and studied world-wide. These specimens are particularly fragile due to their lamellar structure and composition. Condition assessments of paper shale fossils in the FLFO collections indicate that they are in danger of delamination, flaking, cracking, and breaking, which can cause loss of material and decrease accessibility to the samples to prevent further damage. Various consolidants have been used to stabilize these samples in the past, but studies of their effects on the samples have been limited. In this study, we compare how five different consolidants applied to paper shale fossils from FLFO age. The consolidants chosen were two ethyl-cyanoacrylates (Aron Alpha 241F and PaleoBond 40), a medical grade butyl-octyl cyanoacrylate (GluStitch GluSeal), and two types of Butvar mixed 5% weight to volume in ethanol (Butvar B-76 and Butvar B-98). Failures ranked from most severe to least were defined as: failure of consolidant bonds, flaking and loss of material, and change in color or gloss of sample. Two experiments were run to determine consolidant performance: under accelerated weathering conditions, and under conditions simulating the extremes of display and storage at FLFO. For the accelerated weathering experiment, each consolidant was used to treat five samples by flooding the sample surfaces, and five untreated samples were prepared as controls. Nitrile gloves were used when applying all consolidants, and a respirator was worn when handling the cyanoacrylates. The samples were exposed to a total of 800 hours of accelerated weathering in a QUV weatherometer following ASTM D904. Color, gloss, surface roughness, and FTIR data were collected after each 200-hour weathering cycle. For the display simulation experiment, each consolidant was used to treat ten samples using a porcupine quill to stabilize the surface; ten samples were left untreated as controls. The samples were exposed to temperature (°C) and humidity (RH) cycling in a freeze-thaw chamber, ranging from 15.5°C and 45% RH to 21.1°C and 15% RH. Half of the samples were put in a UV exposed section of the chamber and the other half were left in a darkened section. Color, gloss, and surface roughness data were collected every two weeks. Results from the accelerated weathering experiment indicate that the two Butvars cause the least overall change in appearance when compared to the control samples. All of the consolidants maintained adhesive bonds. GluSeal caused the greatest overall color change while Butvar B-98 caused the least. The ethyl cyanoacrylates had the least effect on surface gloss but caused the greatest alteration to surface roughness due to the consolidant beading on the surface. The display simulation experiment is ongoing. Preliminary results don’t indicate a difference in

consolidant performance, though samples in the dark section of the chamber exhibit less overall color change.

WHAT NO EYE HAS SEEN: DIGITIZATION, 3D PRINTING, AND CUSTOMIZATION AS AN INEXPENSIVE MEANS OF RECONSTRUCTING FOSSIL SPECIMENS FOR EXHIBITIONS AND OUTREACH

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Introduction

Among the prominent issues that vertebrate paleontology faces in regard to K-12 education and public exhibitions is specimen availability. The recent advent of 3D printing technology has allowed for major breakthroughs in the accessibility of geological, biological, and paleontological resources for researchers and students. Though 3D prints possess much educational potential, they often do not resemble actual fossils, due to the "pixelated" and topographic nature of the printing material. Though UV-curing (resin) 3D printers have recently become more affordable and easier to use, they still use toxic chemicals and are relatively unaffordable for schools and colleges. By using scientific illustration and artistic techniques used in entertainment production design (e.g, epoxying, undercoating, washing, dry-brushing, etc.) on polylactic acid (PLA) filament prints, we have created "hybrid" specimens that transform affordable PLA from layered polygons to realistic replicas and effective educational resources.

Procedures/Results

Our 'augmented' printing process begins with the acquisition of an 3D (OBJ or STL) file of a fossil specimen. Many of the prints in our library are sourced from free online resources such as Sketchfab, MorphoSource, or Phemone10K. Once the print has been selected, it is loaded into Creality Slicer 4.8 and prepared for printing. Each file is scaled to the appropriate size, while bed supports and the internal structure are tweaked for each given model's dimensions and geometry. After a successful PLA print, the model is cleaned of supports, and then sanded and trimmed with a dremel. Once the print is freed of excess material, two-part Smooth-On XTC-3D™ High Performance 3D Print Coating, Butvar® B-76 polyvinyl butyral resin in a solution of acetone, or a spray-on primer is applied to the print to smooth the PLA texture. These products are selected for the texture of the desired model. XTC-3D™ is used for models that require a generally smooth or glossy texture, while polyvinyl acetate is applied to models that require a rougher finish. After the primer is applied and cured, a uniform base coat of acrylic paint is applied to the model. After this coat is dry, alternating layers of dark washes and light-colored dry-brush strokes are applied to "weather" the model and layer color. The colors applied to each model vary depending on the color and texture of the original fossil specimen. Finally, a protective coating of Rust-Oleum™ Matte Clear Enamel is added, and the print is ready for display or outreach.

Advantages

One of the immediate benefits of PLA printing over traditional molding and casting techniques is that it is marginally lighter, more environmentally friendly, and far less expensive than standard two-part polyurethane resins, ABL thermoplastics, and UV-curing resins. While plaster and resin casts can be difficult to modify after they are poured into their molds, PLA resin can be printed at varying fidelities, speeds, and densities. Though the texture of the printed material does not immediately lend itself to being perceived as a realistic replica, it can be easily modified with the application of epoxy gel or putty. Additionally, 3D printing in PLA allows for the recreation of delicate and complex areas of fossil specimens that would otherwise be impossible or precarious to mold and cast. PLA printing (along with other plastics) is becoming increasingly cheaper and affordable, and thus has already proven to be an extremely accessible medium in this regard. Additionally, the increased ease of 3D scanning and photogrammetry further extends the usability of this medium.

Potential

Even unaugmented PLA 3D printing possesses enormous potential in terms of bringing rare specimens to K-12 students and undergraduate classrooms. In regard to the former, many of the students that App State's Geological and Environmental Sciences Department educate are from rural communities, hours from natural history exhibits or fossiliferous strata. In 1000-level and 3000-level courses, augmented 3D prints allow students access to otherwise challenging specimens such as microbial foraminifera. Additionally, our student interns can use 3D printing to generate both permanent exhibits and traveling interactive displays, which are geared toward specific state standards for K-12 education. With free online resources, students can recreate rare specimens from across the globe in mere hours. Utilizing this technology, we have created dozens of large-and small-scale replicas, exhibitions, and multimedia tools for scientific outreach and display. These applications range from a full-sized replica of a Tyrannosaurus rex skull plaque mount, now on display in our McKinney Geology Teaching Museum, to diverse interactives using scale models. The scalability of 3D technology had allowed our geoscience department to print scale replicas of famous specimens such as the holotype of *Tiktaalik roseae*, *Syntomiprosopus sucherorum*, early cetaceans, *Majungasaurus crenatissimus*, *Coelophysis bauri*, *Bison latifrons*, temnospondyl amphibians such as metoposaurs, and scaled-up conodont teeth, to name a few.

Conclusions

The increased realism of the augmented 3D prints connects to students and audiences on a phenomenological level, more so than unaltered examples. To those unversed in zoology, paleontology, or biology, unmodified PLA prints can often appear as abstracted brightly colored plastic shapes and lack any aesthetic connection to original fossil specimens. By creating realistic textures, colors, and lusters that match fossil bone, shell, or matrix, educators can create interactive proxies to connect to audiences, in the place of delicate and irreplaceable fossils. Though UV resin prints generally yield higher fidelity in their models, they are still far more toxic and costly than these augmented PLA works.

Health and Safety

All PLA printing conducted in Appalachian State University's (ASU) Paleontological Undergraduate Research Laboratory (PURL) in the Department of Geological and Environmental Sciences (GES) is carried out with rigorous safety guidelines. All students trained in the use of our Creality Ender 3 S1 3D printer 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 laboratory, nor are any UV-curing acrylic or epoxy resins. A working dry chemical fire extinguisher is kept within the printing room at all times and is inspected regularly by the Department's staff. Students are trained on how to properly shut off the 3D printer in the event of a thermal runaway, and to keep flammable material away from the device while it is on. 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.

FORGING FOSSIL MOUNTS WITH FOSSIL FUEL: AN ANCIENT CONVERSATION

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The Projects

Milk River *Daspletosaurus* (Mr. D) and Calli, two fossil mounts completed for the Royal Tyrrell Museum in Drumheller, Alberta (2018 and 2022) illustrate how strong design skills combined with traditional forging techniques dramatically enhance the visual impact of a mounted fossil and can also facilitate greater access to primary research of fossil bones. The collaborative working relationship between museum staff and our team was critical to the successful completion of both projects.

Mr. D completed in 2018, was unique in that all the bones were disarticulated and not crushed flat during fossilization. The museum wanted to present the skull in a Beauchêne style or exploded view: a type of presentation for which the bones are mounted in anatomical position but spaced so each bone can be viewed from multiple angles.

In the case of Calli, a ceratopsian collected at Callum Creek and completed in 2022, the specimen presented two significant challenges. Initial preparation of the main skull exposed the palate. So, the first challenge was to design and construct mounts that would facilitate the skull (still encased in matrix and weighing 1480lb) to be flipped over and supported on the base by a single stem. This would provide the preparator access to all other parts of the fossil. The museum's goal to display the skull so the tooth row on the maxilla would sit at an 18-degree angle provided us with our second challenge: it meant the frill would sit in an almost vertical position. The frill consisted of 11 separate pieces; some were as thick at 6.35 cm (2-1/2") and others wafer thin. We had to come up with a solution to securely support the frill at a steep angle and make both sides visible.

<u>Procedures/results</u>

Both projects required the fossils to be supported by a single main stem. The museum clearly articulated they wanted the mounts to have an organic feel. Traditional forging techniques and styles were employed to achieve this.

<u>Mr. D</u>

A typical Beauchene display supports the main part of the skull on a straight vertical post. The outer bones are also supported by straight bars that horizontally intersect the main post at sharp right angles. The plan for Mr. D was to articulate all the bones on the lateral side of the skull and display the other half in an exploded view.

From an overhead wooden frame, the fossil bones were suspended in a general anatomical position above a central steel stem. Taking cues from Art Nouveau ironwork, expressive flowing lines that vary in width and thickness were forged to create an overall asymmetrical composition. From experience we knew that the lines would flow best if the tips of the flat bars were forged thinner. This is how natural structures grow out from a central stalk. Through experimentation we discovered that forging the tips of the flat bars both wider and thinner and then forming curves that matched the underside of individual fossil bones created perfect cradles for them to rest in. We started each mount by forming a cradle and then worked our way back toward the central post following an imaginary line that curved and twisted until it swooped down and fit tight against the vertical stem. Dimensions of the steel for individual mounts were scaled to match the size of the fossil bone it held. Thinning out the bars made them appear to be lighter and gave the impression that the individual fossil bones were suspended in space. The forged lines in three dimensions overlapped and combined with the negative spaces between the forged bars to suggest the presence of a solid form.

<u>Calli</u>

190 mm (3/4") thick mild steel plate was used to support Calli's skull from inside the palate. The Museum provided plaster casts of the palate that were made from silicone moulds taken from the fossil. From these, 2 mm (3/4") plywood pieces were cut out and carefully fit and shaped to match and fill the void making sure to support the fossil on the matrix that was left by the preparator. Test fitting the plywood forms on the actual fossil at the museum revealed that the casts were not accurate. This meant the plywood forms had to be adjusted by sanding and fitting. From these, carefully prepared drawings were sent for laser cutting the steel. The laser cut steel plates then had to be shaped at the museum, each piece one at a time adjusted to fit the contours inside the palate. This was tedious and time-consuming work. Substantial 250mm x 500 mm (1" x 2") steel supports were designed to tie into the central skull mount that would enable us to connect branches that would support the 108 kg (240 lb) frill. Forged and fitted nasal and rostral supports were then strapped to the jacketed specimen to facilitate flipping it over onto the central stem.

Our discovery that the cast of the palate was not accurate eventually led us to acknowledge that the casts of the frill we were using to create mounts for were also not accurate enough to work from. The museum delivered Calli's frill to Lynn's shop where it was supported at a comfortable working height with all pieces articulated as best as they would fit given deformation of the bones as the fossil formed. We then proceeded to create a network of increasingly smaller branches that spread across the frill from four main supports. The museum originally planned to use clear plexiglass to support areas of the frill that were thin and fragile. They performed several experiments to heat and form the plexiglass over cast sections of the frill. At Lynn's shop we continued these experiments over a period of several days, but the plexiglass did not conform to the cast pieces as well as expected. The beautiful thing about forging steel is that increasingly smaller "fingers" of steel could be made to support the fragile parts of the frill (the same overall designs on an increasingly smaller scale). In the end we forged almost sixty small pieces of steel that matched the contours of the frill. We then drilled and tapped these, so they all bolted together. The frill mounts were transported to the museum and bolted to the four branches of main stem that supports the now prepared skull. Casts of the frill were set in place on the armature, and they articulated remarkably accurately with the skull.

The methods we developed for supporting fossils facilitates access for scientific research. Our mounts are designed to enable individual fossil bones to be easily removed and examined more closely. The small fingers of steel we forged to support Calli's frill provided substantial support to the fossil without covering much of its surface. This means the exquisitely preserved surface of Calli's frill can be closely viewed from both sides without distortion.

We designed the mounts to imitate nature. Straight posts are visually distracting. Why not create lines that move more organically and vertically from the base up into the fossil that could arguably represent features of the natural landscape the creatures originally inhabited. We perceived the frill mount for Calli to represent a fern: plant material the dinosaur would have eaten. Scientists at the museum interpreted these same lines depicting the blood flow through vessels in the frill. Both interpretations provide insight about the specimen. The fuel we used to heat the steel bars that support both fossils evolved from plants that were alive when dinosaurs lived. The poetry of this work suggests that the fuel shaping the material whispers to it what shape it should become.

Health and Safety

Work on these projects took place at two separate locations: in Lynn Gratz's blacksmith shop in Strathmore, Alberta and in the Preparation Lab at the Royal Tyrrell Museum in Drumheller, Alberta.

Lynn Gratz's blacksmith shop is a metal clad building that sits on a concrete floor. It is outfitted with two propane forges, an oxy-acetylene torch, a tig welder, power hammer and two anvils. This is where all the forging and welding took place. While working in the shop, we wore steel-toed leather work boots, safety glasses and ear protection. Leather gloves were used when working with hot bars and while welding. An extraction fan provided ventilation and we wore respirators while grinding.

Shop safety equipment included two fire extinguishers, a first aid kit, bright overhead lighting and a carbon monoxide detector. Propane tanks were located on the outside of the building. Two Smiths Safety Manual, used to train employees, addressed all the risks specific to the following tools and equipment: solid fuel forges, propane forges, power hammer, oxy-acetylene, and oxy-propane torches, tig welder, angle grinder, belt sander, drill press. It also provided guidelines for safe practice for general physical labour and treatment of burns.

Site work in the Preparation Lab at the Museum consisted of drilling, tapping, sanding, filing, and assembling mount parts. We set up welding screens to contain sparks from the grinder within a clearly defined workspace. An extraction fan provided good ventilation. We followed all safety procedures outlined in Two Smiths' Safety Manual.

CASE STUDY: CONSERVATION OF A WATERLOGGED MAMMOTH TUSK

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The Project

During routine operation, a partial tusk and pelvis of a Columbian mammoth was discovered in September 2020 by an employee at M.R. Paving & Excavating in New Ulm, Minnesota. The specimens were discovered under approximately 12m (40ft) of overburden substrate and were waterlogged, making conservation of the tusk in particular difficult. Dalton Demarais, the employee who found the tusk and pelvis, wanted the material to remain in New Ulm; however, unsure of how to best conserve the fossil finds, Dr. Alex Hastings at the Science Museum of Minnesota (SMM) was contacted for identification and advice on best preservation practices. After discussing the difficulties of tusk conservation, Dr. Hastings and Ryan Henning—the curator at the Brown County Historical Society (BCHS), the final resting place of the tusk—agreed that the best course of action was to bring the tusk to SMM where it could be stabilized in the paleontology preparation laboratory. Waterlogged tusk conservation difficulties aside, 2 years after stabilization began, the dried and conserved tusk now resides safely in one piece at the BCHS.

Health and Safety

The main health and safety concerns revolved around the use of chemicals in the conservation process. The safety data sheets for every chemical used were referenced for best handling, storage, and disposal practices. Proper PPE, including nitrile gloves, safety goggles, and masks were worn when handling or when near all chemicals used during this process. Each month, when the bath was refreshed, the used chemicals were disposed of properly by museum public safety personnel.

Procedures/Results

Waterlogged subfossil vertebrate material is particularly difficult to conserve and is susceptible to damage such as cracking, distortion, and delamination during the drying process. Multiple techniques have been developed to conserve waterlogged subfossil material; however, each method presents its own problems and no cohesive solution resulting in minimal damage currently exists.

Most damage done to waterlogged subfossil vertebrate material occurs during the drying process due to differential drying, and can be exacerbated by poor preservation or degradation of the subfossil. Tusks present a unique problem—they are made up of multiple layers of dentine (ivory), are denser than bone or antler, and are more likely to crack or delaminate during the drying process, highlighting the need for a reliable conservation method.

Current guidance on conservation of waterlogged materials suggests various methods of air-drying unless the specimen has experienced loss or degradation of the original organic material. Compromised specimens may require consolidation or dewatering before drying; however, the condition of the material may be hard to determine initially and degradation may not be obvious until warping or cracking occurs—a seemingly impossible process to stop once it has begun. For these reasons, in an attempt to minimize the damage caused during the vulnerable drying process, I combined consolidation, dewatering, and drying into a single (many months-long) step. The final process involved consolidation in a solution of increasing adhesive:water ratio, followed by dewatering and drying in a bath of decreasing water:alcohol ratio.

The first problem to solve was obtaining a waterproof container that would fit the tusk—measured at about 130cm (~4.25 ft) long with a maximum diameter of 41 cm (~16 in)—and could withstand being inundated with various adhesives and solvents. I worked with our exhibits maintenance manager, Aaron Schmoll, who suggested and then purchased a 60 gallon polyethylene stock tank that we lined with a 4 mm-thick polyethylene waterproof membrane.

The next series of problems to solve was deciding what adhesive to use, appropriate adhesive:solvent ratios, and how long the specimen would need to be immersed in each chemical iteration. Acrysol™ WS-24, an acrylic colloidal dispersion, was chosen for initial consolidation due to its availability, solubility in water, fairly neutral pH, and small particle size. For the initial consolidation bath, the tusk was fully submerged in a nine-gallon solution of 10% Acrysol™ WS-24 in 90% water. After a month, the tusk was removed from the solution and the condition checked, the solution was completely drained, and the waterproof liner was replaced (as the experiment continued, the waterproof liner was only replaced if holes were present). New solutions were produced monthly, increasing the Acrysol™ to water ratio up to 50:50, with the hope that the initial lower viscosity/lower Acrysol™ solutions would provide greater penetration, stabilizing the delicate internal structure of the tusk.

After bathing for 5+ months in a consolidant solution, the tusk was then placed into a mixture of alcohol and water to begin the dewatering process. The initial mixture used was 10% isopropyl alcohol (99%) in 90% water. Isopropyl alcohol was used due to its availability and affordability. The tusk remained submerged for approximately 8 months—each month the alcohol mixture was drained and a new mixture was produced that doubled the alcohol content. The final bath of 100% isopropyl alcohol was allowed to evaporate naturally, in spirit of the slow-drying process, and took approximately 2.5 months.

Once the final alcohol solution had evaporated, I immediately but tentatively attempted to consolidate the specimen with Paraloid/Acryloid B-72 in acetone. No reaction occurred, and confident that all the water had been removed, I further consolidated the entire specimen with the Paraloid.

Minimal breakage or damage to the specimen occurred throughout the conservation process, and fragments that had broken off during the initial transportation process approximately two years prior were able to be reattached with good fits and contacts, and little evidence of shifting.

BASIC FIELD JACKETING TECHNIQUES – A CASE STUDY OF METHODS USED IN THE NIOBRARA FORMATION OF KANSAS

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Field jackets are a critical component to the work of paleontologists. They ensure safe transport of fossil material from the field to the lab, and safe storage once there. Triebold Paleontology, Inc. (TPI) has completed fieldwork for over three decades and has honed an effective set of methods for successful field jacketing that will be used to discuss techniques and safety. Topics include materials, methods of construction, personal protective equipment, and strategy for extraction. The testing of these different field jacketing methods will provide a basic set of guidelines for the successful removal of specimens from the ground. Some methods TPI uses are specific to the Niobrara Formation, but overall methods discussed here are applicable to most field areas and lithologies. Standardizing field collection techniques has the potential to improve the science of paleontology as a whole.

Field jacketing has a wide variety of construction methods and styles due to both innovation as well as the "apprenticeship" nature of learning field techniques. We investigated how jacket strength may be affected by different fabrication methods. Initially, tests to failure were performed on rectangular plates made using three layers of 45cm x 15cm burlap and USG Hydrocal White Gypsum Cement (Hydrocal). Four different methods were tested:

1) Hydrocal was added to water and allowed to fully cure (control);
2) Hydrocal was mixed with water and allowed to set but not fully cure, then was lightly sprayed with water (rain test);
3) Hydrocal was mixed with water and allowed to partially set and thicken, then water was added to thin it to working consistency (worktime stretch test);
4) Burlap was soaked in water before use, then plate was constructed the same way as the first method.

Each plate was placed between two bars of a livestock scale and tested to failure by adding incrementally more weight perpendicular to the rectangle via steel bars. The control plates and the plates sprayed with water failed at the similar weights of 22lb. and 23lb. respectively whereas the plates made with reconstituted plaster and wet burlap failed at 21.00lb. and 17.50lb. respectively. These results indicate that constructing field jackets using water-soaked burlap or reconstituted plaster will weaken the jacket and are, therefore, inferior techniques.

Additional tests examined whether burlap cut parallel to the weave (straight-cut), or diagonal to the weave (bias-cut) affects the overall strength of the jacket. Hydrocal was mixed in the control method and strips were soaked in the mixture. Three layers of bias-cut burlap strips were laid flat in alternate orientations to create a test square. The resulting square was tested to failure using the same method as above, and was compared against identical flat squares constructed with straight-cut burlap. Results showed that the bias-cut squares failed at 60.50lb. whereas squares made with straight-cut strips failed at 52.50lb., which showed a substantial strength difference. The authors further tested the strength of weave orientation using simulated Niobrara Formation jackets. Multiple polystyrene foamboard forms were used to construct identical three-dimensional templates. These templates then had an identical number of Hydrocal-saturated strips applied and were allowed to fully cure in order to construct test jackets. The foam forms were removed from the simulated jackets before testing to failure. This testing method involved placing jackets across the two bars of a scale and stacking containers of steel ballast on the jackets until failure occurred. These results indicate that straight-cut jackets failed under substantially less weight at 250lb. as well as more catastrophically than bias-cut jackets which withstood 315lb. of weight before failing gradually, a 26% increase. The results of this experiment show that a minor change in the direction that burlap strips are cut will easily and substantially increase strength and resilience of field jackets. This method allows field crews to ensure their jackets will better protect delicate fossil resources as they are extracted, transported, stored, and prepared. In many cases, the method will allow the field jackets to be built with less material, allowing conservation of materials and making the extracted jackets lighter, which may be of importance when a remote dig site is only accessible by foot over long distances. In summary, constructing field jackets with bias-cut burlap is worth consideration by any and all field paleontologists.

AN ABUNDANCE OF BISON: PRESERVING NON-PERMINERALIZED BONES OF BISON OCCIDENTALIS

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The Project

Fossil preparators must consider many factors before beginning a project. The type of fossil, its condition, mode of preservation and the type of rock it is encased in, dictates their approach. With experience, preparators develop the skills to help them discern which tools are best to use, which types of consolidants and adhesives may be necessary to stabilize and conserve the specimen, and what type of archival housing and support the specimen may need once it is ready for collections. But what would their approach be if they are presented with un-fossilized bone? It is here where a fossil preparator's skills may cross over into the realm of zooarchaeology, where they are dealing with non-permineralized bone thousands of years old as opposed to tens of millions of years old. Such is the case with bones recovered from the Olsen-Chubbuck Paleoindian bison kill site, where ancient hunters stampeded a herd of *Bison occidentalis* into a narrow arroyo, trapping the animals for butchering. Amateur archaeologists Sigurd Olsen and Gerald Chubbuck discovered this site southeast of Kit Carson, CO in 1957 on private land. They, along with staff from the University of Colorado Museum of Natural History, completed the excavation of this site in 1960. The remains of nearly 200 *Bison occidentalis* representing both sexes and all age ranges were recovered. Projectile points found among the remains were identified as being from the Firstview Complex, with the radiocarbon date of this site at about 8200 BCE +- 500. (Wheat et al., 1972). The bones are currently housed in the Museum's anthropology collections, including several skulls and some post-crania still in their original burlap and plaster field jackets. The field jackets had deteriorated over time and the bones within were beginning to fracture and crumble and at risk of further damage if their condition was not mitigated. Fortunately, the anthropology department was awarded a grant from the State Historical Fund of Colorado to have these specimens prepared and rehoused properly.

<u>Health and Safety (H&S)</u>

A fume hood in the Paleontology lab was used when mixing up Paraloid B-72 (formerly known as Acryloid B-72), consolidant and adhesive and then stored in a fire-proof cabinet when not in use. An overhead dust collector hose, safety glasses, face mask and ear plugs were used when using a multi-tool saw to trim plaster and fiberglass archival cradles.

<u>Procedures/Results</u>

Before preparation began, communication with the curator of archaeology and the anthropology collection manager was necessary to discuss what the workflow would be and what the final disposition of the prepared material might be. It was decided that there was some potential for this material to be used for future research, exhibit and educational purposes. Because un-fossilized bone may still contain most of its original organic material, there may be a desire to collect samples for future biological and chemical analysis. Therefore, it was decided that the use of consolidants and adhesives would need to be kept to a minimum as they could contaminate and obscure any data retrieved from sampling. However, with some of the skulls from this site, it was evident that consolidants and adhesives had already been used either in the field or sometime thereafter. Elmer's glue diluted in water was the consolidant of choice at the time (Wheat et al., 1972).

The post-crania and skulls are encased in fine-grained sand and silt that had filled the arroyo after the animals were killed and butchered. A small sample of the matrix surrounding the bones from each field jacket was collected in case future soil analysis is desired. The bones were cleaned under magnification using a damp, soft-bristled toothbrush. The dry, unfossilized bone is very porous and becomes very soft when wet, so extra care was taken when using metal dental tools, as they could scratch and gouge the bone. Using paper towel to blot up any excess moisture prevents the bone from getting saturated and helps it to dry quicker. Much of the bone was broken or fractured so at times it was necessary to use a consolidant and adhesive. A roughly 5% and 25% weight to volume solution of Paraloid B-72 in acetone was used as a consolidant and adhesive respectively. Paraloid B-72 is recommended for archaeological faunal material due to it being durable, stable, and reversible and unlikely to alter the material to which it is applied (Sease, 1994; Stika et al, 2017). The old diluted Elmer's glue consolidant that was used on the skulls happened to be soluble in acetone, so much of it was able to be removed, along with the dirt that it was sticking to. Using a soft toothbrush dipped in acetone, the specimen was gently scrubbed and paper towel was used to blot up the dissolved consolidant and dirt. As preparation of the specimens was completed, each skull was digitally scanned and a 3-D digital model produced for educational purposes. Catalog numbers were assigned and the post-crania were identified, labeled, and placed in archival specimen boxes, while custom support cradles were built for each of the skulls using fiberglass reinforced (FGR) Hydrocal plaster and fiberglass cloth with ethafoam used for bedding. All treatments were recorded on Preparation and Conservation forms for future reference.

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THE 'TUNA CAN' FIELD JACKETING METHOD

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The Project

Field jacketing is one of the most tried and true fossil preparation techniques used to safely transport and house delicate specimens— yet they can be notoriously heavy, cumbersome, and challenging to open once back in the lab. One method that aims to minimize these issues often faced by preparators can be referred to as the 'tuna can' field jacket. While this technique may not be new or novel to seasoned professionals, many burgeoning paleontologist and preparators may find this time-saving method advantageous as it: (1) saves lab time by substantially easing the difficulty of opening; (2) reduces overall weight of the field jacket; and (3) minimizes specimen damage upon opening.

Procedures

This method is a 2-part field jacket consisting of a body and a lid. The body is a standard, sturdy plaster field jacket that wraps along the top and sides of the specimen and surrounding matrix before the block is flipped. The lid is a slim cap consisting of 2 to 4 layers of plaster-dipped burlap that is used to seal the jacket after being flipped and excess matrix has been removed. The matrix should be recessed well below the side walls of the jacket body to create a rim for the lid to adhere to. Then a separator (such as dampened toilet paper) should be applied on top of the remaining exposed matrix and surrounding rim of the body. When applying the lid, it is important to place the plastered burlap strips up and over the raised walls of the body. This overlapping of the body's rim and lid are what creates the 'tuna can lip'. Opening a field jacket using this method should produce a much easier and time effective task than a standard, smooth field jacket. Recommended tools used for opening include industrial scissors and/or farrier trimmers. These are used to trim along the rim of the lid— much like using a can opener. Power tools are typically not necessary for opening small to moderate-sized jackets, therefore reducing potentially damaging vibration and minimizing the risk of unwittingly cutting into the fossil. Once the rim has been completely cut, the lid should lift away from the matrix/specimen with relative ease. This field jacket design minimizes risk to the specimen inside, as well as physical effort and anxiety for the preparator.

Health and Safety

Being that fieldwork can be performed in varying locations and environments, it is important to always take your surroundings into consideration. Weather, terrain, flora/fauna, site accessibility, and access to supplies all have the ability to impose unique challenges. Standard safety gear should always include a First Aid kit, safety glasses, tough gloves, wide-brimmed hat, sunscreen, and ample hydration. During the process of removing the plaster cap in the lab, adequate ventilation is heavily recommended as are safety goggles, gloves, mask, and First Aid kit.

THE APPLICATION OF A SOLVENT GEL TO FIX THE MAMMOTH SITE'S GLYPTAL CONUNDRUM

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The Project

Glyptal, a cellulose nitrate adhesive made for a variety of applications such as bonding and varnish, was used in fossil preparation for several decades (e.g., Brink, 1957; Rixon, 1976). Prior to 1986, Mammoth Site staff and volunteers used Glyptal to preserve its in situ collection in the Bonebed. This later proved detrimental, as it was discovered the Glyptal discolored over time and never penetrated the bones to stabilize within, leaving a brown, shiny coat on the bones' surface often too thick to see the detail underneath (aging properties of cellulose nitrates are thoroughly outlined by Koob, 1982). All the while, the bones continue to degrade.

It was recommended by a colleague to try using solvents suspended in a gel, much like art conservators use to remove yellowed varnish from old paintings. When held in gel form, the solvents do not soak into the bone, instead lingering on the surface and reactivating the Glyptal.

The goal of this study was to determine the easiest and quickest ways – in terms of time and resources used, and in mitigating damage to specimens – to remove small areas of Glyptal. By exposing bone surfaces underneath the Glyptal, thin (5 and 10% w/w in acetone or ethanol) mixtures of Paraloid B-72 may be applied to consolidate specimens properly. Eventually, the Mammoth Site's Division of Research hopes to remove all Glyptal from its specimens and to have them fully consolidated.

Health and Safety

The Mammoth Site's in situ dig site is located inside a permanent building, which protects its employees from the standard field hazards. The primary hazard during this project was the fumes from both the solvent gel and the solvents. A respirator was worn to mitigate exposure to these fumes. Typically, the application of the gel before being covered by plastic wrap was brief enough that the fumes were not significant, but one must err on the side of caution. The secondary hazard would be the absorption of the above substances into the skin, so gloves were worn during the entire process.

While solvents and their fumes do pose a flammability risk, no flames or sparks are a part of this process, nor are they present in the Bonebed itself.

Procedures and Results

Variables tested:

- Timing

- Number of fresh gel applications
- Addition of gauze
- Solvent ratios

Uncontrollable variables:

- Bone quality under the Glyptal (e.g., porous, smooth, cracked, friable, …)
- Thickness of Glyptal
- Glyptal adherence to bone surface
- Other substances present
- Personal performance each day

Materials used:

- Bamboo skewer (flattened the point to a chisel)
- Broad dental curette
- 1:1 acetone, ethyl alcohol solvent mixture
- Kimwipes
- PPE (gloves, respirator)
- Gauze surgical sponges
- ¼ inch masking tape
- Scissors
- Brush and/or aspirator
- PVC film (plastic wrap)
- Paraloid B-72 10% w/w in acetone
- Scale bar

Multiple in situ *Mammuthus columbi* rib specimens were selected in the bonebed for this study (94HS016, 94HS017, 07HS173). Ribs were preferred for a few reasons: one can expect them to be fairly identical in size and shape, and they are quite prolific within the bonebed.

For each variable tested, the ribs were partitioned with masking tape, marking cells roughly equal in area. Similar cell size ensured working area was not a variable affecting the results.

In order to grade each cell as quantitatively as possible, a rating system was implemented to score them on how difficult they were to clean. This scale was kept simple:

1. Easy. Removal required less than 8 minutes. Bone surface not scraping off with Glyptal.
2. Moderate. More time needed. ±Some issues with bone. Used more caution.
3. Difficult. Glyptal stubborn. Bone continually breaking off with Glyptal despite best efforts.

Things considered when rating a cell include working time needed to clean it and whether or not the bone surface was flaking with the Glyptal. The default rating is 1. If cleaning a cell required greater than 8 minutes, or if any bone damage was noted, a point was added, with a maximum result of 3. The 8-minute maximum is completely arbitrary: the parameters are fairly strict in order to narrow down the simplest Glyptal removal method.

The solvent gel was made following the recipe outlined in "Cleaning fossil tooth surfaces for microwear analysis: Use of solvent gels to remove resistant consolidant" (Williams and Doyle, 2010). The recipe includes three solvents (xylene, acetone, and ethyl alcohol) mixed with a water-soluble thickening polymer (Carbopol EZ2). Ethomeen C/25 is added to neutralize the acidity from the Carbopol (pH = 4-5).

The Williams and Doyle, 2010 paper was also the guide for how to apply the solvent gel to the specimens, though their methods were adapted slightly for the study herein.

1. Slather about a 1 cm thick layer of gel on the area.
2. Wrap plastic film over the gel to keep air out, without applying too much pressure.
3. Leave gel on area for 20 minutes.
4. Use the plastic film to grab the gel and remove from the specimen. Wipe any remaining excess with a paper towel or kimwipe.
5. Use desired tools to manually remove the Glyptal.

These steps were modified for each variable as needed.

Experiment 1 – 08/06/21
The first two variables, timing and number of fresh applications, were able to be tested together (07HS173). A control cell, Cell 0, was added to test using solvents and tools only – the Glyptal removal method being used already. The steps above were followed for Cell 1, but the time was bumped up to 40 minutes for Cell 2. For Cell 3, there were two applications of the gel, each with a 20-minute resting time.

Experiment 2 – 09/07/21
The addition of surgical gauze was tested next to see if it would affect how the solvent gel interacts with the Glyptal (94HS016). Cell 1 followed the standard application (i.e., solvent gel under plastic film for 20 minutes). Cells 2 and 3 both had gauze on top of the solvent gel, but Cell 3 did not have the plastic film over it.

Experiment 3 – 11/19/21
The final test was with a separate solvent gel mixture (09HS017). The amount of ethanol and acetone was halved, and in their place doubled the amount of xylene. Additionally, elements of the previous variables were tested with this mixture. Cell 1 remained the standard application. Cells 2 and 3 repeated some of Experiment 1: a single application of gel with a 40-minute resting time, and two applications of gel with a 20-minute resting time each, respectively. Cell 4 mimics Experiment 2 with an added layer of gauze

Others – 11/22/21
After the three of the above experiments, there were a couple other things to try. A standard gel application was tested, but only using the 1:1 solvent mixture and Kimwipes to remove the Glyptal after the gel was removed. And because it had been

quite some time since testing the control (Experiment 1; Cell 0), an area without the gel altogether was re-tested, also using only the 1:1 solvent mixture and Kimwipes.

Experiment 1

Control Cell 0: Required the full 20 minutes (while waiting for Cell 1) to manually clean with solvent, wipes, and manual tools. Because this specimen is relatively smooth, and the Glyptal layer was thin, it was overall not too difficult to clean, though it took more careful effort in the crevices = 2

Cell 1: Took about 15 minutes to clean, though some spots were more fragile and required more attention to avoid damage. Difficulty comparable to previous cell, about the same = 2

Cell 2: Took just under 10 minutes. Some tough areas just as in previous cells. Some layers of Glyptal peeled off with no issues = 2

Cell 3: Only took about 5 minutes. Removal was easy, though there seemed to be no particularly fragile areas = 1

Experiment 2

Cells 1, 2, 3: All cells took about 10 minutes to clean, at about a 1.5 rating. That is, it took 10 minutes to do all of the cells at once, not 10 minutes each. No damage to bone noted. It seems that Cell 3 took the least effort, but results were the same across this specimen. Variables that may have led to the short working time include: the quality of the specimen itself (i.e., smoothness vs. porousness); thickness of the Glyptal; our performance that day. Please note: the former Mammoth Site Preparator helped me clean the cells today – all other testing was done by only myself.

Experiment 3

Cell 1: Took about 9 minutes to clean using a bamboo skewer. A 1:1 solvent mixture (acetone and ethyl alcohol) was used to keep the Glyptal malleable. This cell's area was relatively smooth, and overall fairly easy to clean with very few issues with the bone = 2

Cell 2: Needed about the same time as Cell 1 (8 to 9 minutes, had a mishap with my timer and had to estimate). Used the bamboo skewer and a broad, oval-shaped dental tool to scrape. This cell was a bit easier to clean than Cell 1, but hardly notable = 2

Cell 3: Took just over 7 minutes. Again used the bamboo skewer and dental tool. No issues with bone. Glyptal would not peel, just had to scrape. Overall simple cleanup = 1

Cell 4: Needed about 8 minutes here again. Used the bamboo skewer and a broad, oval-shaped dental tool to scrape. There were some portions of this cell with rougher texture, resulting in some wasted time and making cleanup somewhat more difficult = 2

Others

With gel: Test cell required 2 minutes to clean. Used only the 1:1 solvent and Kimwipes after the gel was removed.

Without gel: Test cell required several minutes to clean. Again, only used the 1:1 solvent and the Kimwipes, but it definitely took more effort.

No particular variable that was tested appears to significantly streamline Glyptal removal over another. There are some minute differences, largely in the length of time it takes to clean a cell, but ultimately the gel always loosens the Glyptal allowing it to be removed, and the variation in time needed is a matter of only a few minutes. Ease of Glyptal removal did not vary among the variables significantly either.

Besides using multiple fresh applications of the gel (Experiment 1; Cell 3), which is both resource and time intensive, the best method determined herein is letting the gel rest for 20 minutes, then wiping the Glyptal off with Kimwipes and solvent. Manual tools may be used in addition for thick globs of Glyptal that are not simply wiped off. Using this method saves both on resources and time, especially in terms of training our summer interns and Ice Age Explorers (the Mammoth Site's summer volunteer program) in the process; little expertise is required by simple elbow grease as opposed to the fine dexterity needed for fine-tipped dental tools on sub-fossil bone softened by the solvent gel. Additionally, while one area is being cleaned, another area can begin its 20 minute solvent gel resting period.

Based on the author's experience, it's recommended to apply the solvent gel to small areas, no greater than 9 square inches (e.g., 3" x 3"). The maximum area may be smaller depending on the size and fragility of the specimen or the state of the bone's surface (e.g., is the exposure cancellous bone? Is the cortical bone pitted or friable?). The reasons for the area maximum are as follows: First, the solvent gel will make the Glyptal malleable again, but for a limited time. While the 1:1 solvent mixture can maintain the malleability of the Glyptal, more will be needed for larger working areas as the Glyptal sets again, and one can only work on so much space at a time anyways. Second, the majority of the specimens are not stabilized (i.e., the previous adhesive choices did not penetrate the bone's interior), so if significant amounts of Glyptal are softened or removed before a thin Paraloid B-72 can be applied, one risks the specimen falling apart in the working area. And third, excess fumes from both the gel and the solvent will accumulate in the working space and may create a health hazard without the proper PPE, a resource that may be limited depending on the size of the institution.

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HANDS-ON! BREAKING OUT OF THE OUTREACH TRADEOFFS BETWEEN FOSSIL SPECIMENS AND TRADITIONAL REPLICAS BY UTILIZING 3D PRINTING

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The Project

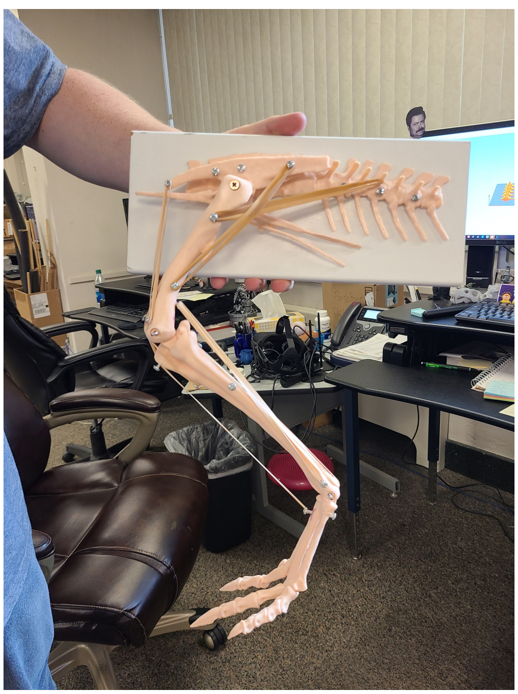
Engaging the public in paleontology is both enhanced and hampered by the use of original fossil specimens. While original fossil specimens allow members of the public to interact with the actual remains of ancient organisms, this very interaction can create issues for the safe care and long-term preservation of the fossil. Likewise, destructive analysis can render fossils unsuitable for many forms of outreach, and standard conservation methods dictate that handling and movement of specimens should be limited to minimize stress and damage to specimens. This creates a conundrum that in the past has been addressed by museums and schools through the use of cast reproductions. There are conservation concerns around the creation of molds for casting, and not every specimen is suitable for traditional casting. Most traditional casts are either heavy (plaster) or brittle (resin), limiting their utility. Additionally, museums and schools may not have appropriate specimens to make reproductions from, or lack the skills or resources to create cast reproductions to fill outreach needs. The Idaho Museum of Natural History (IMNH) has approached this problem with modern 3D scanning and printing technology to create outreach objects that can be created easily, cheaply, and without traditional conservation concerns associated with molding. While the IMNH has been able to balance conservation and outreach needs for fossils and fossil replicas, the education team expanded the range of outreach possibilities by using the scalable and modifiable properties of digital replicas. This has allowed us to create interactive physical models of real fossils held in our collections, that enable the public to interact with past life on Earth in ways that original fossils and traditional cast replicas are unable to provide.

Materials and Results

Three specific completed projects are described here, along with future directions as well as implications for this type of project at other institutions. All projects described here were printed using the FDM 3D printing, with 1.75mm PLA filament. All models were printed on commercially available printers, such as the Creality Ender 3 Pro and Vivedino Troodon, and were digitally sliced using the software Cura (current version as of the print date). 3D models of *Oryctodromeus* were created using fossil reference material within the collection of the IMNH in the program Zbrush and modified using

MeshMixer and ZBrush as described below. Modern eggshell specimens were micro-CT scanned by third parties and imported into ZBrush for modifications described below.

Oryctodromeus is the most common non-avian dinosaur fossil found in Idaho, so its utility for outreach at the K-12 level in Idaho is clear. While numerous articulated and associated specimens exist, these are often still partially contained within their matrix. As a fossorial dinosaur, the biomechanics of *Oryctodromeus* are of particular interest for students and the public. Museum education staff decided that a hands-on model of the hindlimb that participants could physically manipulate would be the best way to disseminate information about how *Oryctodromeus* is thought to have removed sediment from its burrows. In order to create such a model for use, a 3D model of the hindlimb of *Oryctodromeus* was constructed in ZBrush. The sacrum, first three caudal vertebrae, ilium, ischium, and pubis were fused in the digital model, sliced medially to remove their right sides, and printed as one piece. The left femur had a digital roller joint created within the distal articular surface, and a hole inserted through the proximal end, perpendicular to the femoral head. The tibia, fibula, astragalus, and calcaneum were digitally fused, with their proximal surface having a joint digitally inserted to articulate with the new distal femur joint. The distal articular surface of this lower leg file was modified in a manner similar to the distal femur, to allow for a movable joint between the astragalus/calcaneum and the metatarsals. The bones of the foot, from the metatarsals to the ungula were likewise fused into a single file after being digitally articulated into position in ZBrush, with their proximal articulation modified to articulate with the captive astragalus-calcaneum joint. These separate units



(pelvis, femur, tibia-fibula-astragalus-calcaneum complex, foot complex) were all exported as .OBJ files for slicing and final printing on a Vivedino Troodon 3D printer. When printed, this allowed the entire leg to be mounted on a board, using a carriage bolt through the femoral head and two cotter pins to ensure that the knee and ankle joints remained captive. Once mounted, one of the authors (TG) attached screws to the pelvis, tail, and leg at approximate locations for muscle attachment and insertion points. This allowed outreach participants to use rubber bands to simulate the movement of the leg by recreating the leg muscles of *Oryctodromeus*. By having participants create these attachments, outreach staff were able to quickly assess prior knowledge and build on simulated muscle placements to discuss target topics, such as non-avian dinosaur stance and fossorial behavior in *Oryctodromeus*. The participant involvement in the creation of the model also follows pedagogical best practices for creating lasting learning. This would not have been possible with traditional casts, due to their weight and/or fragility, and certainly would not have been possible using original fossils for a multitude of reasons. Only 3D printing technology made it possible to construct this functional, engaging outreach model on a budget of tens of dollars, which is a very low barrier to entry. Some accuracy in the bony anatomy of the pelvis and hindlimb was sacrificed for the sake of creating functional joints, but the payoff of a functional leg model far exceeded the significance in loss of fidelity within the joint, especially as most of the joint surface is not visible during the functioning of the model.

Oryctodromeus was also used to make a creative "free-play" interactive with the educational goal of understanding how bones articulate in the vertebrate skeleton. The IMNH has a large (1.23m x 2.44m) metal plate wall for magnetic play in our "Discovery Room," a space dedicated to open-ended discovery play for young visitors. Prior to fall 2022, this wall only featured geometric magnetic models, which were well-received by visitors but did not connect with the natural history mission of the IMNH. Using the same base *Oryctodromeus* model described above, the skull, lower jaw, and nine cervical vertebrae with their attendant right cervical ribs were isolated and imported

into MeshMixer. Here each vertebra and the skull were sliced medially, leaving only the right portion of the model. A block was inserted into the model of the lower jaw between the dentaries to serve as a spacer, and then this model was sliced as well. The cervical ribs were digitally fused to their vertebrae, allowing each vertebra-rib unit to eventually print as a block. On the medially-sliced surface, hollows were created for the mounting of magnets. This consisted of creating a cylinder using the MeshMix tool in MeshMixer and placing it on the cut surface. The diameter of the cylinder was set to be slightly larger than the magnets selected for this project (3mmx1mm circular neodymium magnets, cylinder diameter of 3.25mm). The cylinders were sunk into the cut surface by selecting the boolean subtract function before confirming the object creation. The skull, mandible with support block, and each vertebra/rib complex were exported as .STL files for slicing and eventual printing on a Creality Ender 3 Pro. The magnets were test fitted into the mounting holes before final assembly, and holes were adjusted as needed using a rotary tool with a diamond ball bit. Magnets were attached using cyanoacrylate glue before the flat surface was covered in felt. The felt serves to both inhibit magnets from becoming dislodged during use and prevent wear on the print itself. The use of natural history objects in the open-ended play area strengthens the connection between this area of the museum and the more formal display areas in the gallery. In addition, it allows visitors of all ages to participate in "putting together a dinosaur skeleton" (though currently only the head and neck are on the wall), creating an authentic, personal connection between the fossil objects represented by the print and the visitor. Additionally, this hands-on experience allows non-sighted and vision-impaired visitors to have an experience they would not otherwise have within a traditional gallery setting. The reduction in anatomical accuracy by including a jaw support and other support materials is offset by the educational and accessibility gains of visitors being able to manipulate portions of the skeleton. This project was accomplished for a material cost of ~$7, and can be adapted to any magnetic surface in a museum.

Manipulation of low-cost, high-fidelity objects is one of the main advantages of 3D printed replicas, but it is not the only one. The scalability of objects preserved digitally means that larger-than-life-scale objects can be created, showcasing features otherwise invisible to the naked eye or hand. The IMNH education department created outreach around egg porosity with precisely this scaling in mind. The educational objective was to raise awareness about egg porosity and secondarily how eggshell from different taxa can have differing thicknesses. In order to do so, eggshell models were needed that could have water poured through them to simulate egg/environment gas exchange. Authors used micro-CT data from eggs of the Orinoco crocodile (*Crocodylus intermedius*) and the ostrich (*Struthio camelus*) for the basis of this outreach model. In ZBrush, small portions (approximately 1cm x 1.5cm) of each egg were isolated from the total model. These sections were then scaled up approximately 20x life size, allowing the microscopic surface texture and pore spaces to become visible without magnification. The center portion of the eggshell section was then deformed using the Move Topology tool to create a strong concave surface, compensating for the loss of curvature from a small sample location. This modification was done in order to allow for water to easily drain to the pore spaces during interpretive programming. Blind pores (pores that did not fully penetrate the shell) were digitally filled in order to prevent water from becoming trapped within the print layers. These files were then exported to .OBJ format for slicing and eventual printing on a Vivedino Troodon 3D printer. When used in programming, the eggshell slices are well received as participants are able to easily see the difference between eggshell thickness and pores. They are able to make predictions about the gas exchange and readily observe the water flow as a test of their predictions. While accuracy has been sacrificed both in the curvature of the shell and the overall number of pores, the model serves as a better representation of an egg to participants than a more-accurate (flat) shell 3D print would; participants expect eggs to have curvature and were surprised to find that the small pieces are essentially flat at a small scale.

In conclusion, the expansion of 3D imaging and printing technology has allowed new methods of outreach to be realized in museum settings. Museums leveraging these technologies can not only better conserve their original specimens but reach audiences in new ways and bridge gaps that traditional outreach programs possess and strengthen the learning experience for all participants.

Health and Safety

3D printing technologies can produce potentially harmful vapors. All 3D printing is conducted in well-ventilated areas of the Idaho Virtualization Laboratory, equipped with air purification systems. Filament material used in FDM (filament deposition method) printing is polylactic acid (PLA), which is non-toxic for handling in both filamentous and final object form. Non-toxic paints are used for final fit and finish, as required.

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COMPARISON OF TENSILE STRENGTH FOR SOME COMMON PLASTER JACKETING FABRICS IN PALEONTOLOGY

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Paleontological jackets serve to safely stabilize fossils while they are being removed from the field, transported, and stored for later preparation. They are the first step that we as paleontologists take to protect the fossils that we work to preserve, so we should develop a knowledge of the material properties of jacketing materials to better identify what is most appropriate in different situations. Current literature on jacketing methods includes qualitative observations on jackets made with different materials and methods. However, very few quantitatively measure and compare the mechanical properties of jackets. To address the lack of published literature, this research used American Society for Testing and Materials International testing standards that were adjusted based on similar work in the medical field to develop a method of collecting and comparing the tensile strength data for plaster jacket material when made with different fabrics, including 10-ounce burlap, chopped strand mat fiberglass, and polyester quilt batting.

Ten plaster jacket test strips were made for each material, all 15.0 x 6.0 cm in dimension and three layers of fabric thick. Plaster was mixed in a two-to-one plaster to water ratio using USG No. 1 Casting Plaster. Test strips for burlap, which has a specific fiber orientation in its weave, had its fibers orientated parallel with the testing direction of the test strips. All strips were made at the same time by the same individual to ensure humidity, temperature, and technique were consistent. The thicknesses of the test strips were measured, and a material testing machine was used to collect the tensile strength data of the test strips while applying an axial load of 10.0 mm min^-1 until the test strips failed. The data were then compared statistically using both ANOVA and Kruskal-Wallace univariate tests and their post hoc pairwise tests to assess significant differences between groups.

The results of the testing showed that plaster jackets made with different fabric materials in similar dimensions with the same number of layers all had differences in their tensile values that were statistically significant with all p-values being less than 0.001. More specifically, the plaster jackets that reported the greatest tensile values, in order, were chopped mat fiberglass, 10-ounce burlap, and then lastly, polyester quilt batting. Mean maximum tensile loads of 1603.48, 570.20, and 239.44 pounds of force and mean peak stress values of 1100.86, 600.68, and 182.50 pounds per square inch were recorded for chopped mat fiberglass, burlap, and polyester quilt batting jackets respectively when made to similar dimensions with an equal number of layers. As can be seen with the peak stress values, different fabrics made jackets with different thickness with the average thickness being 0.619 inches for chopped mat fiberglass, 0.402 inches for 10-ounce burlap, and 0.558 inches for polyester quilt batting.

Though there are other considerations to be made when choosing materials for jackets, these results suggest that as jackets will become subjected to greater tensile force (i.e. contain larger specimens or have wide and thin areas at significant risk of flexing/bending), one should consider the use of chopped strand mat fiberglass, and subsequently burlap, for their jackets over polyester quilt batting to avoid jacket failure. More importantly, the results show that the tensile strength, and other mechanical properties, of jackets can effectively be tested and compared, providing the opportunity for further quantified measurement and comparison of jacketing materials and methods in the future.

LIFT WITH YOUR COMPUTER, NOT WITH YOUR BACK: VIRTUAL RECONSTRUCTION OF A 450-MILLION-YEAR-OLD JIGSAW PUZZLE USING PHOTOSHOP

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In late 2019, the Invertebrate Paleontology Department at the Harvard Museum of Comparative Zoology (IPMCZ) purchased thousands of pounds of specimens from the ~450-million-year-old Fezouata Formation of Morocco. The IPMCZ arranged for this material to be shipped in late Spring 2020, but due to the pandemic and delays in shipping, the specimens arrived in five crates in Fall of 2021. Unpacking of these crates took place during the fall and winter and was finished by end of Summer 2022 with over 7500 specimen blocks accounted for. From field photographs, it was known that some of the largest blocks—weighing upwards of 60kg!—fit together to form a massive block measuring ~4m x 3m and representing numerous large radiodont specimens in a death assemblage. Exactly how these blocks fit together was not apparent. The only indications of which blocks made the assemblage was a numbering prefix of "A4(34-xx)" in the field number marking the original location, and a blurry, scaleless photograph of the blocks assembled at the collection site. Also, many of these blocks were damaged during shipment and broken into many pieces, making them hard to recognize in the original field photograph. The unpacking process made clear a great need for manual labor and time to safely assemble the blocks, so a virtual method was devised to recreate the collection site.

Before recreation of the collection site could begin, repairs were made so blocks were durable enough to be moved. This required painstaking hours of reconstruction and many more hours—sometimes days with the larger breaks—to allow the adhesive (Paraloid B-72, 40% solution in acetone by weight/volume) to fully cure. Once repairs on the A4 blocks were finished, the blocks were photographed using a Nikon D3300 digital camera with Nikon AF-S DX Nikkor 18-55mm lens. It was important that zoom settings on the lens remained the same, and also important that photographs were taken from the same height to ensure scale was the same for every piece. The largest block was photographed first, and camera settings and tripod height were kept the same for all remaining photographs.

The backgrounds were then removed from the photographs using Photoshop (Adobe Photoshop Version: 24.0). The photographs were uploaded as a layer and unlocked (done by clicking on the lock symbol on the layer). The background was removed by pressing the "Remove Background" button (under Quick Actions in the Properties tab). On occasion, another specimen or tripod leg remained after background removal. These leftovers were removed using the Eraser Tool from the Tools window.

Once backgrounds were removed, the photographs were exported as a PNG to a specified file folder. Unlike other file formats, PNG files allow the background to remain transparent after export. This transparency feature was key for virtually arranging the block photographs. In Photoshop, the photographs could be moved around like puzzle pieces when loaded together in the same canvas. Using the field photograph as a guide, the block photographs were virtually arranged until they resembled the photograph taken at the collection site. This was done in Photoshop by opening one of the PNG photographs, then dragging the next PNG photograph from the file folder. Photoshop allowed for complete maneuverability of the pieces. As the photographs were dropped onto the canvas, the photographs became a new layer, and were given the specimen field number as a name. Once the proper placement of the specimen on the canvas was located and the photograph placed, the area was cropped to enlarge the canvas.

Using this virtual arrangement, a physical plan was made to arrange the blocks on the floor with minimal movements. It took two people a few hours to move and assemble the blocks because the location of each block was known beforehand. By using Photoshop to piece together the blocks virtually, specimens were moved only once and set into their exact position, saving precious time and backbreaking labor.

USING ACCESSIBLE GIS SOFTWARE TO IMPROVE DATA COLLECTION AND WORKFLOWS

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Using Accessible GIS Software to Improve Data Collection and Workflows Geographic information system software can be a powerful research tool, but is colloquially considered too expensive or complex to adopt for some institutions. The Raymond M. Alf Museum (RAM) has integrated ArcGIS Online into our fieldwork and collections workflow, allowing us to produce maps that are useful for our teams in the field and collections. RAM's subscription through Esri for ArcGIS Online has the benefit of being the cheapest option for any creator license, and literacy in ArcGIS Online is relatively simple compared to more comprehensive software like ArcGIS Pro.

RAM uses the mobile maps app ArcGIS Field Maps, which integrates with ArcGIS Online. Our digital maps are prepared ahead of a field season through a relatively simple process. Existing locality data from a field area such as latitude/longitude, locality name/number, descriptions, etc., is exported from Specify as a .csv file (most other databases have similar export capabilities). This .csv file is then uploaded as a feature layer in ArcGIS Online, then exported to the Field Maps app. Once in the field, this feature layer can be viewed on Field Maps on a phone or tablet and will display the chosen data from the original .csv file. Through Field Maps a new locality with associated data--including coordinates in WGS84 and photos--can be recorded.

Locality data collected using Field Maps is supplementary to written notes, but has the benefit of being exported as a .csv for easy cross-referencing. Additionally, new data recorded in Field Maps is shared across all devices and can be viewed live by our collections staff back at the museum. ArcGIS Online and Field Maps has also allowed RAM to revisit old localities to verify their integrity. Many of these historic localities don't have reliable coordinates or are only recorded on a physical map. By plotting them in Field Maps and finding them in the field, those localities can be manually adjusted to specific outcrops or old quarries.

There are limitations to ArcGIS Online and Field Maps. There is limited ability to create tile layers--a feature in ArcGIS Pro and Enterprise--which would allow us to view land ownership or geologic formations. Regardless, while RAM has yet to explore full functionality of these programs, they have allowed us to rapidly streamline our field-to-collections process and, importantly, standardize how we collect data in the field. Future work will involve applying other ArcGIS programs such as StoryMaps to our outreach and teaching functions, and standardizing the production of persistent maps to house and display locality data.

HOME IS WHERE THE FOSSIL IS: NAVIGATING A WORK FROM HOME INITIATIVE DURING A GLOBAL PANDEMIC

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In 2020, institutions closed their doors as the global community prepared to face a pandemic. The Natural History Museum of Los Angeles County (LACM) permitted qualified staff, individuals who safely handle collections items as part of their daily job, to work from home (WFH). The following workflow outlines how LACM staff safely and securely selected, documented, transported, tracked, and prepared specimens at a place of residence during a global pandemic.

To ensure specimen safety, limitations on WFH specimens were formerly summarized by LACM based on insurance value, scholarly or scientific value, fragility/delicacy, accessioned vs. non-accessioned status, loaned material, and living situation. LACM required a description of the temporary work space which had to be a well-ventilated area accessible solely by household members but separated from pets and children. The institution's Director of Safety and Risk Management evaluated the working conditions including equipment and chemicals that were requested for at home use. Appropriate containers, especially for the storage of chemicals, were to be utilized, labeled, and kept away from children. Ethanol had to be stored away from ignitable sources. Proper personal protective equipment was mandatory. The preparator had to review and retain a copy of the safety data sheet for all chemicals temporarily used at their residence. To complete offsite work, tools and equipment in which the preparator had demonstrated capability of operating could be taken home.

Collections staff chose WFH specimens based on availability of recorded data, weight, shape, ease of transportation, and preparator capability. For example, specimens from Southern California salvage projects were picked because the fossils were well documented, partially prepared, and of species well represented in LACM collections. A specimen invoice was completed and signed via Docusign along with photographic documentation. Clear transport instructions were approved and executed followed by written acknowledgements of handoffs.

In this case, the garage was chosen as an active workspace while specimens were stored inside the residence after work. The garage had room for preparation, could be locked, and work generated dust could easily be cleaned off the concrete floors. Tools borrowed included dental tools, Paraloid B-72 beads, a microscope, and sandbags. The residence was not properly equipped for air scribes or air abrasion booths. Throughout this process, images and preparation sheets recording progress were sent to supervisors including frequent acknowledgement of the status and security of specimens from the preparator to the Registrar's office.

When supplies were limited, improvisations of materials and suppliers were crucial to continue work. Household items like chamois cleaning cloths proved effective at absorbing cellulose nitrate polymers on fossils from old salvage projects. Plaster, acetone, and rolls of pre-cut burlap produced for arts and crafts were purchased. If unavailable resources or environments were needed to complete preparation, the preparator explained this circumstance to collections staff, returned the specimen, and received another.

The decision making and methods employed during the WFH initiative resulted in a safe and productive experience for both specimen and preparator which allowed staff the opportunity to creatively work on lower priority specimens, diminish museum backlog, and receive and substantiate pay.

DIGITAL DOCUMENTATION OF THE GRANDE CACHE DINOSAUR TRACKSITE – A POTENTIAL LONG-TERM CONSERVATION STRATEGY

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The Project

The Grande Cache Dinosaur Tracksite is located within the CST coal mine, approximately 20 km (12 miles) north of Grande Cache, Alberta and was designated in 2006 as a Designated Provincial Historic Resource under the Historical Resources Act. There are 12 separate localities within the designated area, each containing dinosaur footprint impressions in the Lower Cretaceous Gates and the Gladstone formations, dating to approximately 90 mya (McCrea, 2000). This site represents the only surviving large-scale exposure of dinosaur tracks in Canada, and is believed to be one of the most diverse and abundant trackway sites in the world (McCrea, 1998). This project focused exclusively on the W3 site, a continuous large-scale exposure of fine-grained sandstone, extending roughly 100m (328 ft) vertically, 600m (1969 ft) horizontally, and dipping at an angle of 60-70 degrees. An estimate of 10,000 footprints have been identified on a single bedding plane, originating from a diverse number of Dinosaur taxa (HeRMIS 2006). Many of these impressions exhibit more than 10 consecutive tracks made by individual animals. Some of the most prevalent ichnotaxa identified at the W3 site have been associated with animals such as ankylosaurs, medium to large theropods (including ornithomimids and allosaurids) and birds (McCrea, 2000).

Accessibility has been a major limiting factor preventing thorough documentation of the W3 site. The site is located in a relatively remote area, in a mountainous environment, and within an active coalmine, which makes it logistically challenging to access. The lateral extent and vertical height of the rock face, in conjunction with its steep slope, makes accessing the tracks technically challenging. The logistical and physical challenges of accessing the site have contributed to a relative deficiency in documentation, research, and conservation, as only a small subset of the trackways present at the W3 site have been previously mapped. The absence of a complete inventory has limited the scientific description of the site, restricted its use as a historic resource, and limited the interpretation opportunities available at relevant institutions.

The purpose of this project was to undertake a sample site inventory and create a permanent digital record of the W3 site. The site is at risk due to ongoing erosion and potential slope failure, making a long-term conservation strategy essential to ensure the preservation of the site and its associated values. The digital products created through this project preserved a sampling of the site’s visual and metric data, and created a blueprint for expanding this study to other areas of the W3 site and other areas of the Grande Cache Dinosaur Tracksite. The images and data collected as part of this program will facilitate future scientific research and long-term conservation of this important site. This project was undertaken as a part of graduate studies program through Athabasca University. There was a limited timeframe for completion of the project and a limited budget. As a result, the scope focused specifically on the W3 Main site for high resolution data capture, while incorporating the W3 Extension and W3 Corner sites in the aerial mapping. The resulting 3D images provided a sampling of the W3 site and a step-by-step analysis of how a similar process could be carried out for the rest of the designated area. Under ideal circumstances, the inventory would contain an exhaustive portfolio of each sub-type of trackway represented throughout the site. Given the extreme richness of tracks, several weeks of data capture would be required in order to create a comprehensive inventory.

Health and Safety

Given the height and slope of the rock face at the W3 site, considerations were made for safely accessing the trackways. Nearly all visible tracks at the site are located more than 3 meters (10 ft) above the ground, with the majority existing between 50 meters (164 ft) and 90 meters (295 ft) high. These factors necessitated a rope-access system in order to gain access to the tracks, which created further safety considerations and complex logistics. To mitigate some of the safety concerns of repelling from heights upwards of 100 meters (328 ft), a certified rope-access technician from Yamnuska Mountain Adventures was contracted to complete the rigging and maneuvering of the rope systems. A system that allowed the climber to have free hands was required to allow for effective camera operation and to complete the data capture. Four separate anchor points were established above the exposed rock face, each evenly spaced along the horizontal extent of the wall. The majority of the rigging systems used two standing trees to create a temporary, extended anchor, but in one location, permanent climbing bolts were drilled and inserted into a limestone outcrop.

This rigging design allowed the rope-access guide to be located above the rock face and control the descent and ascent of the individual on-rope. This technique allowed the on-rope individual to maneuver along the rock, operate the camera, and document series labels and other notes without having to focus on the rigging. Constant radio communication was maintained throughout the process in order to indicate direction of movement and other actions. Another technician was stationed on the ground with a radio, safely outside of range of falling rocks and other potential hazards, such as dropped equipment or debris. From this vantage point, the location of the on-rope individual within the tracksite could be easily identified and described and information could be relayed.

A rope-access harness was used in place of a traditional climbing harness to reduce the likelihood of injury and provide lower back support. Helmets were worn at all times while on-site to protect against the potential of rock fall. Steel-toed boots and reflective vests were also worn except while on rope when proper climbing attire was required. Bear spray was kept on hand due to the high likelihood of encountering bears, bighorn sheep, and other local wildlife on site.

Procedures/Results

Five types of documentation were used to capture data for this project. They included manually recorded field notes, digital photography, photogrammetry, drone photography and videography. The digital products included a Photographic Portfolio, aerial photogrammetry models of the entire site, and close-range photogrammetry models of individual sets of tracks.

Field notes were recorded onsite and included a hand-drawn site plan. This sketch captured the extent of the W3 site, including recognizable features of the exposed face, the locations and labels of spherical targets placed in the foreground, and cross-hatch targets drawn directly on the rock face. The areas that were photographed for photogrammetry were also denoted on the site plan, and each series was given a specific label composed of a letter and a number. Each of these series were also labelled with the corresponding number directly on the rock face with a water-soluble chalk marker. These chalk labels were captured in the photographs, so that their locations could be correlated with the hand-drawn site map.

The basic photographic portfolio included contextual, perspective, and detail photographs, as well as specific character defining elements and condition photographs. A Nikon D300 was mainly used while on rope, to photograph specific locations in close range, and to capture images for photogrammetry. This camera was attached to the climbing harness at all times with a lanyard and carabiners. Some trackways were photographed in multiple exposures using a Nikon D70 to create High Dynamic Range (HDR) images. HDR photography was used to capture the highly reflective surface of the wet rock face after periods of rain. A Nikon Coolpix P510 was mainly used to document the process from the ground. A Nikon D200 mainly served as a backup, but was used to capture some elevation and perspective photographs.

The data capture for photogrammetry took place over the course of two days and involved significant planning. Before the data capture began, individual series of trackways were chosen to be modelled based on visibility, clarity, and track type. We attempted to model at least one series of trackways from each major group of ichnotaxa present at the site. Selected trackways were photographed from multiple camera positions and angles to create structure from motion photogrammetry. During the processing stage, Agisoft Metashape software was used to digitally estimate the three-dimensional structure of the trackways using the motion parallax between the multiple images. Photographs were taken approximately 1.5 meters (5 ft) from the rock surface, and each successive photograph maintained 30% overlap with the bordering images.

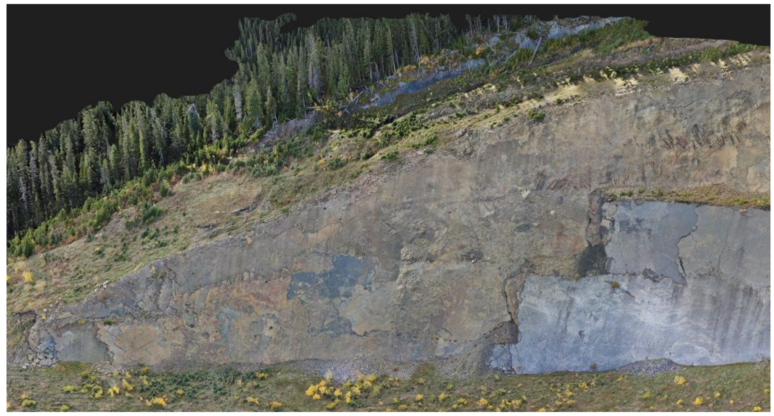
All rope work was completed on the first day on site. During the process of rappelling the rock face to capture images, a total of five cross-hatch targets were also drawn directly onto the rock surface using a water-soluble liquid chalk. These targets were used for the drone work which took place on the second and third day on site. Whenever possible, these targets were included in the photographic data capture so that they would be visible in the resulting 3D models. This also aided in positioning the individual trackway models into the overall site map captured by the drone.

Agisoft Metashape Professional was used to process the digital photographs into 3D point clouds. First, the images were aligned into a sparse point cloud. The accuracy was controlled using the "Gradual selection" feature, and setting the tolerances for reconstruction uncertainty and accuracy for 20 and reproduction error for 1. Next, the sparse cloud was processed into a dense point cloud. Given that most models contained between 200 and 500 images, this step generally took anywhere from a few hours to nearly an entire day to complete. The resulting dense point clouds were edited by cropping out extraneous data and digital artefacts, and then processed into a mesh. A surface texture was applied to the mesh to produce a photo-realistic 3D model. Orthographic images were created and exported for each completed photogrammetry model. This allowed the 3D models to be exported as 2D images for ease of viewing in presentation modes. The models were also exported as .stl objects and imported into CloudCompare to create “heatmaps” of the 3D models. In this software, a horizontal plane was applied to the 3D objects, from which a height-depth field could be applied. The height fields were then colored according to their depth in relation to the horizontal plane. The coloration of the resulting heat maps were then manipulated to help visually identify the relative depths of the individual footprints in the physical rock substrate. This visualization helped to highlight the strengths and weaknesses of the photogrammetry software for capturing fine surface relief.

The purpose of completing aerial photogrammetry was to create an overhead map that encompassed the entire site. In order to do this, we flew a series of missions while capturing photographs using the onboard camera on a DJI Mavic Pro drone. The drone synonymously captured infrared images and jpegs during most of these missions. An overhead ‘fly-by’ motion video was also captured by the drone, which offered a unique perspective of the site. All drone missions were flown by Alireza Farrokhi, a licensed drone pilot qualified to operate the Government of Alberta’s fleet of drones. Boundaries of the area we intended to map were determined prior to arriving on site, and all necessary permissions were acquired in advance of the drone flights. This was done by delineating the W3 site boundaries on Google Earth Pro and plotting out a rectangular-shaped area to be captured in the drone missions. This plotted area was used when acquiring permissions from Transport Canada to fly within the airspace during the timeframe of our data capture.

During the two days scheduled for drone missions, we experienced extremely high wind gusts reaching 80 km/h (50 mph), as well as several brief periods of rain. The wind gusts were unpredictable and inconsistent, making it difficult to judge timing of missions. Several of the missions were cut short due to sudden gusts that were considered unsafe for flight or due to sudden periods of rain that could be potentially damaging to the equipment and/or reduce image quality. We worked around these issues as much as possible by adjusting flight missions “on-the-go.” To deal with other environmental hazards such as thick brambles, tall grasses and trees, we created a broad take-off and landing pad using a white, quilted moving blanket. This provided a soft surface for landing and also served to tamp down the existing vegetation, providing a separator between the rotors of the drone and the vegetation that could potentially damage the equipment.

The amount of data capture during the three days on site, although significant, is only a first step towards documenting and digitally preserving a site as large, densely packed, and significant as the W3 site. There is significant research interest in this site, and the outcomes of this project have spurred more questions. Many of the digital models that were developed are directly usable or could be easily adapted for use in scientific publications.



As a result of inclement weather, missions flown by the drone during high winds produced models of variable resolution. Despite this limitation, the resulting products have high enough resolution to make out individual footprints. These models could be used to create line drawings for the entire W3 site, creating a complete map with clearly isolated individual footprints. Unfortunately, due to the shallow relief of the avian tracks, this aspect of the W3 site was not effectively recorded or mapped. In order to capture these tracks, additional site visits and the use of more suitable technologies for capturing fine surface relief are recommended.

In comparison to an earlier mapping project undertaken by McCrea (2000), our mapped area is approximately ten times larger. In one example, a trackway recorded by McCrea as having 7 consecutive tracks has now been shown to have a staggering 26 consecutive tracks. Extending the survey area to include the entire site will greatly expand our understanding of this site and has tremendous implications for research and conservation.

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A NEW FACE—THE LAST CHAPTER IN THE HISTORY OF *ALBERTOSAURUS SARCOPHAGUS* TMP1981.010.0001

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Described here is an abridged account of the steps taken to make molds to be used to provide wax castings to produce a new reconstruction of *Albertosaurus sarcophagus*. At the Royal Tyrrell Museum of Palaeontology (RTMP) in Drumheller, Alberta, the most iconic dinosaur is *Albertosaurus sarcophagus*. A bit of history is necessary to review its rise to icon status. Joseph B. Tyrrell of the Geological Survey of Canada (GSC) recovered a partial skull (CMN 5600) in 1884 near Drumheller while surveying coal deposits on the Red Deer River. In 1889, T.C. Weston (GSC) also did a survey along the Red Deer River, this time to look for dinosaurs. He collected another skull (CMN 5601) from the Red Deer River badlands, 50 km upriver. Lambe (1904) initially studied them, illustrated a reconstructed skull, and then shared the information with H.F. Osborn (AMNH). In 1905, Osborn erected a new carnivorous dinosaur *Albertosaurus sarcophagus*, the genus named after the new province of Alberta and the species name roughly translated as 'carcass eater'. In 1982, the most complete albertosaur (TMP1981.010.0001) from the Horseshoe Canyon Formation, found by M. Stefanuk, was excavated by the RTMP near the Tolman Bridge crossing on the Red Deer River (Tanke and Currie, 2010). In 1984, a reconstruction of the skull by K.R. Aulenback became the face of Late Campanian albertosaurs. Upon the opening of the RTMP in 1985, *Albertosaurus sarcophagus* became the logo of the museum named after J.B. Tyrrell.

In 2018, a makeover of 81-10-01 (RTMP nickname) was necessary to produce a 3-D bronze skeleton as the centerpiece in a new gallery based on *Albertosaurus sarcophagus*. A new reconstruction of the skull was deemed most important in presenting an improved face using new methods and materials, as well as incorporating photogrammetry and CNC machining. The old latex molds were in bad shape and needed to be replaced with more durable platinum cure silicone rubber molds using Smooth-On products, Dragonskin™10 Fast; Mold Star™20; Rebound™25. These silicone rubbers were fast setting, easy to mix 1A:1B by volume and were soft and pliable. To preserve as much detail, especially for the dentition, a new design was created where the teeth were glove-molded in Dragonskin™10, attached to the Mold Star/Rebound mold on the lateral side, and a detachable wall system on the lingual side. The left side skull elements were more complete, thus provided photogrammetry models to create the missing and distorted elements for the right side. Very thin elements such as the supradentary could not be used for photogrammetry and had to be sculpted in epoxy putty for the right side. Sculpting was done using a simplified method of drawing the element shape on a plastic sheet then applying Smooth-On Free Form™ Epoxy putty to build the element. Anatomical correctness was aided by comparing elements from the Collections and referring to Carr (2010) and Currie (2003). Dremel™ rotary tools with sanding and grinding attachments were used to 'carve' the element into the appropriate anatomically correct shape, or increase articulation between elements.

The result was the spectacular skull and skeleton in bronze that graces the Learning Lounge of the Royal Tyrrell Museum of Palaeontology, Drumheller, Alberta, Canada.

Figure 1. Albertosaurus sarcophagus (TMP1981.010.0001) skull reconstruction in bronze.

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MASSIVE OVERBURDEN REMOVAL ON A STEEP HILL USING A FALL PROTECTION SYSTEM IN DINOSAUR PROVINCIAL PARK, ALBERTA, CANADA

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The Project

In 2021, a subadult hadrosaur specimen was found in Dinosaur Provincial Park (DPP), Alberta, Canada at the bottom of a steep outcrop (up to 70 degrees). The hindlimb and part of the tail were eroding out and both surfaces had well-preserved three-dimensional skin impressions, which may cover the rest of the specimen as well. Royal Tyrrell Museum of Palaeontology (TMP) palaeontologists therefore deemed it important enough to collect. This posed the significant challenge of removing approximately 11 metres (36 feet) of overlying overburden, in a location where park rules prohibit motor vehicles. The overburden removal would have to be accomplished by hand with technicians hanging over the edge of the hill. Even with these major efficiency restrictions and health and safety concerns, the overburden was successfully removed through the use of a hybrid fall protection system, and the specimen will likely be extracted in the summer of 2023 or 2024.

Health and Safety

Even excluding the major safety hazard of hanging over the edge of the hill, we employed many H&S practices during the excavation. Before beginning work at the site every day, we would discuss the hazards we would likely be facing and record them in the TMP's Fieldwork Daily Risk Assessment book as well as discussing hazard controls for the situations. The excavation took place primarily in August of 2022, so temperatures often reached 35 to 40 degrees Celsius (95 to 104 degrees Fahrenheit) even in the shade where we worked for most of the day. We wore appropriate clothing in addition to wearing sunscreen and hats. All technicians and volunteers brought at least 3 litres (0.8 gallons) of water every day and took breaks when affected by the heat. All technicians had up to date certifications in first aid and a first aid kit was brought to the site every day.

The TMP hired the second author, a working at height consultant and industry partner to Brock Canada, for an on-site assessment and to determine the measures necessary to protect against potential falls. We decided to use a fall protection system that allowed the technicians to move freely on the slope but would stop them in the event of a fall. This was a hybrid system for both worker restraint and adjustable work position. The restraint portion was designed to prevent technicians from falling over the steep slope, while the work positioning allowed them to use the equipment and their feet to work on the steep slope. Our plan was for technicians to dig a ledge on top of the hill and then dig it downwards toward the specimen in a stepwise fashion. Having the flexibility of the two fall protection systems allowed technicians to work downwards and side to side with increased flexibility as the work area changed.

The fall protection system for each technician consisted of a full-body work positioning harness, two rope grab devices, and two 11mm low stretch kernmantle life safety ropes attached to anchor points at the top of the hill. Since the ground was too soft to use conventional metal stakes for anchor points, anchors were created using three large nylon construction waste bags filled with dirt and rock rubble. Each bag weighed about 1500 kgs (3300lb) when filled and was used to anchor a single technician. Each technician had two ropes connected to their harness and these ropes were tied to separate triple-lock carabiners using figure of eight knots. The carabiners were in turn affixed to two anchor straps (one carabiner per strap) which were wrapped around the base of each anchor bag. Having two ropes for each technician helped reduce risk by ensuring that, if one of the pieces of equipment were to fail anywhere along the rope system, there was a second, independent rope system that would remain functional and able to prevent a fall.

The harnesses had adjustable waist and thigh straps as well as adjustable shoulder straps for people of varying height. The chest and back of the harnesses sported D-rings rated to 1500kg (3300lb) (Figure 1. A) to act as the connection point to the rope system. Attached to the harness were two energy absorbing lanyards (Figure 1. C), two triple-lock carabiners (Figure 1. D)

Figure 1.

and two back-up rope grab devices (Figure 1. E) which connected to each rope (Figure 1. F), completing the system for the technicians.

We tethered the electric jackhammers used for overburden removal to the anchor bags in case they slipped from our grasp and created a hazard for workers below. Each jackhammer was attached with one rope independent of the two attached to the technicians' fall protection system to keep the weight of the jackhammer off the technicians in the event of a fall.

Technicians all received legislative compliant fall protection training prior to working at height, and then the second author taught the technicians how to use the task specific rope system. While there were many volunteers and additional technicians on some days, only the technicians that had received training were allowed to work on the hill.

Procedures and Results

To move down the ropes, we had to follow proper training and manufacturer requirements for the equipment. We alternated moving each rope grab device so if we were to fall during a move, one of our ropes would still be active. Additionally, the positioning ropes that released the rope grab device to allow movement were intentionally designed to be small and difficult to grab (Figure 2.), so if a technician were to fall while holding one, it would likely slip from their grasp and stop movement. This made movement down the ropes tedious, but it ensured that we were never at risk of falling. Movement up the ropes was much easier; we only had to pull up on our two rope grab devices as they only regulated movement down the hill.

Figure 2.

On work days, we would begin by donning the harnesses and "buddy checking" the other technicians to make sure that everyone's harnesses were free of tangled ropes and that the straps were tight enough to keep the harness on safely, but loose enough to prevent discomfort after many hours of wearing them. We would turn on the electric generators, clip onto the ropes, and grab our tools. We would then carefully descend the ropes by moving one rope grab device at a time until we reached the work area.

To perform the actual overburden removal, two technicians used the jackhammers to break up the rock and the third shoveled it off the hill. At the very beginning of the excavation, there were only two technicians on the hill with one jackhammer, but the work area quickly reached nine metres across so there was sufficient space for three technicians with two jackhammers. Since we were working so close to a steep edge, it was easy to cleave off large chunks of sandstone near the edge of the working area and they would often fall with minimal effort. We needed to re-adjust our ropes often when we moved left or right in the working area as well as when we cleared enough rock that we were standing at a lower height than before. This entailed proactively shifting the ropes above us in whatever direction we were moving to make sure we avoided ropes catching on anything above and creating a large swing potential. If we were to fall while our ropes were at an angle, it would likely cause us to swing left or right in the quarry which could result in injury to ourselves or others. We would also gather the excess rope that continued down the hill into coils and throw it up above us so rocks we dislodged would not fall on and damage the rope. This mostly worked as intended, but excessive movement would often dislodge the bundles of rope from the hill and require us to re-bundle and throw them back up. Towards the end of the excavation, we had much less excess rope since we had moved down so far, so the bundles of rope weighed much less and so they dislodged more often.

The newly exposed rock became more friable with exposure to the elements, and the movement of the ropes across the upper parts of the quarry as we moved left and right provided physical disturbance that dislodged small bits of dirt. To counteract this, we dug out the hill in a staircase shape with four levels so rocks and debris falling from above would most likely be caught by one of the levels above where we were working. This tactic proved effective as we were never showered with debris when working at lower levels.

We began the excavation from the top of the hill. As our plan was to dig a giant staircase shape, we started with the top "step" until it was two metres tall and two metres deep into the hill before moving to the next step down. This allowed us to maintain a flatter work area and reduced workload as there were never lower steps that would catch all the rock from higher ones and need to be cleared multiple times. We continued to use the fall protection system until the height of the quarry decreased to three metres above the ground (to meet national safety standards) and the work area was flat and broad enough that slipping was no longer a concern.

Wearing the harnesses was an overall positive experience as it allowed us to feel much safer working near the steep drops and on the steep slopes which led to quicker and more efficient work. However, we primarily had the rope system attached to our chest D-ring, which meant that the ropes would often get in our way as we attempted to perform work in front of ourselves. This led to us constantly re-adjusting our arms around the ropes to give us space to work. Combined with the constant re-adjustment of the excess rope, it meant that some of our time on the hill was spent adjusting gear to put us in the best position to work rather than actually removing overburden. Luckily, we were able to acclimatize to these requirements over the course of the two weeks and our pace significantly increased over time.

At the end of each day, we would sweep the work area clean of loose rubble so none would fall on the shovelers below. Next, we would climb back up to the top of the hill, unclip from the fall arrest system, turn off the generators, and store the ropes for the night. We would pull the ropes up and stuff them into bags that were stored next to the anchor bags. This made setup and takedown easier for us as we did not have to learn how to tie the figure of eight knots that attached the ropes to the carabiners. We stored the equipment in the bags with the ropes which protected them from animals and weather conditions. We would carry out the harnesses every day and store them in a secure shed.

Once we cleared and stored the equipment, the volunteers from the University of Reading (U of R) would begin shoveling the rock we had dislodged into wheelbarrows and carry it about 20 metres (65 feet) away from the hill to dump it in a low depression well out of the way and approved by park officials.

This excavation is notable as there is little precedent in the use of rope-based fall protection systems in dinosaur excavation in Alberta. The fall protection system that we used allowed us to work in a potentially dangerous environment with no injuries and such a system may prove useful for future excavations as well.

Significance

This excavation represents an achievement as it is the largest scale excavation in DPP history. We removed more overburden from this site than from any other in the past. As of the end of the 2022 field season, we dislodged and wheelbarrowed away around 95 tonnes (105 tons) of rock, and it is likely that we will have to remove another 20 to 30 tonnes (22 to 33 tons) next year. The final block containing the specimen will likely weigh around 5 to 10 tonnes (5 to 11 tons). The weight of the specimen will present us with a whole new set of challenges regarding how to get the specimen out of the park and back to the TMP. The scale of the excavation drew attention and brought positive media coverage to the museum both locally (Irete, 2022; King, 2022) and internationally (Nalewicki, 2022). The proximity of the excavation site to a tour path used by park staff also allows the site to be used as a tourist attraction now and in the future as the large scar left by the excavation in the hill will likely remain visible for hundreds of years. A timelapse of the excavation can be viewed on the TMP YouTube channel.

As the project continues into 2023, we will no longer require the fall protection system as the quarry is now less than three metres above the ground.

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OF PROTOCOLS AND PERISSODACTYLS: BUILDING ON PAST EXPERIENCES FOR SMOOTH TRANSITIONS TO NEW PROJECTS

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During the Late Miocene, significant changes in plant and animal life marked the evolution and spread of grasslands across continents. Fort Hays State University's Sternberg Museum of Natural History holds an extensive fossil vertebrate collection from the Minium Quarry, a Kansas locality that has proved important for understanding these biotic shifts. Most fossils from this locality were collected ~35 years ago, with quarrying only resuming in the past few years. Despite the significance of this collection, only 1717 specimens have been curated with ~3600 additional fossils needing assessment, curation, and preservation. This lack of proper curation and storage impacts their long-term conservation, as well as incorporation into research, education, and outreach activities. In 2022, the Sternberg Museum was awarded an Institute for Museum and Library Services grant to address the long-term preservation of this collection. The Minium Quarry Project (MQP) builds on paleontology collection improvements intiatives that started in 2016 to institute a relational database and advance digitization and data-sharing efforts by the Stenberg Museum. Similarities with previous projects have allowed us to test, update, and build on past efforts to expedite progress towards project goals.

The MQP highlights the value of building protocols to easily train workers and maintain consistency between projects. Most notably, we were able to take advantage of previously written protocols for curation, data entry, 2D digitization, and 3D digitization. Additionally, we could utilize existing hardware and software purchased from other grants. However, because of a gap of time since the last large-scale collection initiative, a pandemic, and near-total staff and student turnover, this project has also emphasized the need to keep protocols current. When we started training a new group of students on digitization and data management, we found many of our existing protocols were outdated due to software updates, changes in institutional security demands, and hardware upgrades. As a result, protocols are now reviewed annually to ensure they maintain accuracy and efficacy. This will be coordinated with our annual inventory for consistency.

Despite previous collection improvement projects implemented by the paleontology department, some aspects of the MQP have provided new challenges and opportunities. This assemblage of fossils has characteristics of an abandoned collection requiring critical assessment of material. For the first time, we are needing to address which fossils should and should not be curated into the research collection on a large scale. To address this, we are ensuring all specimens are photographed and documented, even if they will not be retained in the final collection. Additionally, this is our first project that includes the stabilization of fossils already stored in the collection outside of just rehousing in archival boxes. Because Minium Quarry fossils are not well-consolidated, each specimen in the collection needs to be assessed for consolidant and/or cavity mount needs. This will require transferring material between the collection and the prep lab and recording and storing additional prep data. Unique aspects of this project necessitate the development of new protocols. Documents are now being created to address stabilization issues before fossils are stored and for stabilization issues of specimens already in long-term storage. This is particularly relevant when stability issues are noted during annual inventories.

Although we are just in the first year of a three-year initiative, work on the MQP has validated the importance we have placed on developing protocols over the last five years. The gap between large-scale projects has shed light on areas where we can improve our processes and procedures to ensure smooth transitions between projects and staff turnover. At the same time, working on a partially abandoned collection has provided ways to continue developing documentation and protocols to sustain projects when grant funding ends.

USING THE EPOXY EPO-TEK 301TM AS A CONSOLIDANT AND ADHESIVE/GAP-FILLER IN THE PREPARATION OF A LARGE HORNED DINOSAUR SKULL

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Introduction

Although the use of reversible consolidants and adhesives is generally preferable to non-reversible products like epoxies when preparing fossils, occasionally the use of the latter can be desirable. Here I discuss the use of the two-part epoxy Epo-Tek 301TM (hereafter referred to simply as Epo-Tek) as both a consolidant and an adhesive/gap-filler in the preparation of a large, virtually complete chasmosaurine horned dinosaur skull (TMP 2014.022.0022) collected by the Royal Tyrrell Museum of Palaeontology (RTMP) from Maastrichtian deposits in southwestern Alberta, Canada.

The project consisted primarily of a large (roughly 1 m^3/35 ft^3 and 839 kg/1849.7 lb) block of sandstone and siltstone containing a beautifully-preserved chasmosaurine skull. However, the friable, blocky nature of the siltstone in which part of the skull was preserved, in combination with taphonomic alteration both geologic and anthropogenic (due to its size, the complete skull was collected in multiple blocks) resulted in myriad and sometimes quite large fractures in both the matrix and the fossil bone. Thus, the whole block needed to be consolidated and the gaps filled so as to preserve the integrity of the skull directly, as well as to ensure that the large amount of dense, heavy matrix which held the fossil bone stayed together as a unit during preparation so that it could be removed in a controlled manner rather than having it come apart in surprising and destructive ways.

Epoxy as a consolidant

Why Epoxy?

The large size of the block, in combination with the size and ubiquity of the fractures therein, suggested to us that if ParaloidTM B-72 dissolved in acetone (the usual choice at the RTMP) were used as the sole consolidant, such large volumes would be required that it would take an unfeasibly long time for all the solvent to evaporate so as to ensure the stability of the specimen and the strength of the bonds (Davidson and Brown, 2012; Podany et al., 2001). An epoxy was thus chosen as a consolidant because we assessed that it would cure comparatively rapidly and provide sufficient strength.

Epo-Tek 301 is a two-part epoxy mixed by weight at a 4:1 ratio. It was chosen for its strength (lap shear = 15.5 MPa), chemical stability (it is a low-outgassing epoxy), long pot life (1-2 hours), and a viscosity sufficiently low to penetrate small cracks (100-200 cPs; water is 0.98 cPs). It was also chosen for its optical clarity, which had implications for its use (discussed below) as a gap-filler. It was not chosen for its cost, which is substantial at $490 Canadian (approximately $357 American) for 1250ml (~42 fl. oz.), or roughly 39¢/ml (0.03 fl. oz.). Due to its cost, Epo-Tek's short shelf life of one year at room temperature is potentially problematic. I found that Epo-Tek, when mixed well past its shelf-life, did not seem to cure properly. It hardened, but remained tacky for months afterward and I was unwilling to trust it for long term structural support of the specimen. Note that the identification of this epoxy and other products herein does not constitute an official endorsement of these products by the RTMP or the Government of Alberta. They are provided for educational, future conservation, and historical purposes only.

Pre-application Experimentation

I wanted to be sure that the Epo-Tek could really penetrate deeply into the cracks, so I tested it on a smaller block prior to applying it to the main block. I poured 45 g (1.6 oz) of Epo-Tek into a 5 cm^2 (0.7 in^2) area with several fractures roughly 5 mm (0.2 in) across on the surface. After the epoxy cured, I used an angle grinder to reveal a cross section of the network of cracks and saw that the epoxy had penetrated approximately 10 cm down from the surface and had fully infiltrated cracks less than 1mm across. I took no special effort, beyond stirring the components gently, to avoid introducing air bubbles, but none were visible in the cured epoxy, presumably because its low viscosity and long working time allowed them to escape prior to curing.

I recognized that at least some bone surface would be covered with epoxy, so I wanted to test whether it could be removed without causing damage to the specimen. I applied Epo-Tek both to a bare area of fossil and an area coated with a solution of 10% (by weight) Paraloid B-72 in acetone. I then removed the cured epoxy using an airscribe with a chisel tip, which removed conchoidally-fractured chips of epoxy with small flakes of bone attached thereto. I tried using a jeweler's hammer tapping against a scalpel bearing a #10 blade, which removed the epoxy in sheets with similar results. There was no significant difference in terms of bone loss between the coated and uncoated bone surfaces. However, subsequent reading of Podany et al.'s (2001) methods suggest to me that the barrier layer of Paraloid B-72 in acetone I applied was flawed. It may have been too thin (10% vs 17%) and I did not allow two weeks for drying prior to applying the Epo-Tek.

I also experimented with heating the epoxy using a heat gun, typically on a high heat setting for approximately ten seconds (or less if I noticed scorching). This treatment made the epoxy easier to scribe through and more easily removed from the bone, however this technique presumably compromised both the internal strength of the epoxy as well as the bond between epoxy and substrate and so would have to be used sparingly in specific situations. I concluded from these informal tests that it was, unsurprisingly, preferable to avoid epoxy contacting the fossil directly but that removing it was feasible when necessary. Thus, I continued with the plan to consolidate and gap-fill the specimen with Epo-Tek.

A Note on Epo-Tek and Acetone

In the course of my experimentation with Epo-Tek, I submerged a small disc of the fully cured epoxy in acetone for several days. The epoxy became yellow, rubbery, and friable. When left to dry for several days, the epoxy once again became hard and strong, though it did not regain its clarity and its strength relative to epoxy not subjected to acetone is unknown. Based on these results, I allowed several days for the acetone to evaporate after using Paraloid B-72 in acetone to consolidate the specimen (in the areas where this seemed feasible) prior to using the Epo-Tek. I suspected, however, that the somewhat extreme conditions of the experiment were unlikely to be replicated by the way the products would actually be applied to the specimen.

Application

The application of the Epo-Tek involved trepanning a hole into the upper side of the field jacket containing the main skull block and pouring in small batches of the epoxy. The mixing instructions denote a limit of 25 g (0.9 oz) per batch. Initially I failed to note this prescribed limit and exceeded it by a substantial margin, which resulted in an alarmingly exothermic reaction that caused the pot of epoxy to heat up, bubble, smoke, yellow, and cure in seconds. However, this did not appear to be an issue when multiple batches of epoxy were added to the block, presumably because the epoxy was flowing around and spreading out into various cracks and gaps so that it was not collected in large volumes. It is also possible that the large amounts of relatively cool matrix and bone acted as a heat sink, allowing the heat from the reaction to diffuse rather than catalyze the reaction. Doing the pours over the course of several days further mitigated this hazard. It was necessary to rotate the roughly 850 kg (1873.9 lb) jacket into different orientations (with the use of lifting slings and our 3-ton overhead crane) so that the epoxy could flow into all the desired areas. Despite my best efforts, however, a not insubstantial amount of epoxy ended up pooling in various low points (see next paragraph) and this excess epoxy was removed with a combination of a chisel-tipped air scribe (The Stone Company HW-90) and the heat gun.

An issue I encountered was that the Epo-Tek was flowing away into a crack which I suspected, given how much epoxy had already been poured in, lead all the way to the opposite side of the jacket. Due to the cost of the Epo-Tek, it was considered undesirable to simply continue pouring in epoxy until this fracture was entirely filled. It also seemed possible that the epoxy would end up travelling around the contact with the jacket, coating the specimen. To address the issue, I mixed into the epoxy some Por-A-KastTM solid glass spheres to thicken and add bulk to the product so that it would block the cracks and allow the cavity to fill. The thirsty fracture was filled later when the block was repositioned. The bulking was effective, but unfortunately it planted a poisoned seed in our minds that lead to using the glass spheres to stretch the Epo-Tek for purely cost-saving purposes. Based on informal comparison between the properties of the unadulterated epoxy and the epoxy/glass sphere mixture when both were subjected to air scribing, the resulting mixture is still strong, but not as strong as the pure Epo-Tek (although Podany et al., 2001 suggest that epoxy thickened with fumed silica may be stronger than the pure epoxy). Additionally, the mixture is grey and unlovely. I now regard this latter use of the glass spheres as a mistake, though not a disastrous one.

<u>Epoxy as an adhesive/gap-filler</u>

Due to the size, weight, and geographic location of the skull, it was to be transported to a truck via helicopter and so was collected in several different blocks which were delimited by exploiting existing fractures in the rock. This meant that the blocks needed to be reassembled at the museum, but in many cases the fit was not exact due to material being lost when the blocks were separated (despite extensive efforts to collect and record the position of even the smallest fragments) or when the original fracturing occurred. It is also possible that some gaps were exacerbated by desiccation-induced shrinkage once the blocks were excavated. Furthermore, although the skull is exquisitely-preserved in three dimensions, there is evidence of some minor deformation having occurred, including slickensides on some of the bone surface and the rostrum being subtly shifted laterally away from the midline of the skull. Thus, proper preassembly of some of the components necessitated extensive gap-filling beyond simply adhering together the separate blocks. We decided that this extensive gap filling was necessary because we knew at the outset that the skull would be displayed upright and unsupported except by the armature on the ventral surface. The manner in which the blocks went together prevented us from truly knowing the extent of the gaps compared to the solid contacts, so we endeavored to completely fill all gaps to mitigate this uncertainty.

Epo-Tek 301, as discussed above, was determined to possess sufficient shear strength to adhere the large blocks together. Its low viscosity and long working and curing time would allow it to flow into and fill the irregularly-shaped gaps between blocks. It was also desirable from an aesthetic perspective, as any filled gaps that were externally visible would appear as transparent, luminous veins or give the impression of smoky quartz where the view extended into the black-boned depths of the specimen. This aesthetic consideration, though of secondary importance, was not insignificant as we knew from the beginning that this fantastic skull would be going on permanent display at the Tyrrell.

I was disinclined to use thick Paraloid B-72 as a gap filler, partly for aesthetic reasons, but also because I have found that thick (e.g., 30% by weight Paraloid B-72 in acetone) tends to become very bubbly as it dries where not compressed between two adherends, resulting in a weakened, frothy structure. Fox (2001) notes a similar issue. The gap-filling techniques discussed in Andrew (2009) wherein Paraloid B-72 was mixed with various fillers did not seem applicable to this project as properly filling the gaps by manually applying the filler was not possible in most cases. Indeed, any gap-filling technique requiring manual application of the filler to all areas of the gap was not feasible in the context discussed here.

Filling the Gaps

Although useful for reaching all areas of the gaps being filled, the Epo-Tek's low viscosity presented a problem in that the epoxy had to be prevented from simply flowing out of the specimen entirely. So, once a block had been put in position on the main skull block (often by lowering it into place with the use of lifting slings and our 3-ton overhead crane), I dammed the larger gaps using strips of 5oz. Reemay® Spunbonded Polyester Fabric impregnated with the natural latex 61-1000 Mold All Latex™. The Reemay was chosen for being pliable but also stiff so that the barrier created would be flush with the opening of the gap rather than taking up space inside which would result in an epoxy-less cavity. The specific latex used is very viscous and through testing shown not to be bonded by the Epo-Tek. I left a gap wherein I would pour the epoxy. To mitigate the possibility of air-filled gaps, I configured the block so that the pour hole was the highest point of the gap being filled. Additionally, as when using the epoxy to consolidate the specimen, I ended up reorienting the specimen and cutting new pour holes in the latex to ensure that all the gaps were filled. This

Reemay/latex barrier technique was employed in several parts of the skull both when consolidating and gap-filling.

To complete the stabilizing and gap-filling of TMP 2014.022.0022, we purchased an astounding 10 L/2.6 gal) ($3111/$2294 American) of Epo-Tek. Distressingly, only 7.5 L (2 gal) were used, the rest surpassing its one year shelf life before it could be used. This waste could potentially have been mitigated with better planning or purchasing Epo-Tek in smaller quantities and simply waiting for more to be shipped when the supply ran dry. Where possible I caught any leaking epoxy and reapplied it to the specimen.

<u>A Note on Epo-Tek and Latex</u>

In the course of implementing the Reemay/latex barrier technique, I encountered a notable reaction between uncured Epo-Tek and wet latex, wherein the former would cause the latter to cure immediately. Often the epoxy would find its way out of the specimen through a route I had not anticipated and so I kept the latex on hand to quickly seal the breach. However, it was necessary to thoroughly wipe away the epoxy and swiftly apply a large amount of latex to the area because if the uncured epoxy touched the fresh latex, the latter would immediately cure and thus lose any ability to adhere to the bone surface and seal the leak. There was no obvious effect on the epoxy.

<u>Health and Safety</u>

Proper PPE (nitrile gloves, apron/lab coat, eye protection) were worn during the mixing and use of the Epo-Tek, and lab-mates were made aware of the work. The blocks to which Epo-Tek was applied were either on a plastic sheet, or at later stages on a custom-built wooden working platform. Any drips or leaks were promptly wiped up to avoid slipping or tracking the epoxy through the lab. The work was conducted in the Royal Tyrrell Museum's main Preparation Lab, a cavernous and well-ventilated space. The Safety Data Sheet for Epo-Tek 301 was easily accessible in that same lab in a clearly-labeled 3-ring binder held in a wall-mounted basket dedicated solely to that purpose. With the exception of the notable lapse discussed above, mixing instructions were followed (maximum 25 g/0.9 oz batches) to avoid undesirable chemical reactions, but fire extinguishers of an appropriate type were located at either end of the lab.

When positioning large blocks with the overhead crane, all involved wore hardhats, work gloves, and steel-toed boots. Additionally, we thoroughly discussed the plan in advance, emphasizing the importance of clear communication during the process, and all of the technicians present had completed certificates in hoisting and rigging. Once in position, the blocks were secured together using ratchet straps to immobilize them.

<u>Conclusions</u>

Although Epo-Tek 301 is tremendously expensive and its use in this context was technically challenging, the structural and aesthetic results are desirable and the product seems to be a viable option for use on projects with requirements similar to those discussed here. Sample pucks of cured Epo-Tek have been created and will be retained and linked to the specimen both in our records and physically so that they will be subject to the same conditions as the epoxy within the specimen. In this way they are available for testing in the future should any deficiencies be noted. Reversible products such as Paraloid B-72 might have been sufficient for consolidating the specimen, but seem insufficient for the extensive gap-filling required in this project.

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PALAEONTOLOGICAL HERITAGE 3D CONSERVATION TECHNIQUES IN THE SERVICE OF MUSEOGRAPHY AND CONSERVATION

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Introduction

The research of Evolutionary Biology Group of the Universidad Nacional de Educación a Distancia (Spain) is focused on the vertebrate palaeontology, also has a great commitment to the conservation of fossil remains and to the outreach of palaeontology. The use of 3D technology is becoming a widespread tool for the creation of real and virtual replicas, with great precision, replacing the need for handling and moulding of delicate of the specimens to be studied and exhibited. In the scope of several outreach projects based on the of palaeontological heritage collected in the Iberian Peninsula, various fossils have been prepared, restored, and adapted for use as museum exhibits.

This paper describes the conservation interventions with the aim of ensuring the stability of the fossil remains, which composes a key museum resource. The photogrammetry and 3D printing during conservation interventions were used to help communicate the uniqueness of the fossil record of the Iberian Peninsula (Spain and Portugal). For this purpose, we have taken different examples such as a dorsal vertebra from a sauropod dinosaur found in sedimentary rocks of the Upper Jurassic of Junqueira fossil-site (Pombal, Portugal); and a skull of the Eocene Mesoeocrocodilian *Iberosuchus* crocodile from the Duero Basin (Salamanca, Spain). In these cases, the printing of some elements of these specimens have allowed us to improve their understanding and spectacularise and another use is to generate packaging and exhibition structures.

Procedure

Dorsal vertebral remains belonging to a large sauropod individual (tentatively referred as a member of Titanosauriformes) were extracted from the Junqueira fossil-site, in Pombal (Portugal). One of the recovered vertebrae was found in two separate elements, the centrum and a neural spine. Both remains were found close together supporting the hypothesis that they possibly constitute fragments of the same vertebra. For their study and exhibition, the two elements were first stabilised separately, and it was determined that the spine was too weak to be placed in anatomical position and the centrum was not strong enough to support it.

We believe that this specimen can be interesting for the outreach of knowledge about dinosaurs since its extraction from the field until their study. The performed preparation of both specimens was focused to express, in a museum environment, the singularity and potential of this large dorsal vertebra as a museum object, especially when both elements are in anatomical position. For this purpose, the generation of a copy for the neural spine to replace the original element was considered as the best option for the full reconstruction of the dorsal vertebra.

To generate the copy of the neural spine, once prepared, we carried out:

i. digitalisation using photogrammetry;
ii. processing of the resulting mesh by modifying and reducing the number of polygons; and modelling the missing parts;
iii. milling with a three-axis milling machine on 2cm extruded polystyrene. Due to the limitations of the milling machine, the 3D model of the neural spine had to be divided into 15 fragments that minimised the lack of some of the milling directions;
iv. gluing of the fragments with a solvent-free contact glue that is used as a specific adhesive for extruded polystyrene;

v. sanding of the joining areas to reduce the jumps produced by the assembly itself;
vi. colour reintegration by covering with a layer of stucco and a flat ink according to a criterion of approximate similarity with the colour of the reintegration made on the vertebral centrum, thus avoiding the degradation of the polystyrene by the action of ultraviolet rays and direct contact with the fossil; and finally,
vii. placement by means of a removable element in the position that would correspond to the original neural spine with respect to the vertebral centre vertically.

The specimen of an *Iberosuchus* skull belong to the paleontological collections of the Sala de las Tortugas at the University of Salamanca (Spain). The skull is particularly fragile and its handling for study is risky. For this reason, it was considered a priority to protect the fossil by giving it a suitable support that would fulfil the task of protection and aesthetics that would allow it to be exhibited.

The support for the specimen was made from a digital copy of the fossil by constructing a 3D mesh obtained using photogrammetry techniques. This digital model is used to design a structure with a complementary surface for the areas where the specimen will rest during its exhibition. Some digital modifications have also been added to improve the effectiveness of the support. From this digital design, a 3D printer has been used to produce an ABS (acrylonitrile butadiene styrene) thermoplastic support. The ABS holder has a high strength, and a high resistance to heat and humidity. The holder has a variable thickness and fits perfectly to the underside of the sample. In either of the cases, the procedure was carried out wearing gloves and a protective mask.

Conclusions

By generating supports for storage and display, as well as 3D models, it is possible to reconstruct and conserve a badly deteriorated structure.

The generation of supports allows the manipulation of specimens that are particularly difficult to conserve, both by specialists for study and in the case of exhibition. These elements involve an almost zero degree of intervention, do not cause damage to the specimen and reduce the stress to which the piece is subjected during handling.

The use of new technologies also makes it possible to reconstruct the anatomical elements that would be missing from the specimen to improve its display, especially for a non-specialist public.

Acknowledgements

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PHOTOGRAPHING AND REHOUSING THE EXTENSIVE FOSSIL COLLECTION AT FLORISSANT FOSSIL BEDS NATIONAL MONUMENT

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Florissant Fossils Beds National Monument (FLFO) is located 2 miles south of Florissant, Colorado and encompasses over 6,280 acres. The Monument was established in 1969 to protect the excellent Eocene fossils, including various plant fossils such as wood and leaves, highly detailed insect fossils, and some rare fossilized vertebrate material. These fossils date as 34 million years when the area of FLFO was covered by a large lake. This lake formed due to lahar flows from surrounding volcanic activity with the most likely source being the nearby Guffey volcano, which is now long extinct. This lahar flow blocked a section of the stream flowing through the valley and effectively dammed it up for many millennia. Ancient Lake Florissant became the perfect environment for fragile leaf and insect fossils to form, with organisms settling to the bottom of the lakebed and being covered with layers of volcanic ash and mucus-secreting diatoms. These lake bottom layers lithified as thin laminae <1 mm thick, forming "paper shale" sections that when excavated, peel easily to reveal high detail fossil specimens. Fossils at FLFO have been collected and studied since the 1870s and examples can be found in museums across the world, from the Natural History Museum in London to the Denver Museum of Nature & Science. In addition, a large collection of specimens (currently 11,000) made since 1995 in conjunction with NPS research projects are housed in the collection room in the Paleontology lab at the visitor center. The collection room is monitored monthly and data readings of temperature and humidity are collected by museum staff. Although the collections space is kept at a constant 63°F, there is still some fluctuation of humidity that is due to seasonal weather variations.

After inspection by multiple park officials, it was determined that the main wall of the collection room, separating it from the larger common area and lab space, does not conform to NPS Museum Standards. In addition, there is a lack of vertical space for supplies and archived materials. A complete rebuilding of the wall from the floor to the roof is planned for early 2024, including removal of the ceiling. However, the entire collection room will need to be completely emptied before construction can begin. An NPS project is currently providing funds for a single collections intern to help photograph, stabilize, rehouse, pack, and move the entire fossil collection before the planned construction. This project began January of 2022 and will end in December of 2024.

The first part of this process, photographing the collection, is done by taking stacked photos with a Nikon D7000 camera mounted on a Stack Shot rail that is mounted on a tripod. This rail uses a Stack Shot controller which allows for the user to easily move the camera up and down at will manually and also by buttons in the Helicon Remote program while the series of images are being taken. The camera has a macro lens and manual control button on the lens, which is necessary for the computer to function with the camera properly. The photographs are taken using Helicon Remote software which controls all camera functions based on a series of parameters set by the user such as exposure, shot count, and photograph interval. Once a group of images is taken, the series is opened in another software program, Helicon Focus. This program combines the photographs from multiple focal planes into one stacked image having clear focus throughout. The final step of the photographing project is for all images to be adjusted in Photoshop for color balance and uploaded to the ICMS database as baseline photographs for each specimen housed at FLFO. All specimen images are taken with a scalebar and color balance grid to ensure that accurate measurements can be taken from the image if needed. All hours spent photographing are conducted in an ergonomic rolling chair with regular breaks to stretch the body and rest the eyes.

The second part of this multi-year project is to stabilize and rehouse every fossil that the Monument stores in standard metal cabinets in the collection space. This ranges from insect fossils to leaf fossils, small vertebrate fossils, and fossilized wood. The fossils are mostly low- to no-relief shale slabs ranging in size from millimeters to multiple centimeters and many are extremely delicate due to their preservation in the very thin laminae of the "paper shale." Each fossil is placed in an archival box and a cushion of ¼ inch Ethafoam. However, prior housing techniques with just Ethafoam proved damaging to the thin and fragile shale. The open cells of the cross section of the cut Ethafoam pulled at the edges of the fossil matrix and on occasion caused them to break and fall apart. The Ethafoam also did not provide sufficient support for the fossils and due to gravity, shifting of boxes, and mishandling, the fossils also fell apart or delaminated. Therefore, a secondary layer of Tyvek cloth was determined as necessary to help eliminate these housing issues. With two layers of Ethafoam surrounding each fossil, a barrier of Tyvek is tucked into place around the fossil. This ensures that the base of the fossil is supported, no foam is making any further contact with the edges of the specimen, and handling is made easier due to the slippery texture of Tyvek, with the long-term goal of reducing any permanent damage to the specimen. The process of rehousing is conducted by cutting ¼ inch Ethafoam pieces to fit the various sized archival boxes with a sharp X-Acto blade or scissors, cutting a perimeter corresponding to the fossil or fossils being housed in the box, cutting out finger holds on either side of the fossil bed, and finally tucking a piece of Tyvek either close to the shape of the specimen or around the outside edge of the foam. Careful consideration is taken with the X-Acto blade usage to ensure no accidental cuts occur to the user and all cutting is done under bright light. The blade is replaced regularly for maximum sharpness since a dull blade can increase the potential for slippage and damage to the user. Fossil specimens that are extremely thin and fragile are mounted on archival cardboard (cut to size) with 20% Paraloid B-72 mixed with 95% ethanol (w/v). No consolidants are placed on the surface of the specimen, which is extremely damaging, but the 20% Paraloid adhesives applied to any cracks along the top or sides of the matrix slabs. Any repairs needing to be done to broken specimens is done with the same mixture of 20% Paraloid B-72 in 95% ethanol (w/v). All adhesion is done in a well-ventilated area to reduce risk of vapors from ethanol and the adhesive mixture kept in nail polish bottles and then housed in a fire cabinet when not being actively used.

Once the entire collection is photographed, stabilized, and rehoused, each specimen database entry is updated with relevant information. This includes notes on repair or preparation work done on the specimen, updating storage location in the collection and any identification by the Paleontologist. Once the correct information is properly entered into ICMS and inventory of each drawer is complete, the original collections paper tag is then placed in an archival binder and the specimen returned to the drawer. A new standardized collection label will be printed out and placed with the specimen. Once this process is complete for every cabinet, the process of packing and moving can begin. Following the workflow from a previous move in 2013, each specimen box will be stacked to the top with Ethafoam and voids between boxes with be stabilized with Ethafoam cubes. Each drawer of fossils will be individually wrapped between two sheets of ¼ inch foam and the whole drawer with the foam will be wrapped in plastic to ensure no shifting or sliding of any specimens during transport. After wrapping, each drawer will be placed into the slot of a wood box designed to hold 16 drawers. The cabinets will be empty during transport. Each cabinet will be placed in the basement of an offsite building and each drawer will be unwrapped and placed back into its original cabinet for storage during the brief period of construction. Once all construction is complete, the moving process will be reversed. All fossils will be returned to the newly rebuilt collections spaced and carefully unpacked. During that unpacking the collection will be examined closely to make sure no damage was done and repair any damage that might have occurred.

CHEMICAL PREPARATION OF EXCEPTIONALLY PRESERVED ECHINODERMS FROM THE MIDDLE JURASSIC OF WILTSHIRE, UK, USING THE SURFACTANT REWOQUAT

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Air abrasion is a tried and tested method of fossil preparation that has been in use for over one hundred years. Although it can achieve remarkable results that could not be achieved with other techniques, the potential to cause microscopic surface damage has become increasingly apparent as imaging tools develop (Graham and Allington-Jones, 2018).

In the summer of 2021, a team from The Natural History Museum (London) took part in an excavation at a private quarry in Wiltshire, South West England. Accompanying them on the dig were Sally and Neville Hollingworth, non-professional palaeontologists who had made the initial discovery and alerted the museum to the site's potential. The expedition yielded a substantial amount of exceptionally preserved echinoderms from the Middle Jurassic Forest Marble Formation. Initially, the material was prepared by air abrasion with aluminum oxide, but concerns over the partial or complete loss of taxonomically significant surface detail led to investigations into more gentle preparation methods.

Rewoquat is an organic surfactant that can be used to gently disaggregate clays and marls, while leaving calcite fossil intact – although disarticulation may occur in matrix-supported fossils (Jarochowska et al., 2013). Three methods of Rewoquat preparation were trialled on similar material, inspired by Hellemond et al., 2021: (1) full immersion, (2) inverted partial immersion, (3) localised brush application. For comparison, two other specimens were prepared by air abrasion with aluminium oxide and sodium bicarbonate respectively.

For all of the chemical treatments, the method was similar: Rewoquat was first diluted with isopropanol at 4:1 ratio. Specimens were immersed (or had Rewoquat applied to surface) within plastic containers, which were then sealed with a lid. They were then left for two days, with occasional monitoring. Some surfaces were gently brushed with a stiff bristle brush and isopropanol. The Rewoquat was then decanted (and saved for re-use) and the specimens rinsed or bathed in lukewarm tap water. The water was changed over several days until no bubbles formed. Finally, the specimens were left to dry in ambient conditions.

All the results were effective to some degree, but the treatment was not without its flaws. The process was hard to control – disaggregation of the matrix caused many specimens to drop off the surface (although these were relatively easy to recover by sieving and drying the residue). The process greatly enhanced the contrast between the matrix and fossils but left them with a permanent 'damp' look, implying that chemical residue may remain. A particularly good result was achieved by the paintbrush-application method, which also had the advantage of being easy to apply directly to specific areas. SEM images were taken of this specimen and a similar specimen prepared by air abrasion; the specimen prepared with Rewoquat retained much more surface detail intact. Preparation of the remaining material will be either by air abrasion or Rewoquat on a case-by-case basis.

Rewoquat causes skin irritation and serious eye irritation. Gloves and goggles were used while working with the substance and all work was carried out under extraction. It is also hazardous to aquatic environments, and care was taken that it was not poured down the sink. Used Rewoquat was retained for later use. Water contaminated with Rewoquat from the first rinses was kept in a container and disposed of via hazardous waste procedures.

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ACRYLIC FILMS & COBWEBS: INVESTIGATING PARALOID B-72 AND BUTVAR B-76 IN ACETONE AND 95% ETHANOL FOR TRANSPARENT VOID FILLS

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The Rancho La Brea (RLB) Fossil Lab develops and improves asphaltic fossil preparation techniques, building on decades of accumulated paleontological preparation experience. Voids are common features in fossils, where material has been lost during the preservation or excavation process which may require structural support and accumulate debris post-preparation. Filling voids has historically led to the introduction of opaque materials as gap fillers that obscure the internal structures of the fossil. This study examined two methodologies: acrylic films used in glass conservation (Koob et al. 2011, Barstow and Cutajar 2017), and cobwebbing which was developed by, and is established practice, at the Gray Fossil Site (Haugrud and Compton 2008). These two methods have the potential to provide both support and protection for fossils without visual obstruction. Techniques were assessed on clarity, ease of application, rigidity, and likelihood for further applications. Tensile strength was not tested beyond gentle qualitative observations. Acrylic films are preferred for light structural support and the prevention of debris accumulation due to the ease of application and transparency. These films, regardless of the adhesive and solvent, have a broader potential for applications in ongoing RLB research.

When investigating methodologies for conservation and repair of fossils, it is important for ethical and practical reasons to ensure the reversibility and chemical stability of the materials. Paraloid B-72 and Butvar B-76 are commonly used in fossil preparation precisely because of these qualities. Paraloid B-72 is a well-studied acrylic resin used in a myriad of other conservation disciplines with excellent results. In the interest of determining the efficacy of acrylic films to fill voids in fossils, a known paleontological method was compared with one novel to this field.

Two common conservation adhesives were examined: Paraloid B-72 used by Koob, et al. (2011) for acrylic films, and Butvar B-76, the preferred adhesive for cobwebbing per Haugrud and Compton (2008). These were dissolved in two readily available solvents, acetone and 95% ethanol. The following ratios were initially selected for this study across all adhesive to solvent combinations: 1:4 (w:v), and 1:5 (w:v). These ratios were sufficient for Butvar B-76 in acetone and Butvar B-76 in ethanol for acrylic films and cobwebs. In the case of Paraloid B-72 in ethanol, those ratios were determined to be too thin and were replaced with 1:1 (w:w) and 3:4 (w:w), which were qualitatively similar to all other mixtures used. For cobwebbing with Paraloid B-72 in acetone, 3:4 (w:w) and 1:1 (w:w) were used to achieve the honey-like consistency that was recommended by Haugrud and Compton (2008).

Paraloid B-72 was weighed, wrapped in cheesecloth, tied with cotton string and suspended in a jar of solvent for one week to dissolve (Davidson and Brown, 2012). Butvar B-76, was weighed, added to solvent, and stirred over the course of a week (Haugrud and Compton, 2008). Modern bones were selected for this study because the initial stages of work were performed in a satellite lab during the Covid-19 lockdown, making access to fossils for this project impractical. The acrylic films were adhered to ~1.5-3 cm-thick cross-sectional slices of Bos tibia (n=8) and cobwebbing applied to domesticated Aves furcula (n=8). The voids being filled with acrylic films varied between 2-4.5cm^2, whereas the extent of the voids filled by cobwebs ranged from 2-3.75cm wide.

Health and safety regulations were followed at all points in this study. This included working in ventilated spaces, wearing proper PPE (lab coat, close-toe shoes, safety glasses, nitrile gloves), and having the necessary first aid materials nearby such as an eyewash station and sink with soap and water in case of skin exposure, per the SDS for the materials being studied.

Acrylic films were created without molds by spreading adhesive inside a square marked in Sharpie ink on a moisture-resistant polyester sheet. Test films ($2cm^2$) were dried under two conditions: in an open environment and in closed polystyrene boxes, to determine optimal drying conditions that prevented bubble formation. Closed environment drying is advantageous because it produces fewer bubbles. During the study, polystyrene boxes crazed due to acetone vapor, leading to consideration of polypropylene boxes for future investigations. 5cm2 and 7cm2 films were formed for void filling and were left to dry over the course of one to two weeks, ethanol requiring longer drying times than acetone. Once dry, the films were removed from the polyester sheet, photographed, and examined qualitatively for durability and flexibility. Films were placed over the void and traced with Sharpie to include a ~0.25cm margin overlapping the bone, then cut with shears. This custom film was then adhered onto the bone, over the void, using the same solvent present in the film mixture (acetone or ethanol) with a ⅛" clean room polyurethane foam swab. These were then allowed to dry completely before handling.

To create cobwebs, adhesive was dispensed from a needleless high density polypropylene Luer-Lok syringe. Syringes are currently part of the standard materials at RLB and function in a similar manner to the tubes used by Haugrud and Compton (2008). Moving from the symphysis toward the coracoid facet, adhesive was anchored on one side of the furculum and moved diagonally across to the opposite side. In this way, a zig-zag pattern of adhesive was strung between the two sides for half or ⅔ of the length of the furculum. Small amounts of adhesive were expressed while moving across the open space to form the cobweb strings. Because cobwebs were prone to sagging unless frequently rotated during drying, none were dried in a closed environment. The cells between threads were filled using the same adhesive ratio as for the cobweb threads and following the same zig-zag method. During the drying period, small amounts of solvent were used to tidy up any excess adhesive around the edges of the void being filled. Solvent was applied using ⅛" clean room polyurethane foam swabs.

All acrylic films, regardless of the presence of bubbles, had areas that were suitable for use with minimal visual obstruction except when caught with light glare. All films were strong enough and adhered sufficiently to the bones to withstand gentle pressure. A lateral view of the applied acrylic films made without molds has a negligible profile when attached against one side of a specimen. The ability to form panes without a mold is promising for use with particularly delicate bones such as avian and small mammal crania. Although using molds provides greater control over film thickness and uniformity, they are not necessary provided the adhesive mixture is thick enough to remain on a polyester sheet. Films should dry in a closed environment because slower evaporation rates result in fewer bubbles which is desirable for both strength and clarity. Acrylic films serve to close voids without obscuring the internal view of the specimen. Films can be produced quickly, allowed to dry unattended, cut to fit each project, and applied with minimal training and effort for simpler fossils.

Cobwebbing, in these tests, was less successful at providing unobstructed views through adhesive panes. The adhesives were also harder to control and had a much steeper learning curve than acrylic films, requiring greater practice and expertise. Cobwebs tended to slump without frequent rotations while drying, necessitating more time and attention from preparators than the acrylic film method. In several cases, the open end of the void became unpredictably concave, suggesting that this method is unsuitable for voids that are not fully enclosed. Slumping was not mentioned by Haugrud and Compton (2008), which may be another indicator of the level of expertise needed to achieve desired results. Additionally, the repeated rotations indicated to prevent sagging precluded drying in a closed environment. This led to every sample of the cobweb method displaying a profusion of bubbles, which can act as points of structural weakness. Bubbles varied in size and distribution, creating undesired irregularity, and hindering the internal view of the specimen. This method will not be adopted in the RLB Fossil Lab for these reasons.

In recent years, RLB has initiated the BREAS Initiative (Bridging Research and Education in Asphalt Sites), with the aim of developing and strengthening collaborations with paleontological contemporaries around the world working with asphaltic fossil deposits. Certain materials, such as acetone, may not be available in some asphaltic fossil localities, requiring research into suitable alternatives. Future studies will investigate best practices for producing, storing, and transporting stocks of pre-made acrylic films for use in field work in regions with limitations that impact access to desired materials. Producing and using thicker acrylic films for strength and structural stability will be investigated. Acrylic films lend themselves to a broad range of innovation which is favorable for continued consideration.

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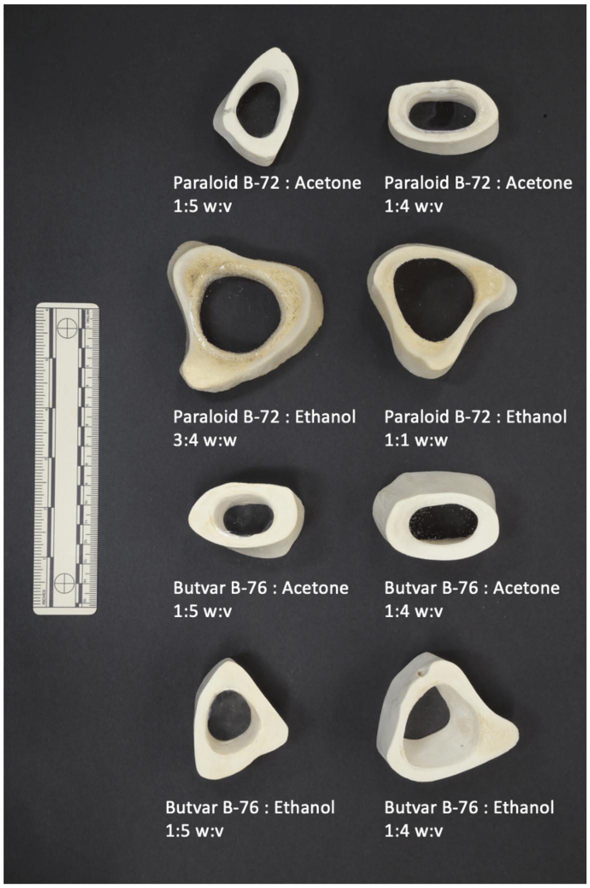

Fig. 1: Acrylic films on cross-sectional slices of Bos tibia

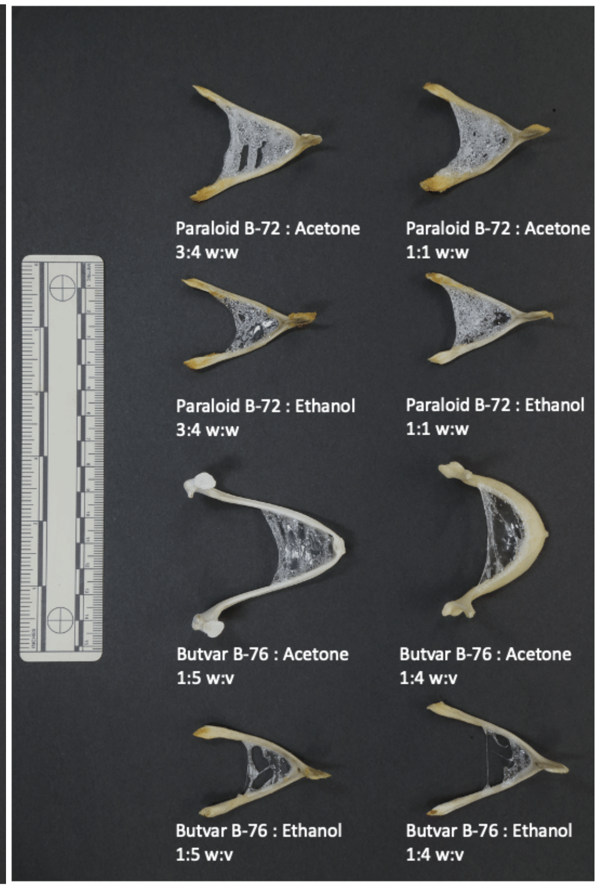

Fig. 2: Cob webs on domesticated Aves *furcula*

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ASSESSING AND IMPROVING SCIENCE STUDENT #SCICOMM SKILLS

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Paleontologists, especially those that work in public-facing institutions like museums, are often on the front line of science communication. However, as the population becomes increasingly connected online, there is a growing need for effective science communication on social media platforms (referred to here as #SciComm). The goal of our project is to assess and facilitate #SciComm skill development among science students at Fort Hays State University (FHSU) to enhance their professional development opportunities. To do this, we are investigating what #SciComm-related skills students are already exposed to through course work and then develop methods to train science majors on how to communicate scientific ideas to the public using popular social media platforms.

This project started with building #SciComm assignments into advanced paleontology classes at FHSU so students could practice communicating complex science ideas to a general audience. These assignments included writing blog posts or social media posts to develop written science communication skills. Students not only had to employ higher-order thinking to deconstructing complex ideas, but also gained experience drafting engaging #SciComm posts. However, when these activities were first developed, no classroom-based instruction was provided for students to practice and develop #SciComm skills despite the assignments being graded.

Starting in Spring 2021, class time was dedicated to discuss and practice how to interact with the public on social media platforms. Key points of instruction include identifying the audience, constructing a narrative, avoiding (or defining) jargon, and using analogies. After more formalized instruction, students were given #SciComm-based assignments. These assignments were generally low risk, either ungraded or not posted to social media. Posted work was published on the Sternberg Museum of Natural History accounts (after going through thorough review) so that students could practice writing posts without having to use personal accounts.

Student feedback was positive, emphasizing the value students place in developing science communication skills, especially on social media platforms. As a result, we are further investigating what science communication skills are currently taught in FHSU science courses and what skills students want to develop. To do this, we deployed a survey to all FHSU undergraduate and graduate science students to gauge their experiences with #SciComm. Questions included what training students already receive on communicating science to non-scientists (e.g., writing plain-language summaries, creating infographics, community outreach, etc.) and which classes incorporate building these skills. We also collected data on what #SciComm content students consume on social media and what skills they want to develop. Results will be used to develop a hybrid workshop for FHSU students to provide a primer on #SciComm during the Spring 2023 semester. Pre- and post-workshop surveys will be used to gauge effectiveness in science communication skill development. Ultimately, we hope to utilize more classroom- and workshop-based activities to prepare better the next generation of scientists for science communication in a digital world.

BONDING AND PAPERING FOR CONSERVATION OF PALAEONTOLOGICAL MATERIAL: EVALUATION OF THE RESISTANCE OF THE MATERIALS CLOSEST TO THE FOSSIL

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Introduction

In paleontology, extraction structures (field jackets) are essential in excavation processes, ensuring the safe extraction and transport of specimens to their final location. These structures protect and support the fossil specimens together with the rock that surrounds them until their final stabilization is achieved, so they are responsible for the safety of the specimens in a particularly unstable part of the preparation process. Therefore, it is important that these structures are correctly built, with the most suitable and compatible materials.

Objectives

Our main objective is to evaluate the resistance provided by different materials in contact with the fossil used in the construction of jackets for the extraction of elements in the field. The validity of the papering method as a substitute for gauze to reinforce fragile surfaces is also evaluated.

Material and methods

Tests have been carried out to verify the usefulness and improvement of the resistance of fossils by applying a layer of paper or gauze, which is a method of reinforcement used to provide stability and to ensure the handling of heritage objects. Therefore it is carried out as a protective treatment prior to making the support or the extraction structure. This treatment consists of adhering layers of gauze or paper to the surface of the object (Calvo Manuel, 2002). This way of protection can be applied to most fossils, even as a preventive measure, even if no evidence of deterioration is detected.

To verify the reliability of the use of glued layers of paper or gauze for the construction of extraction structures, three-point bending tests have been carried out in accordance with the European standard (UNE-EN 196-1:2018 on test methods for cements Determination of strengths). For this purpose, ten plaster prototypes were used in accordance with the standard UNE-EN 13279-2:2014 ("Construction plasters and gypsum-based binders for construction. Part 2: Test methods"), with a size of 40 x 40 x 160 mm and a central crack of 30 mm. The hardness of the prototypes is 97 HC (measured with a portable digital hardness tester TYP-100C), which is like the surface hardness of the fossil specimens of some vertebrates from the Late Cretaceous Lo Hueco fossil site (Ortega et al, 2015). Once dry, the prototypes were consolidated with Paraloid B72 dissolved at 5% in acetone until saturation.

The tests carried out were based on the most common techniques and materials for the creation of these structural reinforcements, such as Veladine gauze and 6 g Tangujo Japanese paper. The adhesives chosen are resins with high reversibility, high resistance to aging and low toxicity for the people who use them. Paraloid B72 (Aberasturi, 2011), polyvinyl acetate -Vinac- (Howie, 1984) and Acril-ME (an acrylic resin in aqueous dispersion) were used.

Discussion and conclusions

The results of the flexural strength test indicate that both paper and gauze are valid for use as field extraction support and as a protective layer for structurally weak parts after preparation. In these tests we have seen the suitability of placing a gauze as reinforcement within the extraction supports. In fact, two tightly fitted layers of gauze with 10% Paraloid B72 in acetone will withstand a tension of 0.622 KN (about 622 kg). All measures were taken under controlled conditions in the laboratory: low humidity and surfaces consolidated to saturation.

N°	SAMPLE	MAXIMUM SUPPORTED FORCE (kN)
P.1	PLASTER PROTOTYPE, WHOLE	1,516
P.2	PLASTER PROTOTYPE WITH CRACK	0,082
G02	2 GAUZE LAYER + PARALOID B72 10% DISSOLVE IN ACETONE	0,622
G03	1 GAUZE LAYER + PARALOID B72 10% DISSOLVE IN ACETONE	0,313
G04	JAPANESE PAPER 6 G + PARALOID B72 10% DISSOLVE IN ACETONE	0,376
G05	1 GAUZE LAYER + VINAC 10% ACETONE	0,147
G06	JAPANESE PAPER 6 G +1 GAUZE+ PARALOID B72 10% DISSOLVE IN ACETONE	0,489
GO8	1 GAUZE LAYER + PARALOID B72 10% DISSOLVE IN ACETONE. HUMIDITY 89%	0,101
G09	1 GAUZE LAYER + ACRIL ME	0,232

Table 1: Maximum force (kilonewton) supported by the different types of treatment applied to the analyzed specimens.

Two specimens were tested for each case. One was reinforced with gauze and exposed to two sessions of accelerated ageing according to rule ISO9142:2003. The gauze layer of the other specimen was applied at 89% humidity. Even in these conditions, the data are conclusive, as the prototype is reinforced in both cases. The prototype subjected to high humidity, although with a light reinforcement, at the point of maximum stress would support 100 kg, reaching the maximum tension at half a millimeter. From this point onwards, the threads of the gauze fracture until they reach the maximum supported tension. Once the plaster cube is cracked, it reaches 3 mm and supports a weight of about ten kg until it breaks.

The Tangujo Japanese paper, despite its thinness, reinforces the fracture where it is placed. If a gauze is added on top of the paper, the weight bearing capacity is not greatly increased, but its flexure capacity is improved, since the gauze that has been adhered on top of the paper, when the paper breaks, continues to maintain its strength for almost one millimeter.

The resin that provides the greatest strength is Paraloid B72. Gauze bonded with polyvinyl acetate and Acryl-ME is less weight bearing but withstands more flexure. Acryl-ME is a good substitute of Paraloid B72 in wet conditions. However, Acryl-ME is less reversible and sensible to UV light, which can cause it to yellow and become insoluble.

Acknowledgments
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STABILIZATION AND CRATING FOR TRANSPORT OF A LOANED HOLOTYPE *TRICERATOPS* SKULL

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USNM V4928 is the holotype of *Triceratops calicornis* (=*Triceratops horridus*), in the National Museum of Natural History (NMNH) collections. The cranium and lower jaws of the specimen were loaned to the University of Colorado Museum of Natural History (CUMNH) in 1981, where the frill was reconstructed in the CUMNH museum exhibit space. A wooden base displayed the cranium and jaws in articulation, with the specimen supported by external and internal steel armature. After the expiration of the loan period, NMNH in collaboration with CUMNH packed and crated the specimen, and arranged for its return to NMNH collections.

Health and safety considerations for this project included considerations for the prevention of the spread of Covid-19. Preventative measures including masking and sanitization were practiced according to local guidance and regulations required by institutions, local governments, and transportation agencies. Travel clearances detailing health and safety practices for travel associated with this project were required for NMNH staff and reviewed by NMNH Safety staff prior to travel. Work by NMNH staff during travel was documented through photography and notes to record and assess site conditions, including safety considerations. Other safety practices included shipping SDS sheets with associated products for reference during work. For the use of expanding foam in an indoor space, ventilation needs were addressed by opening an exterior door and enhancing air exchange with large fans, as well as the use of several air purification machines. The use of a reciprocating saw required wearing work gloves, safety glasses, hearing protection, and particulate respirator masks. Additional personal protective equipment was used in a task specific manner, and included nitrile gloves, vapor respirator masks, and closed-toed footwear.

To return the loaned specimen, two advance trips were made by NMNH to CUMNH to assess and measure the specimen and surrounding spaces. As the reconstructed frill was wider than museum doorways, the challenge was how to crate and remove the specimen with minimal alteration. Preparations included creating technical drawings for crates, mapping reconstructed materials in the specimen, and advance shipment of supplies. A daily schedule of work determined the person-hours required. Arrangements were finalized with University of Colorado campus staff also providing much-needed resources.

To retrieve the specimen, a team of four NMNH staff worked onsite with CUMNH staff over a period of five days. Work was conducted within the museum's Paleo Hall exhibit space, which was closed to visitors. The process to prepare, pack, and crate the specimen included first protecting the surrounding floor and exhibits. Specimen cracks were consolidated, and gaps filled using solutions of Butvar B-76 in acetone. The lower jaws were removed from the mount and packaged individually. The display base became the crate base by adding wood supports and replacing caster wheels. The right side of the frill was removed by cutting through reconstructed materials using an oscillating saw. All specimen parts were padded with Ethafoam polyethylene foam, then wrapped in plastic cling wrap and bubble wrap. Specimen pieces were secured to the deck of the display base for transport using Senflex polyethylene foam for padding, double-sided Velcro, and metal screws and washers. Open space under the ventral surface of the cranium was infilled with wooden supports and expanding foam. The foam product used was Polyfoam R-2 Rigid Casting Foam, manufactured by Polytek Development Corp. Wood studs, diagonal braces, and plywood formed the crate walls and top. Campus Facilities staff used a forklift to take the crate off the museum's front steps and transport it to a dedicated freight truck. All work processes were documented to aid in future work with the specimen at NMNH. Collaboration with CUMNH and Facilities staff minimized the project's impact to the museum and campus. Although onsite conditions required slight deviations from the original plans, advance planning proved essential to a successful project.

IMPROVED PREPARATION METHODS FOR ASPHALT-PRESERVED FOSSILS FROM RANCHO LA BREA, CALIFORNIA

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Rancho La Brea (RLB) is a Late Pleistocene asphaltic locality preserving millions of fossils. Preparation of RLB fossils is specialized and requires degreasing solvents to remove hardened asphaltic sedimentary matrix. Previous preparation methods included submersion by soaking fossils in n-propyl bromide (nPB) to dissolve matrix. Soaking indiscriminately removes matrix, resulting in dissociation of fragile material and loss of supportive internal matrix. Historically, other degreasing solvents have been used or assessed, but data for long-term impacts on fossils is limited. To improve RLB preparation methods, alternative solvents and an exclusively manual preparation technique were tested and tracked for long-term impacts.

Five solvents were selected based on sustainable principles, representing a range of chemical properties: Aerotron, 2-butoxyethanol, d-limonene, Ecolink 1171, and Novec 73DE, with nPB serving as the control. All solvents have higher exposure limits than nPB, requiring less active ventilation in work spaces, as well as other health and safety or sustainability improvements (such as lesser PPE requirements, lower cost, or recyclability). Aerotron and Novec 73DE are proprietary fluorosolvent blends designed as industrial drop-in replacements for nPB. 2-butoxyethanol, d-limonene, and Ecolink 1171 are low volatile organic compound (VOC) solvents with different origins and uses. 2-butoxyethanol is a widely available and inexpensive solvent with multiple applications, d-Limonene is a naturally-occurring compound derived from orange oil that is commonly used in household cleaning products, and Ecolink 1171 is a proprietary degreasing blend. With this wide range of features and properties, useful criteria for selecting future solvents can be identified.

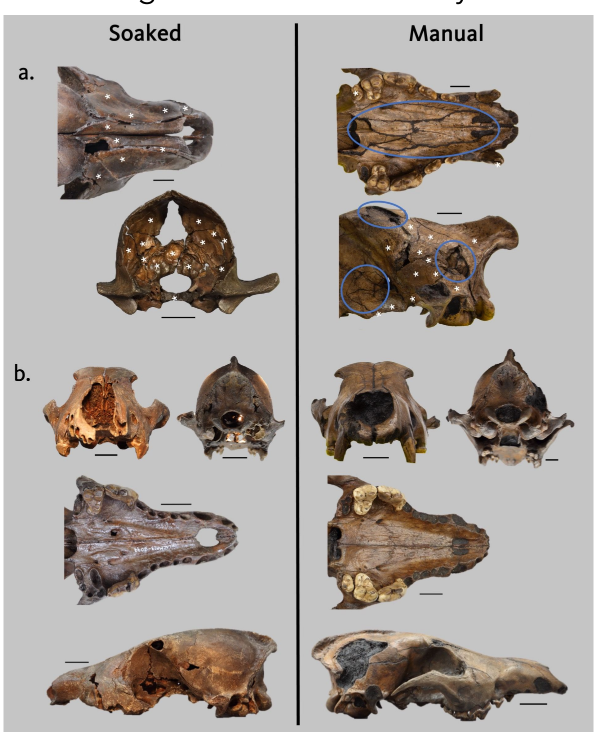

Figure 1.

Representative canid and avian fossils were soaked (n=24, 4 per solvent) and manually prepared (n=24, 4 per solvent). All work was performed in front of ventilation with appropriate personal protective equipment. While all solvents removed matrix, only Novec 73DE and nPB were sufficiently effective. Aerotron had a high evaporation rate that limited asphalt dissolution and matrix softening, requiring more mechanical effort. 2-butoxyethanol, d-limonene, and Ecolink had poor asphalt dissolution that also required high mechanical effort. Changes in fossil integrity were observed 9 months post-preparation, including oozing asphalt, drying, cracking, flaking, and crumbling. Soaked fossils exhibited greater degradation than manually prepared fossils.

Dehydration and cracking were the most common long-term changes. Aerotron and Novec 73DE, the higher volatility solvents, presented the least degradation (Figure 1). 2-butoxyethanol, d-limonene and Ecolink 1171, due to their lower volatility, left residual solvent that was detectable more than 18 months after preparation.

Manual preparation was assessed with canid cranial specimens, because they are morphologically complex with large internal cavities. This technique removes only external matrix through targeted application of solvent. Crania were manually prepared with nPB or Novec 73DE (n=8) and compared to previously soaked (n=13) crania for internal matrix retention and fragmentation. Manually prepared crania retained matrix in the braincase, nasals, and dental alveoli, while soaked crania retained minimal matrix. Foramina and non-morphological cavities retained matrix in over 70% of manually prepared crania, but less than 10% in soaked specimens. Manually prepared fossils were less fragmented (median 2 repairs) than soaked (median 13 repairs), requiring less conservation (Figure 2).

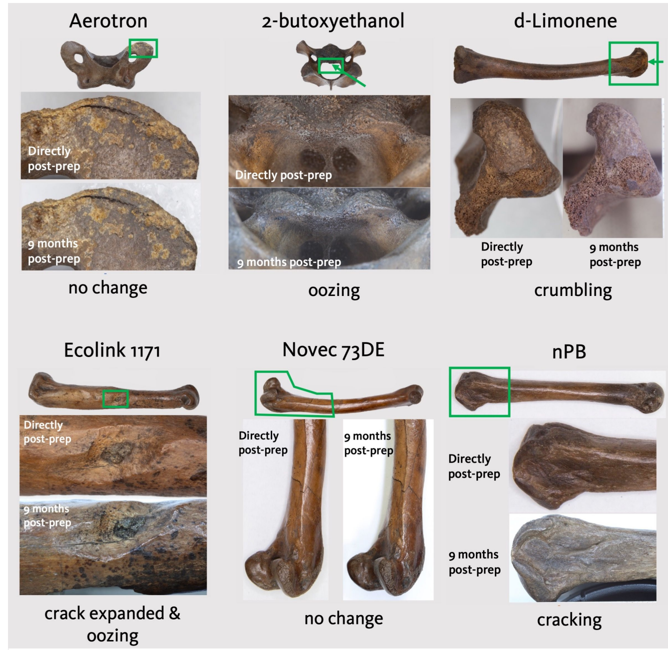

Figure 2.

Manual preparation with Novec 73DE proved most effective for external asphaltic matrix removal, internal matrix retention, and fossil integrity. Based on results of this research, RLB has adopted Novec 73DE and manual techniques as best practices for asphaltic paleontological preparation. Selection criteria for future asphaltic fossil preparation solvents have also been identified. Fluorosolvents or fluorosolvent blends with a vapor pressure between 100-300 mmHg that leave little to no residue (<10 ppm) are most likely to be effective and have minimal long-term fossil impact. Low VOC solvents are not recommended due to limited workability, resistant residues, and long-term impact on fossils. Ongoing and future studies are investigating Novec 73DE manual preparation with fossils from other asphaltic localities, as part of the BREAS Initiative (Bridging Research and Education in Asphalt Sites) to develop resources and collaborations with other asphaltic sites throughout the world.

CASE STUDIES: RESTORATION AND PYRITE DECAY ON BOLCA FOSSIL PALMS

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The Project

This is the description of a complex conservation and restoration treatment performed on a sample of fossil palm of the "Museo cantonale di storia naturale in Lugano's collection (MCSN), catalogue number MCSN8626.

A team composed of Fabio Magnani, the senior fossil preparator of the Museo cantonale di storia naturale in Lugano, and volunteering Cinzia Ragni (now a Ph.D. student at the University of Turin) restored Bolca's fossil in November 2021. Bolca is a Fossil-Lagerstätten in the Veneto Region in North Italy, reaching the fauna and flora of the Eocene (50 Mya).

The fossil was loaned for exhibition and conservation to the "Brissago's Islands," a touristic locality with a big hotel and a fabulous botanic garden (Botanic Park of Canton Ticino, who collaborates with the museum). Owing to unclear vicissitudes, the artifact, after a long period of exposure, was stored inside a dockyard for many years.

The scope of this preparation was to eliminate the presence of pyrite, which could destroy the fossil, improve the aspect of the fossil, repair the damage caused by previous restorations and inappropriate storage, and bring the fossil into the collection of the museum to which it belongs.

The fossil was in bad condition due to many agents of deterioration: high humidity of the place where it was stoked for many years, inappropriate temperature, light radiation, pollution, mechanical shocks, and water.

Health and Safety

The work for the restoration of the fossil palm did not take place in the preparation laboratory of the Lugano Museum; as the finding was extremely compromised, it was decided to work in the rooms of the Hotel Villa Emden. November was chosen to carry out the restoration, as this was a time when the Hotel Villa Emden and the botanical garden were closed to the public, to ensure the protection of the public and the best possible work. Personal protective equipment was used to work safely, including gloves, masks, and protective goggles. In addition, efforts were made to ventilate the room in which the fossil palm had been restored as much as possible.

Procedures

The fossil is embedded in a partially compromised cement structure. Moreover, the matrix, either because previous restorations had not made the fossil stable enough, or because of the weather and poor state of preservation, was very damaged and needed consolidation.

First, to work on the fossil without compromising the specimen, Paraloid B-72 was diluted to 5% in butyl acetate to consolidate the fossils and matrix.

Paraloid B-72 or B-72 is a durable and non-yellowing thermoplastic acrylic resin that can be chemically described as an ethyl methacrylate–methyl acrylate copolymer. It is soluble in acetone, ethanol, toluene, and xylenes, among other solvents and mixtures. In this case, butyl acetate was used because this substance, compared to acetone, is less volatile and dries more time. In this way, the Paraloid can be better absorbed by the matrix and more deeply stabilize the fossil with the consolidating agent.

Second, the team cleaned and consolidated the fossils.

The matrix was cleaned mechanically with the help of a metal brush. The matrix is a mix of volcanoclastic rocks and cement (in which the rocks are embedded).

To clean the fossil, pure acetone was used to remove old putties. In many parts of the sample, the old restoration was evident and removed, which was the only way to consolidate and perform high-quality restoration. To eliminate all the old bonding this phase was did two or three times. Analyzing the fossil, two restorations were estimated in the past, before that of November, one where mastic and cement were used, and a second where a sort of unidentified chemical consolidant was used.

The fossil was fragile, so it was used for a second time Paraloid B-72, diluted 5% in butyl acetate to consolidate the fossil and matrix.

Third, this work focuses on the removal of pyrite. Pyrite was present in all the fossils and matrices, but in particular in 4-5 areas near the leaves, on the palm trunk, and on the roots.

Mineral pyrite, also known as fool's gold, is an iron sulfide with the chemical formula FeS_2 (iron (II) disulfide).

Pyrite occurs in two major forms in fossil samples: compact, well crystallized, and stable, and porous, microcrystalline, often impure, and very unstable. Pyrite decay, or more accurately, oxidation, occurs rapidly only in the latter. Pyrite permineralized fossils have an outer organic layer that exfoliates if the fossil is removed from the fluid.

Pyrite reacts variably once it is exposed to humid air. An apparently stable plant fossil can suffer rapidly after being fractured for examination of internal details.

To remove pyrite, the team performed the treatment described by Cornish et al. (1995). Areas of interest were treated with 5% ethanolamine thioglycolate in 95% ethanol. With this procedure, more evidence of pyrites decays more times, and one time on all fossils and matrices in an attempt to prevent future damage. The ethanolamine thioglycolate solution was injected into the matrix and the fossil using sterile syringes and sprinkled on the surface with Chinese bristle brushes (much softer than normal ones). Where pyrite was more compact and impacting, it was mechanically removed after the treatment described above.

Fourth, the restoration. To restore the matrix, the team used mastic with pigments for the cracks on the cement and volcaniclastics rocks dust for the cracks in the volcanoclastic rocks and near the fossil.

To restore fossil plant, we used two different techniques. Where there were only a few cracks, only black and brown pigments and Paraloid B-72 were used (25% in acetone). In this case, acetone was used because the pigments were less mixed with butyl acetate and remained less impressed on the plate. Where the fossil was damaged, it was grouted with microlized silica and Paraloid B-72 (25% in acetone). This kind of restoration created an opalized effect on the fossil. It is important to perform this procedure under good temperature and humidity conditions; in other cases, the grouting can have cracks or become clear even if black and brown pigments are used.

For the last time, there was used Paraloid B-72, 5% in butyl acetate and where the fossil still presented delamination and was more fragile, we used Paraloid B-72 in 25% butyl acetate to consolidate fossil and matrix in view of the future public exhibition of the fossil.

Transport

The fossil palm (and matrix) is a large rectangular structure (2.3 x 1.2 x 0.2 m) and weighs approximately 1300-1500 kg.

The transport operation was carried out with the help of vehicles made available by the Swiss army, already present in the territory of Canton Ticino with vehicles and soldiers for a military exercise (ODESCALCHI 22). The transport, performed on June 17, 2022, was carried out by loading a truck with a crane onto a "motorized floating bridge" that carried out the lake transport to the Isole di Brissago escorted by two patrol boats of the Swiss army. Here, the fossilized palm, first moved to a more suitable location near the shore, was loaded by a crane onto its trailer. Subsequently, transport was carried out to bring the find back to the mainland, where it was subsequently deposited in the warehouses of the Museo cantonale di storia naturale (Lugano), where the environment for the preservation of the fossil is more appropriate for a sample of historical and scientific value. The location is provisional until it can be displayed. All transport and storage operations were supervised in first person by the second author (FM)

Acknowledgments

The authors are especially grateful to Rudolf Stockar for his expertise and guidance and to the Dipartimento del territorio, Museo cantonale di storia naturale.

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PLASTER FIELD JACKETS USING AIR FILTER MEDIA: AN ALTERNATIVE TO TRADITIONAL BURLAP AND PLASTER JACKETS

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Fossil findings all over the world are collected and transported using plaster field jackets that are commonly made of plaster and burlap strips, a method developed by American dinosaur hunters in the late 19th century. This method however, heavily relies on experts’ touch; from the amount of plaster used, to how to mix, and how many layers are applied to the specimen blocks. Occasionally the plaster starts to set too quickly and becomes unusable, or too much plaster is mixed and the extra plaster adds additional weight to the block. When too little plaster is mixed in the water, the plaster takes a long time to set, but adding extra plaster after mixing the plaster weakens the plaster jacket due to the uneven curing process of the plaster. Furthermore, it is not uncommon to lose track of layering while working with multiple people, resulting in uneven thickness and strength of the plaster jacket.

Over the past 15 years, the Field Museum team has been experimenting using an air filter media to make plaster field jackets since it was introduced in the preparators’ listserv in early 2000 by Russ McCarty, a former chief preparator at the Florida Museum of Natural History. Russ found air filter in a dumpster and he thought of the potential use of the material in plaster field jackets. The air filter is made of polyester, generally used to capture particles in HVAC systems. The high loft structure is randomly blown to create a sponge-like structure and one side is typically coated with colored-tackifier, a pressure sensitive adhesive, to capture particles. Through our experiments, we found that the air filter is best applied as a single piece instead of strips like the burlap used in the traditional method. A bulk roll of a ¾ - 1 inch (~2-2.5 cm) thickness and 3 - 5 feet (~90-150 cm) width is ideal for making the plaster jackets and a 1 ft^2 (~30 cm^2) of ¾ inch (~2 cm) thick air filter absorbs the plaster slurry mixture made of 1 qt (~1 L) of water. The colored tacky side is not very absorbent, so it is important to keep the tacky side down towards the specimen block so that extra plaster can be added. Since the air filter plaster jacket relies on the strength of the plaster, it is important to follow the manufacturer's water-to-plaster ratio in order to achieve its maximum strength. When available, we use USG No. 1 Casting Plaster because of its consistent compressive strength even if there are minor variations in the mixing ratio of water to plaster. The compressive strength is 1200 psi after one hour of setting and 2400 psi after completely dried. USG No.1 Casting Plaster requires 60-66 lb (27-30 kg) water per 100 lb (45 kg) plaster, or 1 qt (1 L) of water and about 1.6 qt (1.6 L) of plaster. Plaster must be properly soaked before mixing,

allowing each plaster particle to be completely saturated with water and evenly dispersed while mixing. Short-cuts in soaking will influence effectiveness of the mixing period and subsequently the quality of the plaster casts. To ensure the proper soaking, we wait for 3 minutes after the plaster is dispersed onto the water before mixing. Variations in water temperature and plaster will affect setting time and can cause difficulty with controlling the mixing time. The higher the temperature of the water and/or the plaster, the quicker the plaster will set. When working under extreme temperatures, using room temperature water and keeping the plaster in the shade to avoid hot sun will help control the setting time. Mixing the plaster slurry is the most important step in producing a strong field jacket. There is a direct relationship between energy input during mixing and strength development but overmixing will introduce porosity, and compromise the strength. To avoid overmixing, we limit the mixing time to 3 minutes. The method of plaster jacketing using the air filter can be described in the following 5 steps:

1) Prepare a block containing fossils by isolating and undercutting the block, cover the surface with a separator such as wet paper towel and fill large gaps and cracks with mud or wet papers to make the block as smooth as possible.
2) Overlay the uncut filter with the tacky side towards the block. Mark a line for cutting and the direction and positions of placement, then cut it with a pair of scissors. Cutting slits and darts to reduce bunching of the filter; place slits strategically to make the weak point of the block to have double layered protection or cut out a dart to reduce extra layering.
3) Measure water according to the size of the filter, disperse the measured plaster evenly onto water (1 ft^2 (30 cm^2) air filter needs 1 qt (1 L) water and 1.6 qt (1.6 L) plaster), soak the plaster without disturbing it for 3 minutes, then mix the plaster continuously for 3 minutes. To simplify the field practice, we use blue camping cups for measuring. Our blue cup is 12 oz. or roughly 350 ml in size and 1 cup of lightly packed plaster weighs about the same as 1 cup of water. Each 1 ft^2 (30 cm^2) of air filter needs 3 cups of water

and 5 cups of plaster. Using Nalgene or other bottles of known volume can be used to measure water quickly.

4) When the plaster slurry becomes creamy, saturate the air filter with the plaster mixture.
5) When the plaster mixture becomes viscous, carefully place the plaster saturated air filter on the block using the direction and position markings. Repositioning the air filter may disturb the separators, so it is important to place the plaster-soaked filter correctly. Rub and squeeze the surface to remove air pockets, and add remaining plaster to smooth the surface.

The cured plaster jacket can be cut using a serrated knife or a jab saw after flipping the jacket. Tear inward so that the plaster jacket does not peel off the block. Cover the other side of the field jacket using the same method. Following the manufacturer's instructions for the proper ratio of water-to-plaster and the timed soaking and mixing technique described above, the strength and the amount of plaster used for a single layer of filter media plaster jacket is equivalent to 3 layers of burlap strips. The filter media plaster jacket with measured amount of plaster is an easy and quick one-piece wrapping technique that eliminates the waste and failures with mixing the plaster and results in uniform thickness and strength, therefore it is an excellent alternative to the traditional burlap strip method.

During fieldwork, regardless of locality and duration, personal precautions for the health and safety are always prioritized and implemented for all team members involved; wearing proper safety gears including foot, hand, eye and hearing protection are mandatory. To minimize dust clouds from handling the Plaster of Paris, the bag of plaster is kept in an airtight plastic bin where it is cut open to create a large opening for an easy access and avoid opening and closing the bag as well as to keep the plaster dry. Use of face covers or masks avoids inhaling the dust and use of appropriate lifting techniques for heavy bags and plaster jackets are highly encouraged. Plaster of Paris is not classified as environmentally hazardous, but the cured plaster and excess plaster jacket materials are always packed out of the field sites to be properly disposed of.

RAPID AND SAFE RECOVERY OF MEGAVERTEBRATE FOSSILS FROM OPEN PIT AMMOLITE MINES IN SOUTHERN ALBERTA, CANADA.

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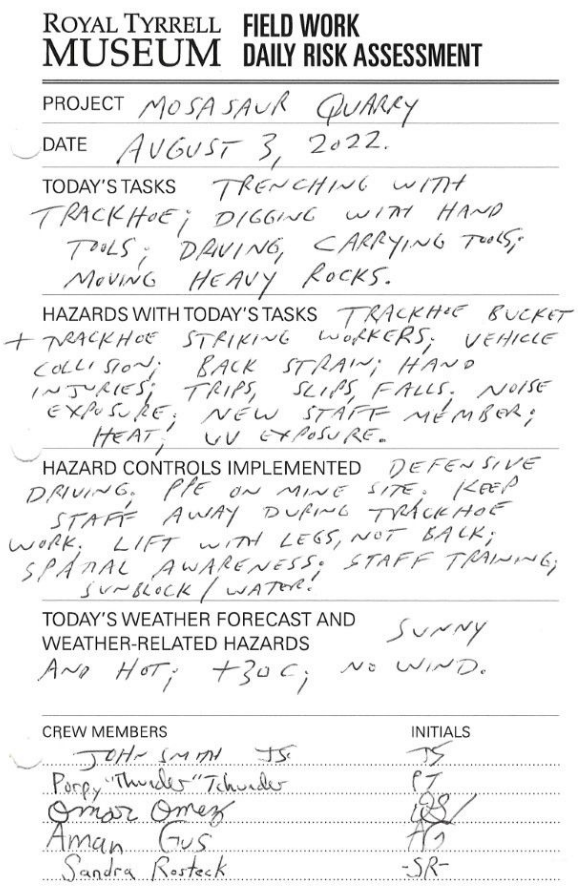
Ammolite (Mychaluk et al., 2001), is a processed gemstone derived mostly from diagenetically crushed *Placenticeras* ammonite shells. Raw material is recovered by open pit mining by several companies digging in Late Cretaceous marine shales southwest of Lethbridge, Alberta (AB). Diesel-powered trackhoe machines (Anonymous, 2022; fig. 1 here) scrape down and through the shale horizontally in 10-15 cm deep passes. Spotters watch for the exposed or uprooted brightly colored ammonites. Megavertebrate skeletons are also found from time to time consisting of mostly of three genera of mosasaurs, one species of elasmosaurid plesiosaur, and dinosaurs, hadrosaurs mostly. By law, work at that spot must stop and the fossil discovery reported to the Royal Tyrrell Museum of Palaeontology (TMP). The call then starts a now well-practised process to quickly examine and collect the remains (Tanke, 2014; Tanke, 2016; Tanke et al., 2013).

Figure 1.

Figure 1. A typical mid-sized trackhoe, used globally for a variety of excavating and other purposes; see also Anonymous, 2022. Here one clears away loose rock prior to jacketing and trenching at a *Prognathodon* mosasaur TMP 2007.034.0001 dig (lower centre), Korite ammolite mine, SSW of Lethbridge, AB, early October, 2007. TMP photo.

Health and Safety

TMP field and in-house H&S are taken very seriously. Upon receiving a phoned-in report of a major vertebrate find, several events happen prior to a TMP initial site visit. Emergency Response Plans (ERP) and a hazard assessment report are generated. These are computerized, prefilled forms and are specific to a work project, or, in the case of the ammolite mines, tailored to that specific site/work conditions. The ERP contains information for the hospital nearest to the field locality, First Aid tips (though all field staff have First Aid and more senior staff have Wilderness First Aid training), crews emergency contact information, etc. ERPs stay in the field vehicle. Each TMP vehicle also has a H&S "Blue book," a small 3-ring binder with preprinted pages (fig. 2) with fillable entries covering the name of work project, date, forecasted weather, hazards associated with travels to and from the mine from TMP or local hotel, hazards on site, and what steps TMP staff will do to mitigate these hazards. At the beginning of the trip from the museum/hotel to the mine or at the beginning of each work day at a tailgate meeting on-site, each section is discussed with all crew and filled in, then mitigation procedures that will be conducted by all to address these issues are recorded. Everyone is encouraged to contribute and comment. Finally, each crew member prints their name and initials to indicate we have discussed, understand, and agree on these H&S matters. It is not a legal document, but simply shows we have discussed H&S as a group and are practising due diligence. This particular safety protocol is modelled on that used at the Suncor Oil Sands mine north of Ft. McMurray, AB where intense safety culture is followed, which so impressed the author that he asked for it to be implemented at the TMP.


ROYAL TYRRELL MUSEUM — FIELD WORK DAILY RISK ASSESSMENT

PROJECT: MOSASAUR QUARRY

DATE: AUGUST 3, 2022.

TODAY'S TASKS: TRENCHING WITH TRACKHOE; DIGGING WITH HAND TOOLS; DRIVING, CARRYING TOOLS; MOVING HEAVY ROCKS.

HAZARDS WITH TODAY'S TASKS: TRACKHOE BUCKET + TRACKHOE STRIKING WORKERS; VEHICLE COLLISION; BACK STRAIN; HAND INJURIES; TRIPS, SLIPS, FALLS. NOISE EXPOSURE; NEW STAFF MEMBER; HEAT, UV EXPOSURE.

HAZARD CONTROLS IMPLEMENTED: DEFENSIVE DRIVING. PPE ON MINE SITE. KEEP STAFF AWAY DURING TRACKHOE WORK. LIFT WITH LEGS, NOT BACK; SPATIAL AWARENESS; STAFF TRAINING; SUNBLOCK / WATER!

TODAY'S WEATHER FORECAST AND WEATHER-RELATED HAZARDS: SUNNY AND HOT; +30C; NO WIND.

CREW MEMBERS	INITIALS
JOHN SMITH JS	JS
Poppy "Thunder" Thunder	PT
Omar Omez	OO
Aman Gus	AG
Sandra Rosteck	-SR-

Figure 2. A hypothetical filled in sample page from the TMP's Field Work Daily Risk Assessment "Blue book" at an ammolite mine megavertebrate dig.

Now we arrive at an ammolite mine for a preliminary site assessment. A rough gravel road without guardrails or berms zigzags down into the bottom of the river valley. Open pit mine health and safety rules vary from company to company. Some larger mines or industry work sites require any paleontological workers take online H&S courses before being allowed on mine property and can even involve a mine liaison person present at all times. Ammolite mines presently don't do this. As in any open pit excavation, numerous H&S hazards exist. Normally the fossil site itself is isolated and away from immediate hazards. Mine equipment will move to another area to work and minimize risks, though certain phases of the digging project will require us to work with them directly. Trackhoes, articulated earth movers, bulldozers, dump trucks, worker's personal vehicles, and service trucks move about the area, but these are usually well away from our work site. The mines themselves are overall moderately deep (~12-15 metres; ~40-50 feet) and descend down to the bottom in wide benches connected by ramps, in a stepwise fashion about three times so the height of vertical drops is reduced. Waste shale berms along the edge of the uppermost drop are often built to avoid personnel driving or falling into the open pit.

Other H&S concerns can also include water seepage infiltration (pumped out by mine); non mine/TMP visitors, temperature extremes, frequent strong winds and blowing dust, diesel exhaust, loud machinery with backup alarms, rock slumping/fall, tripping/slipping, and muscle strain. Onsite TMP H&S equipment are steel-toed boots, high-visibility fluorescent orange safety vests, hardhats, sitting/kneeling pads, safety glasses, dust masks, work gloves, nitrile gloves (for plastering), and ear plugs. All glue bottles have WHMIS labels. Fossil poachers (after lucrative ammolite-grade ammonites) are a potential human interaction problem but usually do their evil after work hours (Mychaluk, 2009:196). Standard hard hats (worn when machinery is close) provide minimal UV protection so facial sunblock use is suggested and provided, but not mandatory. The shale is dark gray, so on a hot sunny day the on site temperatures can reach +35°C (95°F). Skeletons are found year-round, so in winter, warm flame-resistant coveralls, lined gloves and quilted hardhat liners are provided. In February, 2022 we collected, in cool but relative comfort, a *Plioplatecarpus* mosasaur (TMP 2022.043.0001) outdoors without shelter in -9°C (16°F) with still to light winds. Soon after, another *Plioplatecarpus* (TMP2022.043.0002) was found close by and the weather turned worse with daytime highs of -19°C (-2°F) and up to 50 km/h (31 mph) winds resulting in windchills of -34°C (-29°F). In these conditions, frostbite will freeze unprotected skin in about 12 minutes. We worked in a 6-man collapsible plastic ice fishing shack with a small propane heater that allowed floor to ceiling temperatures of -5 to +10°C (14-50°F). In the shack, our collective breath and body moisture froze on the ceiling and rained cornflake-sized ice pieces onto us as the winds gusted, or dripped on us when we used the heater- all potential H&S concerns. A zippered door had to be left partly open for ventilation and mitigate possible CO exposure from the heater. When cold, people can leave the worksite and warm up in a museum truck close by. Better ways to collect industry finds in extreme cold weather conditions are being considered. A much larger ice-fishing shack and heating system has been purchased but not field-tested.

Procedures

Initially, an informal meeting between TMP staff and a mine manager and workers is held on site. The miners show what bone pieces they've saved, which will soon be wrapped and boxed up. We discuss issues concerning possible duration of the dig, potential of on-site trackhoe support, logistics, site security, safety, etc. A quick and careful general walk over around the in situ specimen is conducted to look for any additional loose pieces. The last few buckets of shale dumped prior to discovery are often picked up again with the trackhoe and deposited in long lines on bare ground so the debris can be searched for any missed bone. Loose rock debris is swept away from exposed in situ bones. White typewriter correction fluid or white paint is dabbed with a small brush onto the shale creating a dotted outline of the bones which are otherwise sometimes hard to see in the rock. Doing this helps avoid accidental trampling and loss of pieces. Paraloid™ B-72 in acetone is applied to broken pieces and any exposed bone, stabilizing it and also enhancing its visibility. The shale is damp and heavy; ~15% by weight is water. On occasion, especially after a rain, the glue does not work well so it can be lit on fire, utilizing the "Burnt Dope Technique" (Baird, 1978, 1980; Sues et al., 2013; see also Brown and Holliday, 2021) which flames off solvent, heats and dries the rock which expedites glue drying time. While this preliminary work is being done, others back at TMP are gathering tools, supplies, organizing lodging, getting an excavation permit, etc. The reconnaissance crew returns home, usually the same day, calling en route to report their observations and recommendations for amounts of people and supplies needed. The next day, the recovered fossils are examined, more focused plans made, truck(s) loaded with gear, permits handed off, and the crew departs. The TMP has a long history of rapid response to industry finds of all types, with staff examining the reported fossils within as little as one-four hours and a full crew working the site in as little as 24 hours. Industry managers appreciate the quick response which fosters a good mutual and cooperative relationship. During work, there is more focus on the rapid delineation of the skeleton vs. fully uncovering bones. We are at someone else's worksite, delaying their work, so expediency on TMP's part is a priority. Bones are usually heavily permineralized and harder than the surrounding rock. They are typically exposed at their extremities only; i.e. the tips of ribs exposed vs. uncovering them fully. Smaller isolated bones are quickly mapped, numbered, and removed, sometimes in pieces. Many pictures are taken. Larger isolated bones are removed in small plaster jackets. Any bones that break during uncovering may simply have the pieces identified and bagged - there is just not enough time in most cases to try and effect a proper repair on site. Bones exposed in large concretions are simply capped over and the concretion itself becomes the jacket. Once the main concentration of bones is identified, trenching with Hilti™ electric jackhammers run off gas-powered Honda™ electric generators is done. Once the trenching has moved past the lowermost bone, trenching stops for the time being. Typically, a large fossil skeleton is divided into small sections or blocks to reduce weight and ease their movement and transportation, but at a mine site, where heavy equipment is available, these concerns are not an issue. In 2007, the author was sent down to the Korite mine to help oversee the finishing of a large plesiosaur skeleton (the holotype of *Albertonectes vanderveldei*, TMP 2007.011.0001). It was a huge, labor-intensive project that would take a long time to complete. Instead of working by hand, he decided to try using a trackhoe to speed up the digging work. Half a day's work by hand could be done in 30 seconds with the trackhoe. Both trackhoe operator and author were in full view of each other, the rest of the crew well away. The author stood close to the fossil. Via hand signals, he guided the vertically-oriented blade on the bucket to where the cut was wanted. The blade then went slowly and steadily down about a metre, then pulled back in one fluid motion. The entire skeleton was trenched in under 45 minutes. Now ubiquitous trackhoe support is utilized on all industry digs for overburden removal, trenching, block flipping/short-distance transport, and loading. All done for free - the mines recognize providing them will expedite our work and departure. An occasional caveat of this work is differing museum and mine work cultures. Sometimes they wanted to dig or transport the field jacket in certain ways that were unsafe for the specimen. At these times, we had to be direct with mine workers to get them on board with our line of thinking.

Once the blocks are trenched and pedestalled, Hydrocal™ FGR-95 gypsum cement is used instead of regular plaster. FGR sets quickly and is extremely strong – one layer with burlap is about the equivalent of 3-4 layers of plaster of Paris and burlap. Due to the extreme rock weights involved, wood splints are almost always used. With trackhoe support, we can make larger jackets, sometimes weighing several tons. Wood struts are used for undercuts. Once the blocks are ready to flip over, a loose shale pile is laid down nearby as a cushion, then lifting straps of the desired length and strength are laid atop the pile. TMP staff are trained in the use of slings and lifting straps as part of an H&S regimen. The trackhoe bucket then gently nudges and flips the block over onto the straps. The trackhoe lifts the blocks out and takes them to another area where they are placed on heavy timbers to keep them out of mud and to allow the passage of lifting straps. Excess rock is removed, the jacket sealed and tarped. Usually, a museum crew will pick up the blocks later. Water weight loss through evaporation over the interim reduces the block's weight.

Following various H&S procedures and common sense in an open pit mine with many safety hazards, the TMP has demonstrated repeatedly that large fossil skeletons can be collected both safely and rapidly. A large skeleton that might take a month or so to complete under normal circumstances, can be done in as little as a week. A successful working relationship with industry, with their assistance in providing access to heavy machines with trained operators, and all present adhering to safety practises is imperative to expedite this work and do so safely.

Other than one shoulder/arm muscle strain, we have not experienced any serious H&S issues in the ammolite mines since beginning this type of work in 2007.

Note: Product names used herein are not an endorsement by the Royal Tyrrell Museum of Palaeontology or the Alberta Government; they are included here for educational and historical purposes only.

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CASE STUDY: CONSTRUCTING ARTICULATION CRADLES WITHIN A MOTHER JACKET TO PRESERVE TAPHONOMIC POSITIONING OF PHYTOSAUR TRUNK VERTEBRAE

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In September of 2021 members of the Virginia Tech Paleobiology and Geobiology Research Group unearthed a (likely) Triassic age *Machaeroprosopus lottorum* phytosaur in Garza County, Texas. The specimen comes from the "Patty" site in the Dockum Group, Cooper Canyon Formation and was discovered by Doug Cunningham.

Fossil Preparator Geno Iannaccone opened the field jacket and removed the overlaying mudstone with airscribes and finished the bone surface detail with hand tools. The specimen consists of a femur, trunk and caudal vertebrae, osteoderms, and a rib. Notably, two sections of articulated vertebrae are preserved parallel to one another. Given the potential taphonomic importance of this offset, we determined that the articulation and positional relationship of the vertebrae and osteoderms within the field jacket should be preserved. Additionally, we desired each articulated section be safely removable for study. We then drafted a plan to create individualized articulation cradles within the larger jacket cradle that could both preserve the original position of the vertebrae and cradle them when removed from the encompassing mother jacket.

The specimen was laid out on a countertop surface with upside prepared and unexposed down side still in original field jacket. The delicate vertebral processes and neural spines were supported with tightly packed jersey fabric. We covered the entire jacket and contents with a plastic sheet to provide a protective moisture barrier during the plastering process. Next, two 1/8" thick mats of sulfur free clay were placed over the two parallel sections of vertebrae to provide a form-fitting mimic of a final Ethafoam storage jacket lining. Aluminum Foil, acting as a final separator, was then burnished over the clay using a spoon. Three layers of USG Hydrocal FGR 95 gypsum cement with fiberglass veil were applied and hand-smoothed before setting, allowing the jackets to be thin and lightweight. Fiberglass veil was only applied up to one-half inch inside the final edge to create a fiberglass shard "poke free" jacket.

The dried FGR-95 was lined with a protective/separating layer of Ethafoam using small drops of Elmer's rubber cement adhesive. The discontinued archival contact cement Rhoplex N-580 would be preferable, however an equivalent substitute had not been identified. However, rubber cement can easily be removed and is not in direct contact with the specimen. Also, the planned 1/8" Ethafoam prevented the jacket from fitting securely on the vertebral sections and was swapped out for a better fitting 1/16". The completed articulation cradles were then fitted in place on the vertebrae and the process repeated. We put the plastic sheeting in place covering the entire specimen. No clay layer was needed at this stage so FGR-95 with fiberglass applied directly on the plastic layer and a mother jacket was made.

The mother jacket and plastic sheet were removed, and the still damp gypsum edges rasped to a smooth finish and allowed to fully dry. With the inner articulation cradles and mother cradle in place, we were able to flip the entire block and complete preparation.

Each vertebral section could now be independently removed from the supporting jacket while still being cradled in the smaller articulation jackets. This creative arrangement allows for full study of the specimen without losing critical data and provides a stable and secure housing that travels with the desired study elements.

This project required the use of PPE (personal protective equipment) including hearing, dust, and eye. The block was prepared in front of a Kana Flex hose connected to a Torit dust collector. Tools and equipment included Microjack 1 and HW-10 airscribes under a Wild Heerbrugg microscope with six-and-a-half-inch depth of field. We used nitrile gloves and N-95 dust masks when working with gypsum cement and cutting fiberglass veil.

L.A. UNDERWATER: A DEEP DIVE

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The current exhibition "LA Underwater" at the Natural History Museum of Los Angeles County showcases vertebrate and invertebrate fossils from southern California. Two of the largest specimens needed help from the prep lab before going on exhibit.

The skull of the Miocene mysticete *Mixocetus elysius* had been prepared and mounted in the 1930s. But by 2020 it resided in storage and required restoration before returning to public view. The two dentaries were broken in several places and the entire specimen had been painted a solid shade of brown at an unknown date. It was determined the skull – at 8.5' -- should remain attached to its original steel armature and hardwood base during restoration. But this base rested unevenly on a cart too small to support it properly: the front end sagged slightly, contributing to fracturing in the rostrum. The consensus was that the mount was in too precarious a state to move to the lab. The Exhibits Department was tasked with welding a new, custom cart on which the specimen could be moved safely.

In order to meet the exhibition deadline, the arduous process of stripping the paint off the skull began in the storage area. With no records of the earlier painting, the paint was tested for lead and the results were negative. Further tests determined that water served to remove the paint from the dentaries, but acetone was required to dissolve the paint from the skull. While a reasonable amount of ventilation was achieved in the work space, a mobile dust collector and half mask respirator, both outfitted with organic vapor filters, were employed for added safety. The stripping effort ran through innumerable pairs of nitrile gloves, Kimwipes, and natural bristle brushes.

When the cart was ready, the Exhibits, Conservation, and Vertebrate Paleontology Departments strategized a complex plan to move the mounted skull onto the new cart and up to the lab. This involved manually reorienting the mount on the old cart and supporting the sagging front end with a customized furniture dolly. With no easy elevator access the specimen was carefully rolled out into the museum garden. Specially prepared rails were inserted under the exhibit base. This allowed the mount to be lifted on a pair of modified pallet jacks and settled onto the new cart. The cart was then rolled along a plywood track across the museum grounds. The specimen re-entered the building close to the freight elevator which transported it to the 4th floor lab.

Once in the lab, the dentaries were repaired. An earlier attempt had inserted threaded steel rod into one side of adjoining sections of the jaw. Sockets to receive those rods had to be drilled into the opposite sections using a Foredom. These were filled with Apoxie epoxy putty. While the putty was still soft, the adjacent sections were temporarily put in place to ensure the rods would fit snuggly in the sockets. After the epoxy had set the sections were glued in place using thick Paraloid B-72. Special supports were crafted from expanding spray foam to ensure proper alignment of the sections. Powdered cellulose bound with Paraloid B-72 was used to fill small gaps at the joins. This reversible repair was used because at 8.5′ these heavy dentaries would be unwieldly to remove from the mount in the future, dismantling them seemed the better option. A crack that had opened in the plaster reconstruction was filled by injecting FGR 95 inside. Other small repairs were effected with Paraloid B-72. Exhibits placed an extra steel post under the anterior tip of the skull for added support.

The removal of the paint revealed that a high percentage of the specimen was plaster reconstruction. Only these plaster portions were to be repainted. Photoshop enabled pre-visualization of color options. A uniform shade was sought that would neither conceal the reconstruction, nor distract from the experience of the specimen as a whole. Finally, a color was mixed in Golden acrylics and the reconstructed parts painted. A formula for the paint mixture was included in the prep record so that it could be replicated in the future.

The restoration complete, skull, mount and cart were lifted together in the lab hoist and placed on a temporary exhibition pedestal and wheeled to the gallery.

A large Cretaceous ammonoid (*Eupachydiscus*) was also slated for the exhibition. It needed to be molded so that the Exhibits Department could use a cast to fabricate a mount. Casts would also serve research and outreach while the specimen is on display. The shape of the ammonoid was not complex, a two-part mold would suffice. But its size – 20″ in diameter – and weight – 140 lb. – presented challenges.

The specimen was centered on a sheet of 1″ plywood, a sheet of thin foamcore between, all atop a sturdy cart. The cart enabled moving the specimen between different work areas. A foamcore scaffolding was hot-glued around the ammonoid at the midline. This supported the layer of Plastilina used to set-up the mold. Liquid silicone was painted on in successive layers, with cheesecloth added to a central layer. The silicone – MPK 2125 – used two different catalysts for thin and pasty viscosities, and the thin layers took days to set completely. Mold plugs were poured using the thin silicone in the cup-and-cork method and attached to the mold with the last layers of rubber. A mothermold with a 3″ wide flange was made using FGR95 plaster and fiberglass veil. The foamcore scaffolding was removed and replaced with a lumber frame which was bolted to both the mothermold and the plywood base. This allowed four coworkers to gently flip the entire sandwich over on the cart. All the lumber was removed to expose the reverse of the ammonoid nested in the first half of the mold and mothermold. The second half of the mold was made using the same methods. Working out of doors and wearing a half mask respirator with organic vapor cartridges, Fiberglast Isophthalic Polyester 90, reinforced with fiberglass veil, was tinted and painted into the mold to make several casts.

The successful outcome of these efforts required the collaboration of the museum's Vertebrate Paleontology, Exhibits, Conservation, and Invertebrate Paleontology departments. Despite several hurdles, these projects were completed on schedule and contributed to a stellar exhibition.

Kelsie Abrams received her MS in Geoscience from Fort Hays State University in 2015. She has been managing fossil preparation labs for eight years and has been leading fieldwork crews for twelve years. She specializes in microvertebrate preparation and has worked extensively on Permo-Triassic animals from Africa, Antarctica, and Arizona. When not preparing strange reptilian holotypes or digging dinosaurs, she enjoys collecting live modern orchids. (*Workshop Leader – Polyethylene Glycol and Its Uses in Fossil Preparation and Conservation*)

JP Cavigelli has been Prep Lab Manager and Field Trip Organizer and Collections Manager at the Tate Geological Museum at Casper College since 2004. He has been preparing fossils since he was a skibum, starting by experimenting with a drywall screw on the dining room table. JP convinced some people to let him prepare fossils for them and started attending SVP conferences where he was able to ask Bill Amaral about carbowax when Bill mentioned it in an SVP presentation. JP managed to get his hands on some with help of the vertpaleo listserve (he believes) and by begging the big chemical companies for samples. He has been using the stuff since then and teaching volunteers how to use it and has used it for many delicate fossil prep projects both professionally and personally. JP accidentally discovered one day at a big box store that carbowax can be acquired in your local pharmacy and is very affordable. (*Workshop Leader – Polyethylene Glycol and Its Uses in Fossil Preparation and Conservation*)

Cornelia (Connie) Clarke is a preparator in the Fossil Lab at the La Brea Tar Pits and Museum, specializing in asphaltic fossil preparation since 2018. With Stevie and Stephany, Connie has worked to supervise and train over 80 volunteers in fossil preparation techniques and microfossil sorting. The volunteer team incorporates people aged 16 to 92, including summer-only volunteers, other museum staff, and interns that only have brief commitment periods, requiring quick turn-around and efficient training. Connie has presented on improved asphalt fossil techniques at AMMP, GSA, and SVP. (*Workshop Leader – Paleontology Preparation Training Manual*)

Shyla Davison is a graduate curatorial assistant at the Sternberg Museum of Natural History at Fort Hays State University. She has gained experience with the topic of data acquisition, transfer, and archiving in fossil preparation labs during her graduate research project. The purpose of her project was to assess how data are collected and archived in fossil preparation labs, and how accessible the data are to those who need it such as researchers and collections managers. The results of the project showed that many institutions struggle with lack of standard protocol for data communication between the preparation lab and collections. She hopes to bridge the gap in communication to ensure all data collected in preparation labs are properly archived and made available to those who need it by collaborating with other institutions to create a best practices protocol. (*Workshop Leader – Standardizing Fossil Preparation Lab Protocols*)

Sanaa El-Sayed is co-founder of Mansoura University Vertebrate Paleontology center (MUVP), the first Egyptian school dedicated to studying vertebrate paleontology. She is currently a PhD student in the Department of Earth and Environmental Sciences at the University of Michigan, USA, where her studies are supported by a scholarship from the Egyptian government. Miss El-Sayed is the first female National Geographic Explorer in Egypt and the Middle East in the area of paleontology, as well as the first female in the Middle East to lead an international peer-reviewed paper in vertebrate paleontology. In 2019, Miss El-Sayed was a Fulbright scholar at the University of Michigan in USA and was also shortlisted as one of three Egyptian female scientists for the L'Oreal UNESCO for Women in Science Fellowship. Miss El-Sayed received multiple awards from the most significant conference in the field of vertebrate paleontology, the Society of Vertebrate Paleontology (SVP), for the novelty of her research. Miss El-Sayed is actively involved as a leader/co-leader of several paleontological field projects and involved in more than 40 vertebrate paleontological field projects in Egypt, which aim to recover vertebrate fossils from the Late Cretaceous and Paleogene. Miss El-Sayed research is supported by competitive awards from the National Geographic Society, the Leakey Foundation, and other scientific organizations. Due to Miss El-Sayed's outreach efforts as a female role model, MUVP now includes three female graduate students. In addition, there have now been roughly one hundred female volunteers and undergrad students in MUVP over the years. (*Symposium Presenter*)

Alania Fike is a fossil preparator with over 10 years of paleontological experience who has completed field work in South Dakota, North Dakota, Nebraska, Wyoming, Montana, Kansas, and Colorado. She has worked for Triebold Paleontology Inc. since 2018 as a member of the prep/field team. Leading paleontology field crews is a duty of hers and she also has experience of leading amateur crews on day trips. She has the perspective of the ins and outs of working on Forest Service, National Park, BLM, and private land. Presented a talk including basic field techniques and safety at SVP (2022). (*Workshop Leader – Field Courtesy*)

Marilyn Fox is the Chief Preparator at the Yale Peabody Museum of Natural History. As such, she is asked to comment on all incoming destructive sampling requests and has been instrumental in creating the current guidelines in use at the museum. (*Workshop Leader – Destructive Sampling Protocols; Symposium Presenter*)

Christopher Griffin Christopher Griffin is an NSF postdoctoral fellow in the Department of Earth & Planetary Sciences at Yale University. He one of the principal investigators on an ongoing field program in Zimbabwe, in collaboration with the Natural History Museum of Zimbabwe. In Summer 2024 he will become an Assistant Professor of Geosciences at Princeton University. (*Symposium Presenter*)

Michael Holland began to explore and implement 3D printing and imaging in exhibit production in 2013, subsequently utilizing these technologies at NMNH (Smithsonian) and the Burke Museum. Today 3D surface scanning has become a regular part of his work flow in fossil preparation, exhibit fabrication, and the creation of hands-on educational objects. Ongoing learning involves integration of scan-based 3D models and digital sculpture for both scientific and artistic pursuits. (*Workshop Leader – 3D Scanning & 3D Printing in Paleontology*)

Dr. David Krause is Interim Director of Earth & Space Sciences and Senior Curator of Vertebrate Paleontology at the Denver Museum of Nature and Science; Emeritus Distinguished Service Professor in the Department of Anatomical Sciences at Stony Brook University (Stony Brook, NY); Research Associate of the American Museum of Natural History (New York, NY) and the Field Museum of Natural History (Chicago, IL); Founder and Executive Director of the Madagascar Ankizy Fund (www.ankizy.org); former Editor of the Journal of Vertebrate Paleontology (1987–1990); and former Vice President (1992–1994) and President (1994–1996) of the Society of Vertebrate Paleontology. Born and raised on a cattle ranch in southeastern Alberta, Dr. Krause received his B.Sc. and M.Sc. from the University of Alberta (Zoology) and his Ph.D. from the University of Michigan (Geology, 1982). He was awarded a Distinguished Alumni Award from the University of Alberta in 2010; an honorary doctorate from The University of Antananarivo (Madagascar) in 2012; and the Romer-Simpson Medal from the Society of Vertebrate Paleontology in 2022. Dr. Krause is a 50-year veteran of field research in Canada, the United States, Pakistan, India, and Madagascar and has published over 130 peer-reviewed research articles and edited four monographic volumes (SVP Memoirs). (*Symposium Presenter*)

Zoe Kulik has 8 years of bone histology experience making thin sections of anything from dinosaurs to zoo animals. She was trained by Dr. Megan Whitney and Dr. Kristi Curry Rogers at Macalester College where she managed the Curry Rogers' Paleohistology lab. Her expertise is primarily focused on synapsid cranial and postcranial histology, and has also worked with oversized titanosaur bones and skeletonizing and sectioning modern bones. (*Workshop Leader – Paleohistology*)

Siri Linz (she/her)has been the assistant archaeology collections manager at the Burke Museum since 2013 and the curation services coordinator since May 2021. In these roles, she collaborates with the archaeology collections manager to oversee the delivery, processing and care of archaeological collections that include more than 1 million belongings from all over the world. At the Burke, she supports hourly student staff, graduate/undergraduate student research and communicates with our federal, state, and Tribal partners. Siri holds a Master of Arts in Museology and a Bachelor of Arts in Anthropology from the University of Washington. Siri has taught an archaeology collections management lab course in the UW Museology graduate program since 2014. (*Workshop Leader – Custom Box Making*)

Alex Lowe (he/him) is a paleobotanist who is interested in dominant controls on the ecology of plant communities over the Cenozoic. Alex worked with paleontology collections and geochemistry labs during his BS at the University of Utah and worked on the early Eocene McAbee Fossil Beds during his MS from Brandon University. Alex is currently a PhD candidate at the University of Washington (UW) studying the response of plant community ecology in the Pacific Northwest to the mid-Miocene climatic optimum within a highly resolved temporal framework. Throughout this career, Alex has worked on a variety of plant fossil localities, managing the fossil collection and preservation process from the field to the museum. (*Workshop Leader – Be-leaf-able Plant Preparation*)

Melissa Macias is a Senior Paleontologist and GIS Analyst at Applied EarthWorks, Inc. in Pasadena, CA. She has many years of experience using GIS to create maps for reports and fieldwork, and regularly trains staff on the proper usage of the ESRI applications in the field for large-scale paleontological mitigation projects. (*Workshop Leader – GIS for Field Paleontology*)

Anthony Maltese is a certified outdoor crew leader for trail building, former lifeguard, 27 years of paleontological and geological fieldwork experience in the USA, and overseas (Mexico, Canada, Scotland, Netherlands and Portugal), field safety talk at AMMP (Lincoln) and led field safety workshop at SVP (2018). Fortunately, he claims to still have all his fingers and toes attached. (*Workshop Leader – Field Courtesy*)

Aaron McCanna Aaron McCanna is the Decolonization Coordinator at the Burke Museum. He grew up in Kingston, WA, where he spent nearly all of his time in the trees and forest, learning from the oldest teachers. He received his MA in Public Archaeology at the University of New Mexico, and his academic background is in the field of zoo-archaeology and indigenous archaeology. Today, he uses his lived experience as a Yup'ik and Mexican American mixed-race person in connection with his love for science to work on the concept of decolonization in a natural history and culture museum. To Aaron, decolonizing a museum is about realizing a brighter and more powerful museum, one that is more capable of realizing its mission and bolstering scientific ventures at the same time. (*Symposium Presenter*)

Hillary McLean has extensive knowledge of multiple field work issues from my multiple years spent in fossil preparation and leading field groups of my own. (*Workshop Leader – A Beginner's Guide to Paleontology Fieldwork: What You Need to Know Before You Go; Symposium Presenter*)

Jess Miller-Camp began taking museum studies classes while in grad school for vertebrate paleontology. They have since worked in university collections as a collections manager, plus other duties as they arise. Much of their work has involved training and managing students in museum work. They started a student club for natural history museums at UCR and have encouraged the creation of one at IU. Creating workflows is one of the things they create and encourage in their museum work. Because they also have a background in comparative vertebrate anatomy, they've been able to incorporate basic training in that with various activities partaken in by the students they supervise in order to make collections information more useful to researchers. (*Workshop Leader – Creating and Implementing Dual Anatomy/Inventory Workflow Guides*)

Stevie Morley has worked at the La Brea Tar Pits and Museum Fossil Lab as an Assistant Preparator and Museum Associate since 2017. They have experience in both excavation and preparation techniques unique to Late Pleistocene asphaltic fossil deposits. During this time Stevie has helped identify and refine new materials and methods for the removal of external asphalt from macrofossil bone. Prior to the CoVid-19 Pandemic, the Rancho La Brea Fossil Lab supported a large volunteer cohort which Stevie helped train and supervise. The Fossil Lab staff (S. Potze, S.L. Morley, and C.A. Clarke) created a manual to improve volunteer training and to enhance fossil preparation and microfossil sorting results. Since 2019, Stevie has co-presented preparation-based research with 3 posters for the AMMP Annual Meetings held in 2019 and 2021 and collaborated on 2 poster presentations for the Geological Society of America's Cordilleran/Rocky Mountain section meeting in 2021. Their poster submission for the AMMP 2022 Annual Meeting has been accepted for presentation, describing adhesive techniques in fossil preparation. (*Workshop Leader – Paleontology Preparation Training Manual*)

Conni O'Connor (she/her) is the Museum Technician at Florissant Fossil Beds National Monument. She specializes in the intricate micro preparation of plants and insects in paper shale and works to actively advance the conservation techniques and methods for the Florissant Formation and similar matrices. (*Workshop Leader – Be-leaf-able Plant Preparation*)

Polly Olsen has experience in tribal relations that provides a perspective of Indigenous Ways of Knowing and lived cultural experiences. She leads with creativity, and healing models that provide authentic voices for tribal communities focused on the past, present, and future narratives for the diversity of tribal communities. Polly is a member of the Yakama Nation. Her work is focused on enhancing reciprocal partnerships with tribes and communities. She is a UW graduate with a BA degree in Cultural Anthropology. Her work at the Burke Museum began in June 2017. (*Workshop Leader – Perspectives on Consultation from the Burke Museum*)

Laura Phillips has been the Archaeology Collections Manager at the Burke since 1993, caring for a collection of over one million artifacts, bags of dirt and field records. Her work has taken her throughout the Western US as well as abroad to Sweden, Indonesia and East Timor. More locally, she co-founded the Seattle Heritage Emergency Response Network and is a member of the American Institute for Conservation Collections Emergency Response Team. Today, much of her work involves returning collections to Tribal Nations, strengthening community relationships, mentoring and teaching students, and focusing on museum management and archaeological stewardship. She also loves to make boxes! (*Workshop Leader – Custom Box Making*)

Stephany Potze has been with the La Brea Tar Pits and Museums since 2016, where she has trained a diverse audience (~200 people), ranging from elementary school students to volunteers, on asphaltic fossil preparation and microfossil sorting. Over the past five years, the Rancho La Brea Fossil Lab has been active in developing and improving asphaltic paleontological preparation techniques that have been presented at various conferences, including the Association of Materials and Methods in Paleontology. Prior to working on Rancho La Brea material, she trained and supervised preparation staff and volunteers in acetic acid preparation techniques from hominin-bearing cave deposits, while working at the Ditsong Museum of Natural History in South Africa. In November 2022, Stephany and her colleague Connie Clarke were awarded the Hix Preparators Grant, in association with the 82nd Annual Society of Vertebrate Paleontology meeting. This workshop forms part of the BREAS initiative (Bridging Research and Education at Asphaltic sites) and will introduce all aspects of asphaltic fossil preparation to students in Trinidad, with the aim of developing and strengthening collaborations to build capacity with paleontological contemporaries around the world working with asphaltic deposits. (*Workshop Leader – Paleontology Preparation Training Manual*)

Danielle Serratos earned her Bachelor of Science in Geology at Texas A&M University – Corpus Christi and her Master of Science in Geology from the University of Alaska Fairbanks. Her research focused primarily on Mesozoic marine reptiles, paleontological collections and digitization, and education and outreach efforts. She has shifted career paths towards Museum Administration but still manages to spend time each year getting boots muddy with research and field collection.

Serratos has worked in a number of fields outside of paleontology, including developing and teaching 4th and 7th grade science curricula, monitoring and maintaining field equipment that provided coastal weather information at both state and federal levels, developing educational expos that brought together the local scientific community and military families, and curated and databased modern botanical specimens.

Within the paleontological field, Serratos has provided both formal and informal educational initiatives that have donated, or brought temporarily, fossils into classrooms in Texas, Alaska, and South Dakota; taught college-level paleontological and geological labs; been an organizer for sedimentary geology and paleontological communities throughout the entire United States; participated in developing novel approaches to how paleontological and neontological specimens are databased and accessed online for research and educational activities; curated and databased fossils from around the world; and published a new genus of elasmosaur as well as co-authored one of the most complete evolutionary understandings of Plesiosauria to date.

Within the museum industry, Serratos has led the development of a world-class experiential tourism opportunities in Nova Scotia such as the one-of-a-kind Fossils on Horseback Overnight Package that provides guests the opportunity to explore the shores of the Bay of Fundy on horseback and discover 200 million year old fossils of some of Canada's oldest dinosaurs. She has also worked with museum professionals across the Maritimes to develop, fund, and provide hands-on experiences that go beyond the narrow engagement model of just looking at specimens behind glass displays. Serratos is an active leader within the Women In Science and Engineering (WISE) Atlantic community, as well a local leader of the Nova Scotia Young Naturalist Club (Cobequid Chapter).

Before joining the Fundy Geo team in Nova Scotia, Serratos has lived and worked in South Dakota, Colorado, Alaska, and Texas. She is an avid gamer (both video and tabletop), fibre artist, proud member of the LGBQTIA2S+ community, and loves to read all the SciFi/Fantasy novels she can get her hands on. She has an incredible family and can reliably be found teaching her children how to be superheroes. She knows that humanity only succeeds when we are all excellent to one another. (*Symposium Presenter*)

Crystal Shin is a scientific illustrator and a botanical artist who has illustrated multiple paleo illustrations for published papers. She graduated from The Natural Scientific Illustration Certificate program at The University of Washington. She has illustrated the paleo scientific illustrations for the researchers at the Burke Museum, University of Washington for several years. She has a highly tuned attention to detail, and fine drawing skills. She also worked as a primary illustrator on the second edition of the renowned plant identification book, "Flora of the Pacific Northwest" at the University of Washington Herbarium. She teaches workshops and classes through various organizations throughout the Pacific Northwest. She is passionate about serving science as an artist. She works in graphite, pen and ink, colored pencils, and watercolor. (*Workshop Leader – Illustrating Fossil with Pencils*)

Christian Sidor received in bachelor's degree from Trinity College (CT) in 1994 and then completed his Ph.D. at the University of Chicago (2000). He was briefly a postdoctoral fellow at the Smithsonian Institution's National Museum of Natural History before starting as an assistant professor at the New York College of Osteopathic Medicine (2001–2005). Since 2005, he has been at the University of Washington and the Burke Museum, where he is currently a professor of biology and curator of vertebrate paleontology.

Sidor's research interests focus on Permian and Triassic tetrapod evolution, including the synapsid ancestry of mammals as well as the effect of the end-Permian mass extinction on the biogeographic distribution of tetrapods on Pangea. To expand the geographic coverage of Permian and Triassic localities, Sidor has been involved in international fieldwork for most of his career. In particular, he is the veteran of four field seasons exploring the Triassic of Antarctica including, most recently, six weeks spent in the Shackleton Glacier region of the Transantarctic Mountains in 2017–2018. (*Symposium Presenter*)

Mariah Slovacek (she/her) is the Paleontology Lab Manager at the Perot Museum of Nature and Science in Dallas, Texas. She earned her MS studying tooth enamel microstructure of plesiosaurs at SDSMT. Previously the Invertebrate Paleontology preparator at AMNH and assisting collections tech and preparator of fossil plant specimens from Florissant, Colorado. Currently she is in charge of fossil preparation for Perot, preparator of plant fossils, managing the lab spaces, and overseeing safety protocols within the labs. (*Workshop Leader – Be-leaf-able Plant Preparation*)

Dr. Xiaoming Wang is the Vertebrate Paleontology at the Natural History Museum of Los Angeles County and holds a PhD from the University of Kansas, where he studied the evolution and ecology of an extinct dog group known as the Borophagines. He was a Postdoctoral Fellow at the American Museum of Natural History in New York and later became Assistant Professor of Biology at Long Island University before starting as an Associate Curator of Vertebrate Paleontology in 2002. He has held the position of Curator since 2007 and has received several grants in support of oversees field work in Inner Mongolia and the Tibetan Plateau of China. Dr. Wang's research interest in the evolution of terrestrial mammals is primarily focused on the history of carnivores. Over the past 20 years Dr. Wang has specialized on the systematics and phylogeny of canids, the group that includes the dogs, wolves, foxes, and coyotes. He has published over 100 peer-reviewed papers and a popular level book titled, *Dogs: Their Fossil Relatives and Evolutionary History*, by Columbia University Press. Dr. Wang actively mentors graduate students pursuing courses of study similar to his research interests and holds many adjunct professorship positions at local universities and international organizations, such as the University of Southern California, the University of California Los Angeles, and the Chinese Academy of Sciences. He is also currently serving as a Member-at-Large for the Society of Vertebrate Paleontology (SVP). (*Symposium Presenter*)

Patrick Wilson is a 5th year Ph.D candidate at South Dakota School of Mines and Technology (SDSMT). Before attending SDSMT, Patrick worked for the Sternberg Museum of Natural History during his Master's of Science degree and as a Field Instructor in Montana. While attending SDSMT, he has had numerous opportunities for field and lab work to broaden his skill set. One of these opportunities at SDSMT was to take a Fossil Vertebrate Preparation and Conservation course, where he learned the basic principles and techniques of preparation and microsorting. These principles and techniques will be shared with the membership during his workshops. (*Workshop Leader – Fossil Prep 101; Introduction to Microsorting*)

Paige Wilson Deibel (she/her) is the Paleobotany Collections and Lab Manager at the Burke Museum of Natural History and Culture. Paige started working with geologic and vertebrate paleontological collections during her BA at Dartmouth College. In 2022, Paige received her PhD from the University of Washington (UW) with her dissertation studying plant macrofossils during the Cretaceous-Paleogene Mass Extinction. She now manages the macro- and micro-plant fossil collections at the Burke, maintains the plant fossil prep program at the Burke, and manages the safety and protocols of the paleobotany and paleoecology labs at UW. (*Workshop Leader – Be-leaf-able Plant Preparation*)

Alan Zdinak is Senior Fossil Preparator in Vertebrate Paleontology at the Natural History Museum of Los Angeles County. He mostly works on fossil whales and Miocene mammals. Over the last decade he's also prepared fossils at the Smithsonian's NMNH and Yale's Peabody Museum. He received his initial training in fossil prep at the AMNH. A former Vice President of AMMP, he's taught workshops in specimen housing and lab design, and delivered many talks at AMMP meetings and elsewhere. During pandemic lockdown, without access to a compressor, he gained a deepened appreciation for the role rotary tools can play in fossil preparation, applications he'll illuminate in this workshop. (*Workshop Leader – Beyond Airscribes*)

The Association for Materials and Methods in Paleontology is currently seeking applicants for the 2025 meeting and beyond.

The Annual Meeting is vital to fulfilling AMMP's Mission: *education and advocacy to improve ethics, standards, and practices in paleontology*.

For inquiries, please email the Annual Meeting Committee:
annualmeeting@paleomethods.org

We look forward to hearing from you!

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 o Bullying behavior, including intentional microaggressions o 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, 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.

Contact information to report an incident: conduct@paleomethods.org

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.

Appendix B
Essential Competencies for the Professional Vertebrate Fossil Preparator

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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