6TH ANNUAL FOSSIL PREPARATION & COLLECTIONS SYMPOSIUM 2013

Royal Tyrrell Museum

ABSTRACT VOLUME

DRUMHELLER, ALBERTA, CANADA APRIL 20 – 22, 2013

6th ANNUAL FOSSIL PREPARATION & COLLECTIONS SYMPOSIUM

at the Royal Tyrrell Museum of Palaeontology
Drumheller, Alberta, Canada
April 20–22, 2013

Programs and abstracts compiled and edited by Allison Fotheringham, Graeme Housego, Marilyn Laframboise, Brandon Strilisky, Lara Strilisky, Darren Tanke, Wendy Taylor

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The organizing committee thanks the contributors, participants, sponsors, and the volunteers who helped to make the symposium a success.

Special thanks to the Royal Tyrrell Museum Co-operating Society and Carr McLean for their gracious support.

SYMPOSIUM EVENTS AT A GLANCE

DATE & TIME	LOCATION	EVENT
FRIDAY, APRIL 19		
6:00 pm – 8:00 pm	*Lobby*	Icebreaker Early Registration Workshop Registration Julius Csotonyi book signing
SATURDAY, APRIL 20		
8:00 am – 8:40 am	*Lobby*	Registration
8:40 am – 12:00 pm	*Auditorium*	Oral Sessions
10:00 am – 11:00 am	*Learning Centre Lobby*	Poster Session Julius Csotonyi book signing
1:00 pm – 5:30 pm	*Gallery, Collections Storage, Prep Labs, Research Areas*	Guided Tours
5:30 pm	*Auditorium*	Association for Materials and Methods in Palaeontology meeting
SUNDAY, APRIL 21		
8:00 am – 12:00 pm	*Auditorium*	Oral Sessions
9:40 am – 10:40 pm	*Learning Centre Lobby*	Poster Session
1:00 pm – 4:30 pm	*Various venues*	Workshops
5:30 pm – 8:00 pm	**Badlands Community Facility**	Banquet & Silent Auction
MONDAY, APRIL 22		
8:00 am – 12:00 pm	*Auditorium*	Oral Sessions
9:40 am – 10:40 am	*Learning Centre lobby*	Poster Sessions
1:00 pm – 4:30 pm	*Various Venues*	Workshops
TUESDAY, APRIL 23		
8:00 am – 8:00 pm	**Dinosaur Provincial Park** (Departure/Return Ramada Inn)	Field Trip to DPP Dinner at Patricia Bar

**Locations in italics are held at the Royal Tyrrell Museum.*

ORAL PROGRAM AT A GLANCE

	SATURDAY	SUNDAY	MONDAY
8:00 am – 8:20 am	Registration	Morning Remarks	Morning Remarks
8:20 am – 8:40 am	Registration	Mark Graham	Angie Thompson
8:40 am – 9:00 am	Opening Remarks	Dave Hone	Patty Ralrick
9:00 am – 9:20 am	Mike Getty	Melissa Bowerman	Al Lindoe
9:20 am – 9:40 am	Meredith Rivin	Clive Coy	Pete Reser
9:40 am – 10:00 am	Robert Evander	Break & Poster Session	Break & Poster Session
10:00 am – 10:20 am	Break & Book Signing	Break & Poster Session	Break & Poster Session
10:20 am – 10:40 am	Break & Book Signing	Break & Poster Session	Break & Poster Session
10:40 am – 11:00 am	Break & Book Signing	Don Henderson	Matthew Brown
11:00 am – 11:20 am	Philip Currie	Rhian Russell	Darren Tanke
11:20 am – 11:40 am	Vicen Carrió	Becky Sanchez	Chris Capobianco
11:40 am – 1:00 pm	Lunch	Lunch	Lunch

ORAL PROGRAM SCHEDULE

SATURDAY MORNING, APRIL 20 — Auditorium

Moderators: Chris Capobianco and Rebecca Sanchez

8:40 – 9:00	Andrew G. Neuman	*Opening Remarks*
9:00 – 9:20	Mike Getty, Carolyn Levitt, Katherine Clayton and Jelle Wiersma	Moving paleontological collections into our new home at the Natural History Museum of Utah
9:20 – 9:40	Meredith A. Rivin	The Cooper Center: Development of a new curatorial facility and volunteer training program
9:40 – 10:00	Robert L. Evander	Everything you never wanted to know about plaster
10:00 – 11:00	*BREAK*	
11:00 – 11:20	Philip J. Currie and Eva B. Koppelhus	Extracting data from poached and old quarries in the Nemegt Formation of Mongolia
11:20 – 11:40	Vicen Carrió	From the Royal Museum to the National Museum of Scotland
11:40 – 1:00	*LUNCH*	

SUNDAY MORNING, APRIL 21 — Auditorium

Moderators: Marilyn Laframboise and David Lloyd

8:00 – 8:20	Marilyn Laframboise and David Lloyd	*Morning Remarks*
8:20 – 8:40	Mark R. Graham	The conservation and mounting of a large skull of the ichthyosaur *Temnodontosaurus platyodon* from the Jurassic coast of England, UK
8:40 – 9:00	David W. E. Hone and Darren H. Tanke	Scientific communication of fossil preparation in the digital realm
9:00 – 9:20	Melissa S. Bowerman, Darren H. Tanke and Roger Kehoe	Recovery of a giant fossil tree stump by barge from a remote Albertan field locality
9:00 – 9:20	Clive Coy	George Sternberg's tools
9:40 – 10:40	*BREAK*	
10:40 – 11:00	Donald M. Henderson	Estimating the volumes and masses of big plaster jackets
11:00 – 11:20	Rhian Russell	Blue-green discolouration of fossils at the RTMP: Potential causes and treatments
11:20 – 11:40	Rebecca Sanchez	Techniques utilized to isolate and prepare Chondrichthyan vertebrae and submilimeter-sized denticles for photography and description
11:40 – 1:00	*LUNCH*	

MONDAY MORNING, APRIL 22 — Auditorium

Moderators: Rhian Russell and Joseph Sanchez

8:00 – 8:20	Rhian Russell and Joseph Sanchez	*Morning Remarks*
8:20 – 8:40	Angella Thompson and Chase Shelborne	Testing a new procedure for removing aged consolidants from historic collections
8:40 – 9:00	Patricia E. Ralrick	Plastic milk crates and livestock watering troughs: A quick and inexpensive microvertebrate screening complex
9:00 – 9:20	L. Allan Lindoe and Clive Coy	Colour copy transfer technique for reproduction of low to no-relief fossil specimens
9:20 – 9:40	Peter K. Reser, Matthew Brown, and Michael Holland	Creating a high-resolution mold and cast of *Vancleavea campi*
9:40 – 10:40	*BREAK*	
10:40 – 11:00	Matthew A. Brown	Fossil preparation and conservation at the University of Texas at Austin: 1935-2009
11:00 – 11:20	Darren H. Tanke and Pete Reser	Eye surgery and the fossil preparator: Some personal perspectives
11:20 – 11:40	Christopher Capobianco	The use of plastic siding and other water-resistant material in the construction of screen-washing boxes: A year in review
11:40 – 1:00	*LUNCH*	

POSTER SESSIONS

AUTHORS	TITLE
Allison Fotheringham	How to clean a fish: Techniques developed to prepare small fish skeletons
Allison Fotheringham	Using plaster in winter: Ongoing experiments with additives to alter setting times
Christopher N. Jass, Alwynne B. Beaudoin, and Mike Luchanski	Evolving research methods, evolving collections management
Marilyn C. Laframboise	Polar fieldwork
Claudine Miserez, Martine Rochat, Géraldine Paratte and Daniel Marty	Development and production of a support for dinosaur track-bearing slabs recovered from highway A16 excavations (NW Switzerland)
Mark Mitchell	The collection, preparation and mounting of the holotype of the Late Cretaceous elasmosaur *Albertonectes vanderveldei*
Vanessa R. Rhue	Cultivating pedagogy: A holistic approach to professional development
Rhian Russell and Brandon Strilisky	Testing the tensile strength of paraloid B-72 to determine its potential applications as a palaeontological adhesive
Darren Tanke, Jennifer Bancescu, Daniel Spivak and Chris Jass	Professional palaeontology and industry in Alberta, Canada: A successful working relationship

WORKSHOP SCHEDULE

SUNDAY, APRIL 21 & MONDAY, APRIL 22 — Royal Tyrrell Museum

	1:00 pm – 2:30 pm	BREAK	3:00 pm – 4:30 pm
LEARNING CENTRE Classroom 1	**Silicone Molding Materials** Myra Bumgardner Silicones Inc, New York, NY Ana Balcarcel AMNH, New York, NY		**Gypsum Products: Types, Applications, & Techniques** Mike Vigo Georgia Pacific Gypsum, Rocklin, CA
LEARNING CENTRE Classrooms 3 & 4	**Palaeontology Education at the RTMP** Lena Braman RTMP, Drumheller, AB		
CASTING SHOP	**Vacuum Molding (Sunday)** **Vacuum Casting (Monday)** Ian Morrison ROM, Toronto, ON		
PREPARED COLLECTIONS			**Digital Photography** Sue Sabrowski RTMP, Drumheller, AB
UNPREPARED COLLECTIONS	**Seven Adhesives for Fossil Preparation** Amy Davidson AMNH, New York, NY		
SMALL PREPARATION LAB	**Cast Painting** Jennifer Bysterveld & Cory Hapfner Canada Fossils Ltd, Calgary, AB		**Air Scribe Care & Maintenance** Bill Murray PaleoTools, Brigham City, UT
LARGE PREPARATION LAB	**Hoisting & Rigging: Lifting Techniques & Gear Selection** Ron Clark Fly on the Wall Rigging, Calgary, AB		

RECOVERY OF A GIANT FOSSIL TREE STUMP BY BARGE FROM A REMOTE ALBERTA FIELD LOCALITY

Melissa S. Bowerman[1], Darren H. Tanke[2], and Roger Kehoe[3]
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Background and logistical considerations

Although petrified wood is the provincial stone of Alberta, large, well-preserved specimens are rare. Therefore, a report about the discovery of a large fossilized tree stump (Fig. 1) generated considerable interest from scientific, educational, and display perspectives. Made aware of this report, the Royal Alberta Museum (RAM) contacted the Royal Tyrrell Museum of Palaeontology (RTMP) to call on their technical expertise in large specimen recovery. In May 2012, we travelled by jet boat to the find site on the shore of the Athabasca River, south of Fox Creek, Alberta, to assess the specimen and prospects for its recovery. The stump was fully permineralized and intact except for a few minor cracks. Though not yet identified to species, the stump appears similar to permineralized *Metasequoia*-type trees found in Late Cretaceous and Paleocene deposits elsewhere in the province. The circumference at its widest point (base) was 5.8 metres (19 feet) and it had a maximum height of 88 centimetres (35 inches). A few loose samples of the trunk were collected to help determine the fossil's weight, later estimated to be approximately 3000-4000 kilograms (6614-8818 pounds). The excellent educational and display potential enhanced our enthusiasm for a recovery effort.

Retrieval of this specimen was fraught with challenges due to its remote location and position on the river's edge. Its riverside location also made it vulnerable to damage from winter ice, heightening the concern for its recovery in 2012. The nearest boat launch with reasonable road access was 11.2 kilometres (7 miles) downstream. Despite the distance involved, removal by boat was deemed the best option, but a conventional boat was unsuitable. The amount of wood required for the stump to travel over the transom and into the hull of a conventional boat was similar to constructing a dedicated craft.

Spring runoff and high summer water levels submerged the specimen until late summer. Meanwhile, we made plans for a fall 2012 collecting trip. After considering ways to stabilize the stump using glues or a plaster field jacket, we decided to use large ratchet straps due to their ease of use and because their nylon webbing is unaffected by moisture. We decided that multiple ratchet straps should be used in overlapping crisscross patterns, to maximize specimen support.

Barge construction

We devised a plan for a floating flat-decked barge onto which the stabilized stump could be dragged. A barge with the dimensions of (width, length, and height) 2.4 metres (8 feet), 6.1 metres (20 feet) and 44.5 centimetres (17.5 inches) had a predicted carrying capacity of 4536 kilograms (10,000 pounds). The design was refined using a small working model before the full-scale barge was built. The bow was given a radiused edge to assist with planning. Flat aluminum bars were installed around the periphery to provide multiple spots to fasten strapping. The barge was built with all marine-grade plywood with eight watertight compartments fitted with 12 bilge pumps. A removable axle assembly was fitted through the barge to allow for highway transport. The final product was tested by driving a loaded pickup truck on board and towing the barge by jet boat on the North Saskatchewan River in Edmonton.

The end result was a barge that looked surprisingly like the scows used by the palaeontological field crews from the American Museum of Natural History and the Geological Survey of Canada in Alberta in 1910-1916 (Tanke 2010), though with a squared-off stern. The barge was towed by a square-bowed jet boat. Heavy wooden L-frames, with hand-powered winches attached, were added to the front gunnels of the jet boat. These were used to raise and lower the back of the barge to allow the barge's bow to go under the tree stump.

Fig. 1. Don Waddell, who reported this specimen, with the fossilized tree stump on the shore of the Athabasca River.

Specimen removal, preparation, and loading

In September 2012, accompanied by additional field crew, we travelled by jet boat to the field site. Inspection showed that the stump had tilted towards the river, obstructing good access to the underside. Sediment on the bank-side of the stump was removed to just above the river level (Fig. 2). The ratchet straps were attached around the specimen's circumference, crisscrossed and run under it. Wads of burlap were placed under the ratcheting mechanisms and any other metal components to prevent abrasion on the fossil. Next, the specimen was undermined with a shovel to approximately one-third of its footprint. This excavation revealed the well-preserved, gently convex underside of the specimen. There was no protruding taproot, which had been a major concern. To complete the leveling, the trench was filled with river water, liquefying sediments underneath and allowing the specimen to settle and tilt back to a nearly horizontal position. We did more trenching on the riverside of the specimen to remove sediment and allow the barge's bow to approach.

The barge was moved into position downstream of the specimen by the jet boat and the tip of the barge's bow was worked almost two-thirds of the way beneath the stump. Once the barge was in place, the jet boat's position was maintained through its idling engine and ropes secured to the bank. Next, we fastened a large custom-made nylon sling around the specimen. The sling was a network of straps that wrapped around the bank-side of the stump with loops on the open end towards the barge. Two strong winches, powered with car batteries, were mounted on both corners of the barge's stern. Hooks on each winch cable were connected to the nylon loops on the sling. By operating the winches alternately, the stump was easily "walked" onto the barge and then both winches operating simultaneously pulled it fully on board (Fig. 3). Thick plastic sheeting on the bow and deck allowed the stump to slide easily. After loading, heavy ratchet straps, connected to strong aluminum rails on the sides of the barge, held the stump in place.

Fig. 2. The petrified tree stump with ratchet straps for support, after trenching. The barge is coupled with the jet boat prior to being moved into position for loading.

Fig. 3. Winching the petrified tree stump onto the barge. Darren Tanke, left, Roger Kehoe at right.

Towing the loaded barge and delivery to Edmonton

The next day, the jet boat towed the loaded barge down river to the boat launch (Fig. 4). There, the stump and barge were loaded onto a large tilt-deck flatbed truck and driven to Edmonton where they were offloaded. After arrival, the stump was gently cleaned with water and small nylon brushes. In November, the fossil was lifted from the barge and transferred to a display base. During transfer, the specimen's actual weight was measured: 3034.5 kilograms (6690 pounds). A five-month exhibition featuring the petrified tree stump opened on December 7, 2012 (O'Donnell 2012) (Fig. 5). Plans to incorporate the specimen into a long-term exhibition at the Royal Alberta Museum are in progress.

Closing comments

Successful collection of the fossil stump is a significant achievement because it is the heaviest geological or paleontological item recovered from a remote locality by the Royal Alberta Museum. The project demonstrates a successful collaboration that overcame a technically difficult and challenging field situation. The work also fostered a good cooperative relationship between two major museums and sharing of technical expertise.

Acknowledgements

We thank our colleagues at RAM and RTMP for their many contributions to this project. In particular, we thank Chris Robinson (Executive Director, RAM) and Andrew Neuman (Executive Director, RTMP) for their support and encouragement. Also, Don and Julia Waddell, the Alberta Motor Association, Alpha Pickers, Travis Schiewe, Rod Perkins of Windsor Plywood, Lawrence and Lachlan Dent, Mac Livingston, and Jim Nielson were critical to the success of this project.

Fig. 4. The petrified tree stump being towed to the boat launch by jet boat.

Fig. 5. The authors (left to right: Melissa Bowerman, Roger Kehoe and Darren Tanke) with the petrified tree stump at the December 7 opening of the feature exhibition at the RAM.

References

O'Donnell, S. 2012. Petrified stump at root of new display. Edmonton Journal, 12 December 2012: A4. Print.

Tanke, D. H. 2010. Reconstruction of a scow used in early Albertan vertebrate palaeontology expeditions and a commemorative 2010 expedition. Alberta Palaeontological Society, Fourteenth Annual Symposium, Abstracts, pp. 49-54.

PRESENTING PREPARATION TO THE PUBLIC: EDUCATIONAL PROGRAMS DESIGNED FOR ALL AGES

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Importance of Education

Mandate of the Royal Tyrrell Museum:

"To be an internationally recognized public and scientific museum dedicated to the collection, preservation, protection, presentation, and interpretation of palaeontological history with a particular emphasis on Alberta's rich fossil heritage."

Mission Statement of Educational Program at the Royal Tyrrell Museum:

"To provide engaging, educational experiences that reveals meanings and relationships of Alberta's unique palaeontological and natural history."

Vision Statement of Educational Program at the Royal Tyrrell Museum:

"The Education Program aspires to provide all visitors with an enhanced knowledge, respect and appreciation for Alberta's palaeontological and natural resources."

Education and interpretation is an integral part of the Royal Tyrrell Museum's mandate. The Science Education Program has developed a number of indoor/outdoor programs intended to introduce aspects of palaeontology to students and the public. Included in these are less realized, but vital components of palaeontology, such as prospecting, excavating, transporting, preparing, articulating, molding, and casting. These programs are specially designed to suit different age groups and school grades.

Registrants in this session will review these school and public programs. If the weather co-operates, participants will be taken on short hikes in the hills (wear appropriate footwear). Other programs will be reviewed indoors with hands-on activities. The final part of the session will be a full Fossil Casting workshop (45 min – 1 hr), one of our most popular school and public programs. In this workshop, participants will be treated as a class and taken through the process of creating a cast the same way we present to the students and public.

We will touch upon the following popular programs, as described on the website. This will give participants a glimpse into the work of a science educator at the Royal Tyrrell Museum. If weather permits, some of these will be outdoors:

ARTiculation (school program) – Art and science come together as students cast a complete skeleton of a small carnivorous dinosaur. This two-hour program explores how we create realistic copies of fossils, and how those bones are arranged in the vertebrate body plan. Students will have the chance to make and paint their own cast and then, as a group, assemble the bones into a full skeleton that they will take back to their school.

Fossil Casting (public and school) – This program explores the process of casting as it pertains to the science of palaeontology. As each student creates their own fossil cast they learn about the casting process and its importance.

Digging for Dinos (school program) – It doesn't get any more hands-on than this! In this exciting workshop, your class will experience the exhilaration of discovery as they uncover real dinosaur fossils. Using tools of the trade, students will learn how to excavate fossils in our simulated quarry and how scientists map and interpret their finds.

Dino Adventure Hour (public) – Crafts, costumes, dino-games and fossils combine for an interactive 60-minute program. Children aged three to six will experience the thrill of learning about dinosaurs and digging for fossils.

Dinosite/Indoor Dinosite (public program) – Search for fossils, see real dinosaur remains still in the ground, and learn about ancient Alberta on this 90-minute journey through the badlands.

Dig Experience/Indoor Dig Experience (public program) – Experience the thrill of excavation on this realistic dinosaur dig. As a member of an excavation team working in the badlands, you will use the real tools and techniques of Palaeontology. With Museum staff as your guides, you will uncover replicas of dinosaur bones and learn how to read the stories the fossils tell.

Fig. 1. Excavating on Dig Experience

Fig. 2. Interpreting the finds on Junior Dig Experience

Fig. 3. Prospecting and interpreting fossil finds on Dinosite

FOSSIL PREPARATION AND CONSERVATION AT THE UNIVERSITY OF TEXAS AT AUSTIN: 1935-2009

Matthew A. Brown[1,2]

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Much of our knowledge of vertebrate paleontology has been shaped through the processes of laboratory preparation and conservation. The holdings of the University of Texas at Austin (UT) Vertebrate Paleontology Laboratory (VPL) represent specimens that have been collected and prepared over more than 125 years. Laboratory methods can variably illuminate or obscure scientific information; an understanding of past techniques and materials applied to fossil data can help distinguish these between natural morphology and anthropogenically modified objects.

While early fossil collections associated with UT must have received preparation treatments before study, the first record of official facilities dates to the 1930s. Paleontology exhibits were created for the Texas Centennial celebration, and shortly thereafter laboratory facilities were constructed under the Bureau of Economic Geology for the Works Progress Administration Statewide Geological/Paleontological Survey of Texas. Thousands of specimens were collected and prepared for research between 1939 and 1941, and though reduced in output, this work continued throughout World War II. Many of the specimens prepared during this time were mounted for exhibit at the Texas Memorial Museum. After the war, UT vertebrate fossil collections were consolidated into the newly created VPL. Laboratory preparation continued as new methods and equipment were implemented over subsequent decades, and a large number of students and professional preparators were trained in these techniques. The laboratory remains a hub for paleontological research at UT, and as lines of inquiry in paleontology become more specialized, the role of the laboratory grows ever more important.

The legacy of laboratory preparation at UT persists indefinitely. Public understanding of the history of life (specifically the paleontological history of Texas) has been broadened through research and display of fossils that remain on exhibit decades later. The collections are composed of specimens acquired from federal, state, municipal, and private land, all which must be conserved in the public trust. The historical context for how and why specimens have been treated in the past is critical to the care and study of them in the future.

Fig. 1. The VPL preparation laboratory ca. 1958. Preparator Lansing Craig, 3rd from left, and VPL founder Dr. Jack Wilson, 5th from left.

SILICONES WORKSHOP

Myra Bumgardner[1] and Ana Balcarcel[2]
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Fossil preparators have historically drawn from other fields of science, from the arts, and from industry as inspiration for techniques in preparation. Mold-making is just one of the areas where expertise from multiple fields converges. The silicones workshop at the 6th Annual Fossil Preparation and Collections Symposium will create an opportunity for fossil preparators, volunteers, and others to learn about the use of silicones, both in and outside of paleontology. The workshop leader will be Myra Bumgardner, a chemist representing Silicones, Inc., a company that has been manufacturing RTV-2 silicones since 1974, and has worked directly with numerous scientific institutions over the years including The American Museum of Natural History. The workshop will focus on 1) how the silicone is made, 2) the different chemistries involved, and 3) how these differences may impact you. Other discussion topics will include the best means of maximizing returns on your molds. This is a unique opportunity to have the maker of the product address common issues encountered in fossil mold-making.

Myra Bumgardner has 26 years of experience working both as a chemist and a technical representative in the marketplace. In an informal and discussion-based format, Myra will address a range of topics focusing on the basics of mold-making such as: proper mixing, safety recommendations, ideal working conditions, extension of library and mold life, proper mold storage and cleaning, variation in silicone bases, variations in catalysts, accelerating and inhibiting factors, plus an introduction to novel products on the market such as a silicone for use in wet conditions.

The workshop is open to those with all levels of mold-making experience, and to anyone interested in the subject. After a short presentation on how silicone is used in areas outside of paleontology, the session will switch to an open discussion where all questions are welcome. The course of discussion will be driven by the topics that interest attendees the most. Some of the common issues addressed include, but are not limited to, the following:

- What causes a mold to deteriorate? How can we slow this down?
- Which silicone has the best tear strength, or most flexibility?
- Can any solvent or chemical "cut" through inhibited silicone?
- What are the latest products on the market?
- Platinum or tin, which is better?
- What is off-gassed during the curing process? Do we need to be cautious?
- What safety precautions are exercised when working with silicone?
- Is de-gassing with a vacuum pump a common technique outside of paleontology?

THE USE OF PLASTIC SIDING AND OTHER WATER-RESISTANT MATERIALS IN THE CONSTRUCTION OF SCREEN-WASHING BOXES: A YEAR IN REVIEW

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In 2012, plastic (Polyvinyl chloride, or PVC) siding was proposed as a new alternative to wood in the production of screen-washing boxes (Capobianco 2012). This material is beneficial due to its ability to be worked like wood; it can be cut, drilled, routed, nailed, screwed, and painted, all while maintaining its water-resistant nature. Unlike screen-washing boxes made of pressure-treated plywood, which will deteriorate over time, plastic siding will retain its shape making it a more cost effective option long term.

An issue with the previous screen-washing box design was that it utilized materials that were not intended to be constantly immersed in water. To make (PVC) siding a more viable long-term solution to plywood, all the components used in the new design had to be water resistant. T316 stainless steel mesh, commonly used in marine settings, was selected as a more resilient choice to the typical T304 stainless steel (Continental Wire Cloth 2001). From repeatedly washing and drying the screens, it was determined that the T304 stainless steel previously used would eventually rust over time. This occurred primarily along the cut edges of the mesh, with some rust forming on the screen surface.

The area where water-resistant materials were most important was the screws. This was the most noticeable defect from the plywood screen boxes and the prototype PVC screen box. Normal steel screws would rust quickly, with it becoming noticeable after only two weeks of being immersed in water. With continuous oxidation, the screws would become too difficult to remove, making some of them irreplaceable. Many of the old boxes were discarded when a simple repair could have been made. Stainless steel deck screws were used to replace the steel screws. They corroded much slower and therefore would last longer than the standard steel screws. This is beneficial to the design using PVC siding as this has the ability to be re-screwed, and therefore can be taken apart and put back together for repairs or replacement of the screen.

Even with the change to all water-resistant materials, the screen-washing boxes were still displaying signs of rust along the edges where the screen was attached. As only the inside edges of the boxes were caulked using silicone, the outer edges still allowed water into the crevasse where the screen was sitting. It was discovered that it was not the screen that was rusting, but the staples that were used to hold the screen in place while the bottom of the boxes were screwed in. With a new set of boxes being built, the switch to stainless steel staples was made to add strength and security to the boxes along with preventing the rust from spreading onto the PVC siding and affecting the integrity of the frame.

One locality that was screened needed several washes to reduce the amount of concentrate to a more manageable size. Dry screening the material before and after, although tougher on specimens, can help reduce the amount of fine particulate matter prior to screen-washing and the number of washes the material needs. This method works exceptionally well when the rock matrix is composed primarily of sand-sized grains. Previous Royal Tyrrell Museum dry screens were bulky and difficult to use due to their poor, stacked design. Using PVC board, a new design of layering dry screen boxes was created to make dry screening more manageable in an indoor setting. These boxes can be nestled perfectly inside the 18” screen-washing boxes created, making them extremely versatile and compact allowing for greater ease in use. They have also been used to size sort material when screen-washing, as they have the ability to float inside the larger screen-washing box while matrix is being washed.

When at a microvertebrate locality, palaeontologists are faced with the task of either trying to screen the material on site, or transporting the bulk matrix back to lab or other controlled setting where the screen-washing can take place. Ideally, screen-washing would occur at the field site. Transportation of bulk material can be cumbersome, with some bags weighing upwards of 80 pounds that need to be carried several kilometres from the field site over challenging, uneven terrain. However, transportation of screen-washing boxes into the field is equally as arduous. Their large, rigid frame with a large amount of unused open space makes them inefficient at packing field vehicles where space is quite often limited, and then carrying them to the field locality can be difficult. To make collecting microvertebrate material easier, a small collapsible box was created using the leftover plastic siding. They are small enough to fit in a backpack and are almost entirely self-supported. These boxes are still in the prototype stage and will be put through rigorous testing in the summer of 2013 to see how durable they can be after repetitive use in the field.

PVC siding and other similar plastic products are a superior option to wood in the screen-washing of microvertebrate material. Its water-resistant nature allows the boxes to hold their shape without expanding and contracting like wood. In addition to the PVC siding, it is important that every component in the new screen-washing boxes is water-resistant. This greatly increases their durability, and ultimately, their longevity. The use of PVC siding allowed for experimentation to find a better, more efficient design while easing construction of the screen-washing boxes, leading to the exploration into practical uses of the leftover material, demonstrating how versatile this product can be in the collection and processing of microvertebrate material.

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FROM THE ROYAL MUSEUM TO THE NATIONAL MUSEUM OF SCOTLAND

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In July 2011, the National Museum of Scotland (NMS) in Edinburgh reopened the Royal Museum building to the world after four years of closure. Although the task of emptying the building, developing the new exhibitions, and opening the museum to the public might seem a straightforward job, the logistics were very complicated and not easy to manage at times. The Geology Section of the Natural Sciences Department had to pack and move several galleries together with cellars full of specimens in drawers and cupboards. The palaeontological collection was moved temporarily to several locations: the invertebrate collection was moved to another area of the Royal Museum building, the vertebrate collection to two separate buildings at the National Museum Collection Centre (NMCC which is two miles off site) and the Type and Figured Collection to a third building at NMCC. The move was only temporary until a new Palaeontological Store could be finished at NMCC. The mineralogical and petrological collections were moved to temporary spaces also. The sheer volume of material (over 250,000 fossils and 50,000 minerals and rocks) meant that it took several years to undertake the entire packing and moving of the collection. In this presentation I will show you some of the packing techniques with reference to certain key objects, as well as some discoveries, problems and issues that we confronted during the whole process.

GEORGE STERNBERG'S TOOLS

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During an inventory of equipment housed in the University of Alberta's Lab for Vertebrate Paleontology (UALVP), a quantity of 'old-fashioned' tools were found among the general supply of fossil preparation equipment in use by students. Steel needles, wooden awl handles, and carpenter's chisels with the incised letters 'GFS' were among the items retrieved and retired from use.

It became apparent that some of the tools used during George Sternberg's time at the University of Alberta (1920-1922; 1934-1935) had survived several major moves, and had been retained in context for nearly a century.

Few examples of small hand tools directly attributable to a 'Golden Age' dinosaur hunter have survived. The nature of excavation and preparation work causes small tools to become worn, broken, or lost in quarry rubble. In addition, as better tools become available, older types are typically discarded.

The range of points fashioned from harness needles indicates a reliance on these once common items to serve a variety of preparation needs.

Examination of original field and laboratory photographs show several of the same tools in use by Sternberg during the collection of the University of Alberta's first dinosaur specimens, and during subsequent preparation at the University of Alberta's first fossil preparation lab in the basement of Convocation Hall.

In addition, close examination of field photographs has revealed that the University of Alberta's *Gorgosaurus libratus* skull, UALVP10, is not an intact skull, but was originally found as separate elements, and that some materials collected by Sternberg for the University were traded to other institutions.

Investigation of widely scattered and incomplete departmental files produced detailed lists of equipment and supplies used by George Sternberg in the field, and laboratory. This information has led to a better understanding of how specimens were collected, prepared and stabilized.

Sales receipts revealed the use of materials such as Corrosive Sublimate [Mercuric Chloride, $HgCl_2$], Gum Arabic and Dextrin, materials once in common use in early fossil preparation. Knowledge of what was used is leading to a more complete understanding of their future care needs, and potential problems.

Discovery that Mercuric Chloride, a cacogenic compound, was used as recently as 1935 in the preparation of fossil specimens, led to a literature review of the material's historic uses. There is a potential for this highly toxic compound to be present in small amounts in early field jackets and fossil restorations containing plaster and or dextrin compound repairs or gap fillers from 1880-1935.

EXTRACTING DATA FROM POACHED AND OLD QUARRIES IN THE NEMEGT FORMATION OF MONGOLIA

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The Nemegt Formation of Mongolia was discovered and named by an expedition from the USSR to Mongolia in 1946 (Lavas 1993). It is exposed along the south flanks of Nemegt Mountain and various sites in the Nemegt Basin, and at Bugiin Tsav and Hermiin Tsav in adjacent basins. The strata are Campanian to Maastrichtian in age, and have a diverse dinosaur fauna comparable with similar aged sites in Alberta. The Polish Mongolian Palaeontological Expeditions (1963-1971), the Soviet-Mongolian and Russian-Mongolian Paleontological Expeditions (1970-present), the Mongolian Academy of Sciences- American Museum of Natural History Expedition (MAE, 1991-present), the Mongolia Highland International Dinosaur Project (1996-1997) and the Japan-Mongolia Joint Paleontological Expedition (JMJPE, 1992-2010) followed the Soviet expeditions of the 1940s, and recovered hundreds of dinosaur skeletons from the Nemegt Formation. The Polish-Mongolian expeditions produced maps of the sites so that they could pinpoint the locations of their discoveries. Unfortunately, the Soviet and Russian locality information is limited to site name, and specific GPS coordinates of the JMJPE and MAE quarries have not been published.

Beginning in 1996, staff of the Royal Tyrrell Museum of Palaeontology and the University of Alberta participated in the Dinosaurs of the Gobi trips of Nomadic Expeditions, and subsequently the Korea Mongolia International Dinosaur Project (KID). All expeditions have been extremely successful in collecting specimens that are curated in the Paleontological Center of the Mongolian Academy of Sciences in Ulaan Baatar. The quarry locations were marked on the Polish-Mongolian maps so that subsequent researchers can return to the sites to collect additional sedimentological, stratigraphic and taphonomic information. This is particularly important for specimens that subsequently became type specimens. GPS coordinates were also taken for each quarry starting in 1999.

The Polish-Mongolian maps were hand drawn by the expedition geologists, who built cairns of rocks (Fig. 1) around the periphery of each area of interest, and at visually obvious landmarks within the area. The mapping framework was then produced by triangulating using the cairns and a brunton compass, and details of the topography were sketched freehand. The results were reasonably accurate, and over the years, it has been possible to return to many of the Polish-Mongolian quarries using the maps. In some cases, the quarries were large enough that their positions are still conspicuous. However, time and erosion have erased the evidence of digging in most quarries. Expedition photographs in Warsaw were copied and used in the field to find some of the quarries. Quarry locations can often be confirmed by the presence of graffiti, nails, wood and/or plaster. Unfortunately, photographs were never taken for many of the fossil localities, and collapsing quarry walls and other sediment movements have buried any evidence of human activity.

Repeated attempts over several years to find one of the largest Polish-Mongolian quarries (that of the sauropod *Opisthocoelocaudia*) failed even though the quarry had been marked on the map and there were more than a dozen photographs. The geologist on the 1964 and 1965 expeditions (Ryszard Gradzinski) was not able to come to Mongolia to help us, but he sketched from memory a route map from a location on their map that we knew. His sketch and some additional photographs that he labeled led us to the right area, where we were able to use the expedition photographs to find the quarry, which had been filled in by more than a metre of sediment (Fig. 2).

The realization that the Polish-Mongolian quarry maps were not accurate enough to allow us to find many of the excavations initiated a project to modify the original maps. Although many of the cairns built by the Polish geologists had collapsed or even fallen down into the canyons, most of them are still where they were left more than forty years ago. One complication is the potential confusion caused by additional cairns that have been built over the years by locals, by subsequent expeditions, and by poachers. All cairns that could be found were GPSed in the field, and the coordinates downloaded onto a grid that was adjusted to the same scale as the Polish-Mongolian maps. The latter were then digitally distorted so that the known quarries aligned with the GPS points, which in turn aligned the cairns on the map with the GPS coordinates. GPS readings for the undiscovered quarries were then calculated from the corrected maps, and these were used (with some success) on subsequent expeditions to try to find more Polish-Mongolian quarries.

We were also fortunate in that Zofia Kielan-Jaworowska, the leader of the Polish-Mongolian Expeditions, was able to join our expedition in 2000 and show us several of their sites.

At present, we have been able to find two of the three Polish quarries at Altan Ula III, six of the twelve at Altan Ula IV, thirteen of the thirty-two quarries at Nemegt, and two of the seven at Tsagaan Khushuu. Additional American, Japanese, Mongolian and Russian quarries have been pinpointed and GPSed using photographs, descriptions and rubbish left behind. There was little evidence of fossils being vandalized. There was little evidence of fossils being vandalized or poached by locals when one of us visited the Flaming Cliffs (Bayn Zag) in 1989. However, with each succeeding visit this problem became progressively worse. In the year 2000, a visit to Bugiin Tsav was alarming in that a half dozen skeletons of *Tarbosaurus*, which had been found by a Mongolian expedition in 1964 and put under protection by the Mongolian government, had been dug up. The work had clearly been done by unprofessional, poorly trained people, who left piles of broken bone (including partial skeletons and slabs of skin impressions) in each quarry. We took GPS readings, collected identifiable, measureable bones from each of the poached sites, and catalogued the specimens into the collections of the Paleontological Centre of the Mongolian Academy of Sciences. This was the beginning of another phase of the project to pinpoint the geographic and stratigraphic positions of articulated skeletons in the Nemegt Formation. As the intensity of the poaching increased in the period from 2000 to 2010, an alarming number of specimens were collected and/or destroyed. At this time, poached quarries have been identified for 98 tyrannosaurids, 86 ornithomimids, 53 hadrosaurids, 32 sauropods, 20 ankylosaurids, and more than twenty pachycephalosaurids, small theropods and miscellaneous dinosaurs. The animals that came from another thirty or so quarries could not be identified, and may or may not have been poached. The localities of articulated dinosaurs found during the Dinosaurs of the Gobi and KID expeditions have been added to this database, which now rivals that of Dinosaur Provincial Park (Currie and Russell 2005).

The poachers usually take only the most saleable part of a skeleton when they find it. Often this is just the teeth or jaws of a tyrannosaur, a whole skull, the unguals, or the hands and feet. In their efforts to find these parts, however, the rest of a skeleton is often hacked out of the ground and destroyed. In two cases (an ornithomimid and a pachycephalosaurid), the skulls were not recognized and were also thrown onto the rubble piles around the illegal excavations. A specimen identified as an uncollected *Tarbosaurus* on the Polish-Mongolian maps was poached in 2003, although nothing was apparently taken because the bone was badly eroded. In 2004, the poachers returned, however, dug deeper, and found the skull. They attempted to remove the skull in a plaster jacket, which they made too thin; the jacket crumpled and collapsed when they tried to turn it over, thereby destroying the skull. Rather than try to repair the damage, they simply smashed up the maxillae to remove the teeth, and presumably took most of the lower jaws.

It is very discouraging to see how much damage the poachers have done to these invaluable palaeontological resources. The specimens are smuggled out of Mongolia (probably mostly on mining trucks transporting coal from Mongolia into China) and sold internationally. Some specimens have been seized by Mongolian Customs officers and given to the Paleontological Center in Ulaan Baatar, but the majority have made their way across the globe to be sold privately, over the internet, in stores, at rock/mineral/fossil shows, and in auctions. In 2012, the Mongolian Government officially asked the government of the USA to intervene when a skeleton of *Tarbosaurus bataar* was auctioned off in New York for more than a million dollars. The specimen was seized and will be returned to Mongolia during the summer of 2013 (Williams 2013). The US Department of Homeland Security has confiscated other specimens across the country, and is continuing investigations on many others. In the meantime, we have become part of a team investigating ways to identify the source of some of the specimens using our knowledge of poached quarries, the parts of the skeletons that we recovered, and geochemical fingerprinting. Although there is little chance of succeeding in most cases, we do seem to be on the verge of associating one major specimen with the quarry it was poached from.

Although the number of specimens destroyed by poachers and lost to science is horrendous, we have managed to collect a lot of information that can be added to the database that arose from the Polish – Mongolian Palaeontological Expeditions. Scientifically important specimens (such as the skulls of *Gallimimus* and *Prenocephale* that have already been mentioned) have been collected from poached quarries. And in several cases, poaching activity has led to the discovery of important sites. One example is the botched excavation of a *Gallimimus* that we investigated in 2009. While we were collecting articulated skeletal parts of the ornithomimid, we realized that one of the articulated feet was imbedded in a layer of ornithomimid footprints (Fig. 3). In addition to finding a dinosaur that had died in its tracks when it became mired in the mud (Lee et al. 2011), investigation of the site also led to the discovery of a rich palynological assemblage.

Since the high profile case of the auctioned *Tarbosaurus* being seized in New York in 2012, we have noticed a reduction (or even cessation) of poaching in the areas that we visited in 2012. A trip to the Tucson Rock, Mineral and Fossil Show in 2013 was also educational in that no Mongolian fossils were being overtly displayed or sold. Several arrests have been made in Mongolia, and the Mongolian government is working towards signing agreements with other governments in addition to the USA. Finally, they have also announced the creation of two new facilities to house dinosaurs in Mongolia in a move to better protect their own resources and to better educate the public.

Fig. 1. Rock cairns, like the one on top of the rise to the left of this sauropod quarry, were used by the geologists of the Polish-Mongolian expeditions to triangulate when they were making maps of the Nemegt localities.

Fig. 2. *Opisthocoelocaudia* quarry (AU4004) at Altan Ula IV when it was being excavated in 1965 (left), and in 2009 (right). The photographs were taken from a hill with coordinates N43°36.150', E100°27.305'. Photographs by Wojciech Skarzynski (left) and Philip Currie (right).

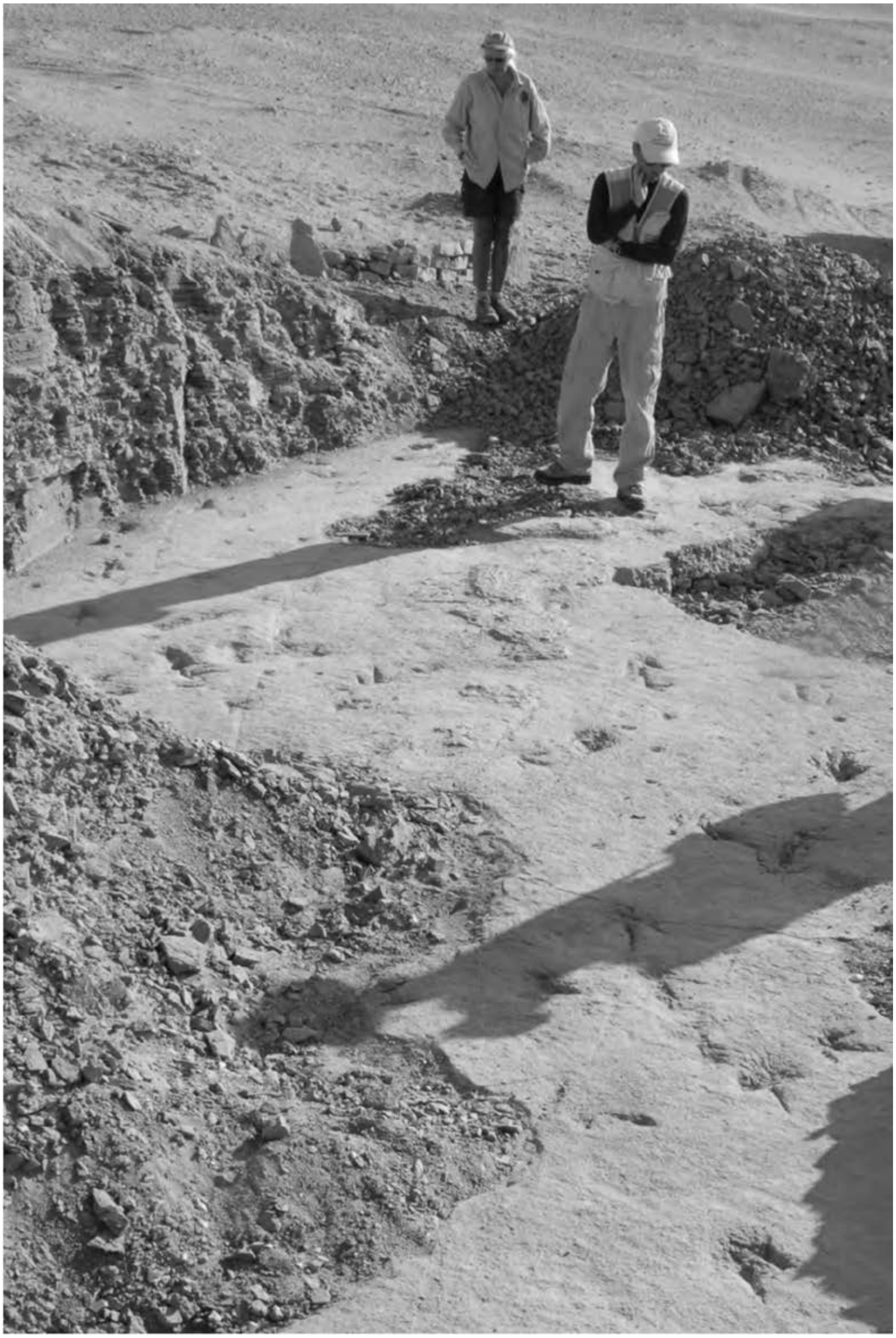

Fig. 3. Footprint site at Bugiin Tsav, Mongolia in 2009. The site was originally found and excavated by poachers (their quarry can be seen to the right of Yuong-Nam Lee's feet), who were collecting the skeleton of a *Gallimimus* that had died when it became mired in the mud).

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SEVEN ADHESIVES FOR FOSSIL PREPARATION WORKSHOP

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Workshop description

Most fossil preparators work with just a few adhesives and consolidants. This three-hour workshop is an introduction to a wider range of commonly used adhesives. Participants will construct their own charts using technical information and observation of behavioral differences, such as viscosity, solvent effects and the response of hardened samples to handling and heat. A group discussion at the end will focus on shared experience and practical tips for consolidation, joining, and other fossil preparation tasks.

Adhesives

Paraloid B-72, Butvar B-76, Butvar B-98, McGean B-15, Primal WS24, Devcon 2 Ton epoxy, and Paleobond PB002.

Seven Adhesives for Fossil Preparation Workshop, FPCS April 2013, Royal Tyrrell Museum, Alberta, Canada.

Trade Name	Grade	Declared Chemical Composition	Reference (MSDS or technical data sheet, including date of publication)
Butvar	B-76		
Butvar	B-98		
McGean	B-15		
Paraloid	B-72		
Primal	WS24		
Devcon	2-Ton epoxy		
Paleobond	PB002		

Viscosity of Solution Adhesives

Adhesive/Solvent	Concentration	Relative Viscosity (resistance to flow) thin = low viscosity ; thick = high viscosity
Butvar B-76 in acetone	20% weight/vol	
Butvar B-76 in ethanol	20% weight/vol	
Butvar B-98 in ethanol	20% weight/vol	
Butvar B-98 in 60/40 ethanol/toluene	20% weight/vol	
McGean B-15 in ethanol	20% weight/vol	
McGean B-15 in acetone	20% weight/vol	
Paraloid B-72 in ethanol	20% weight/vol	
Paraloid B-72 in acetone	20% weight/vol	

Handling Properties of Dried/Cured Samples

Sample/Solvent/ Concentration	Date	Response to handling (brittle? tough? flexible?)	Response to immersion in hot water	°F/°C
Butvar B-76 in ethanol 20% w/v				
Butvar B-98 in ethanol 20% w/v				
Butvar B-98 in ethanol 10% w/v				
McGean B-15 in ethanol 20% w/v				
McGean B-15 in acetone 20% w/v				
McGean B-15 in acetone 20% w/v				
Paraloid B-72 in ethanol 20% w/v				
Paraloid B-72 in ethanol 20% w/v				
Primal WS24 as supplied				
Devcon 2-Ton epoxy				
Paleobond PB002 (no solvent)				

Penetration of High Concentration Solution in Loose Sand- Effect of Pre-Wetting

Adhesive/Solvent--------	Concentration	Pre-wet w/ ethanol?	Relative penetration
Paraloid B-72 in acetone	50% weight/vol	no	
Paraloid B-72 in acetone	50% weight/vol	yes	

EVERYTHING YOU NEVER WANTED TO KNOW ABOUT PLASTER

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Three calcium sulfate minerals exist in nature. Gypsum and anhydrite are relatively common. Bassanite is rare. Gypsum has the chemical formula $CaSO_4•2H_2O$ Gypsum produces flattened, transparent crystals in the monoclinic crystal system. Bassanite has the chemical formula $CaSO_4•½H_2O$. Bassanite produces translucent prismatic crystals in the monoclinic crystal system. Anyhdrite has the chemical formula $CaSO_4$. Anhydrite, as its name suggests, does not contain any water of hydration. Anhydrite commonly occurs in massive deposits. Crystalline anhydrite belongs to the orthorhombic crystal system.

Plaster of Paris is manufactured calcium sulfate hemihydrate, which has the chemical formula $CaSO_4•½H_2O$. It has traditionally been manufactured by two distinct processes, and the products of each of these two processes are generally regarded as distinct (O'Brien 2008). Both of these processes use the mineral gypsum as their starting point. The dry heating of gypsum to temperatures in the range of 110–220° C. for several hours produces β-calcium sulfate hemihydrate. The steam heating of gypsum to temperatures in the same range produces α-calcium sulfate hemihydrate (Singh and Middendorf 2007). The steam heating of gypsum can also be carried to higher temperatures and higher pressures to produce a γ-calcium sulfate hemihydrate. γ-Calcium sulfate hemihydrate may contain little to no water of hydration. In such cases, its characterization as soluble anhydrite is more accurate.

None of the three manufactured forms of plaster are stable in the normal atmosphere, for they all react with water to set as gypsum. To make gypsum plaster, ß-calcium sulfate hemihydrate is mixed with water in ratios of roughly 70 parts water to 100 parts plaster by weight. Only 10% of the water added to the slurry reacts with, and is chemically bound up in, the set gypsum. The remaining 90% of the water mixed with plaster functions to maintain the fluidity of the slurry. To make plaster with α-calcium sulfate hemihydrate, the slurry is mixed roughly 45 parts water to 100 parts plaster by weight. That is, the slurry contains less inert water. As a result, α-calcium sulfate hemihydrate produces a denser and hence a stronger set gypsum.

Set plaster consists of a porous mesh of microscopic grains of gypsum that grew independently during an early phase of setting (Lewry and Williamson 1994). As water evaporates from this mesh during the late phase of setting, spot welds form between these grains. The gypsum crystals in all set plasters are monoclinic, but the monoclinic crystals that grow from α-calcium sulfate hemihydrate slurries are pseudomorphic after the hexagonal crystal system (Ballirano *et al*. 2001). These pseudomorphs suggest the involvement of γ-calcium sulfate hemihydrate in the setting process, as γ-calcium sulfate hemihydrate alone among the calcium sulfate system belongs to the hexagonal crystal system.

The density of set gypsum can also be modified by deflocculants added to the plaster slurry. The deflocculants used historically in the field of paleontology are gum Arabic and dextrose (Troxell 1916). Gum Arabic is the dried sap of the acacia tree. Dextrose is a glucose sugar derived from a starch. The likely active ingredient in both cases is a polysaccharide. In modern times, other negatively charged organic polymers such as sodium polymethacrylate have proven to be deflocculants. Sodium polymethacrylate is the active ingredient in Darvan N-7™, a commercial deflocculant.

Plaster setting time is a function of the particle size of the plaster powder. Extra fine-grained plasters set more quickly than fine-grained plasters. Setting time can be slowed by chemical retardants added to the plaster slurry. A wide variety of chemicals can act as retardants, but many of these retardants produce a weaker plaster (Singh and Garg 1997). Some organic polymers act as effective retardants at concentrations measured in parts per million (Boisvert *et al.* 2000). Because of their low concentration, their use results in little effect on the strength of the resulting gypsum.

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USING PLASTER IN WINTER; ONGOING EXPERIMENTS WITH ADDITIVES TO ALTER SETTING TIMES

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Introduction

Due to a relatively short field season in southern Alberta and year-round discoveries in the province, it is sometimes necessary to quarry and jacket specimens in colder weather. Anyone who has tried to jacket a specimen in less than optimal conditions knows how difficult it can be to finish the task properly and have the plaster dry quickly and effectively. Various trades, such as the oil and gas industry and highway workers, routinely use additives in their mixtures, which contain a form of plaster, for various reasons, one of which is to help reduce setting times (Accelerating, 2011; Calcium Chloride [$CaCl_2$], 2007; Alberta Road Builder, 2007; Concrete Additives, 2007; Uses of Lime, 2010; Science of Cooking, 1999). It is proposed that the trade of palaeontology use similar additives to alter setting time of plaster for use in cold weather.

The oil and gas industry employs additives in the concrete they use to construct the wells to increase rate of strength development and/or shorten or lengthen the setting time (Accelerating, 2011; Concrete Additives, 2007). The most commonly used additive is calcium chloride ($CaCl_2$) (Accelerating, 2011; Oil Drilling Fluids, 2007) where it is used mainly in surface casing to increase setting time. Highway workers also use $CaCl_2$ in road construction and maintenance, including ice and dust control (Calcium Chloride [$CaCl_2$], 2007; Alberta Road Builder, 2007; Concrete Additives, 2007; Calcium Chloride, 2007). The oil and gas industry also uses lime (calcium hydroxide) in their concrete mixtures (Uses of Lime, 2010; Product Data Guide, 2013), as do construction sites to help dry wet soils to decrease down time (Soil Stabilization, 2013).

Another common additive in many industries is sodium chloride (NaCl), or regular table salt. It is used by highway maintenance crews and the public to help clear roads and sidewalks of ice as it lowers the freezing temperature of water (Science of Cooking, 1999; Moore, 1999-2013)

In the following experiments I use pure calcium, garden lime, and table salt, which are readily available, to test the hypothesis that the use of additives will reduce the setting time of plaster.

Materials and methods

- Table salt (Sifto® Table Salt -iodized, free running)
- Calcium pills (Jamieson™ Natural Sources Mega Cal Calcium, 650 mg)
- Lime (Green Harvest Horticultural Lime)
- Plaster of Paris (Georgia Pacific, Atlanta GA)
- Digital thermometer; probe (Accu-Temp® Instant Read Digital Thermometer)
- Digital Thermometer; indoor/outdoor (Accu-Temp® Digital Suction Cup Thermometer)
- Plastic tubs (Amcor Rigid Plastics, 32 oz)
- Micro-beakers (Fisher Scientific disposable polystyrene, 50 ml)
- Wooden tongue depressors
- Measuring cups and spoons
- Water (prepared by reverse osmosis)
- Stop watch
- Mortar and pestle
- Scale (Starfrit Electronic Kitchen Scale)

Setup

1. Label twenty-four tubs; six tubs with 'calcium,' six tubs with 'lime,' six tubs with 'salt' and the last six with 'NA' (no additive).
2. Add 75 g of Plaster of Paris to all tubs using the scale and measuring cup. Plaster was added in measured amounts to half a cup of water until the typical viscosity of plaster used in the field was reached, then these amounts of plaster and water were weighed separately to get the weights for these two items for these experiments.
3. Crush calcium pills using mortar and pestle into fine powder and mix 2 g of powder into the six tubs labelled 'calcium' using a measuring spoon. The oil and gas industry typically uses 2-3% CaCl in their mixes (Accelerating, 2007) so I used the higher percentage here. The scale I used only measures to the full gram, so I rounded it down to the nearest full gram.
4. Measure and mix 3 g of lime into the six containers labelled 'lime.' The oil and gas industry typically uses 4% in their mixes so I used the same amount here.
5. Measure and mix 15 g of salt into the six containers labelled 'salt.' It takes 58 g of salt to alter the temperature a litre of water by 1°C (Moore, 1999-2013) so I used the same ratio here.
6. Measure 50 g water into twenty new containers.

Experiment

The ambient temperature and water temperature was recorded before adding the plaster. The initial water temperature was kept constant at 9°C and 6 sets of experiments were run at different ambient temperatures; -3°C, -1°C, two at +13°C and two at +23°C. Ambient temperatures were selected to represent a range. The stop watch was started as soon as the plaster was poured into the water and stopped as soon as the tongue depressor used to stir the plaster and water mixture would not mark the plaster with gentle prodding (i.e., plaster was fully set). Each tub was stirred for a full sixty seconds after being combined.

Results

Neither calcium nor lime appeared to have any effect on the setting time of the plaster, although the setting times for the salt trials increased dramatically as the temperature rose (see Table 1).

Temperature (°C)	**NA (no additives)**	**Calcium (Ca)**	**Lime ($Ca[OH]_2$)**	**Salt (NaCl)**
-3.2	36.12	43.17	43.17	244.29
-0.8	42.78	42.01	50.28	241.36
13.35	41.31	51.84	41.69	119.74
23.01	36.0	36.47	37.70	75.92

Table 1. Setting times (in minutes) of Plaster of Paris with and without additives for different temperatures. Ambient temperature fluctuated slightly with each set; the temperature given is the average. The two trials for 13 and 23°C were averaged. Relative humidity for all was 50%.

The lime trials showed a slight trend towards having a faster set time as the temperature rose, as did the 'no additives' trials, while the calcium trials appeared slower in the mid-range temperature.

The salt trials dried differently than the other three; many small bubbles formed during drying, and it appeared to harden from the bottom of the container up. The other three trials had few to no bubbles, and appeared to harden from the centre of the container out. After the plaster was fully set, there was a film of water left on top of the salt trials, but not on any of the others.

Twenty-four hours later, the plaster was checked again. The salt trials again showed marked differences than the other three. The saltwater left on the surface after setting was evaporated and these trials were dark in colour. The lime trials were slightly darker than the calcium and NA trials, but lighter than the salt trials. Also, it was impossible to mark the set 'salt' plaster with a fingernail when scratched; the other trials were easy to scratch. And lastly, while the other three trials appeared normal, the salt trials had salt deposits across the surface.

Discussion and conclusions

The oil and gas industry, as well as highway workers, use $CaCl_2$ and not pure calcium as used in the current experiment, which may be the cause of the calcium in the current experiment not affecting the setting time. Also, industries tend to use Portland cement, which is a hydraulic cement, while palaeontology tends to use Plaster of Paris, which contains gypsum, a non-hydraulic cement (Cement, 2013). Properties unique to these two types of cement may also have an effect on setting times for both the calcium and lime trials. There is a need for future experimentation as variability in setting times for 13 and 23°C was high.

The only additive which showed any discernable effect was salt. The setting went from over 4 hours at low temperatures to approximately 2 hours at a warmer temperature, as well as created a harder plaster. The addition of salt to the plaster may be useful in the hot summer months when jacketing fossils becomes a race to finish before the plaster sets, when the need to remove fossils from the quarry daily is not as urgent. It may also be useful to create a harder, more durable plaster for everyday jacketing. The long term stability of the salt in the plaster should be determined however before being employed. Other materials, as well as $CaCl_2$ itself, are being looked into for future experiments.

Acknowledgements

I am grateful to David MacLeod for his knowledge on the use of additives in the oil field.

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HOW TO CLEAN A FISH; TECHNIQUES DEVELOPED TO PREPARE SMALL FISH SKELETONS

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Introduction

I have been a preparator at the Royal Tyrrell Museum for 9.5 years, the last 4.5 of which I have spent exclusively preparing fossil fish. I have spent the last four summers working in a quarry called Pisces Point in Dry Island Buffalo Jump Provincial Park, which is the first of its kind for the Scollard Formation, or the latest Cretaceous, in Alberta. It contains isolated remains of all sorts of animals and plants that lived in the community, and also preserved beautifully articulated fish skeletons from about 27 different species, only one of which was known to science before their discovery at this quarry.

A lot of what I've written may be known to most preparators, but I've included every detail from quarrying, transporting, and preparing them just to be thorough. I cannot stress enough how fragile a lot of the fish skeletons we've collected are and how important some of these seemingly simple steps are in preserving the fish.

Field work

Finding fossils

Putty knives are used to split open layers of sediment instead of the typical hammer and awl; without this technique it is very easy to miss the tiny bones of these fish. Bright, direct sunlight is also a necessary tool in finding these fossils, as the light highlights the reflective nature of the bones and surface relief.

Consolidation

Two consolidants are used at Pisces Point: hair spray and paraloid (Paraloid B-72) dissolved in acetone). The hair spray is used for very small, delicate bones, scales, and skeletons. This material is very easy to remove in the lab as it peels off with little effort, as opposed to paraloid which requires a lot of scraping with tools and is more likely to damage the bones. The only concern with hairspray is that the high pressure released in aerosol-based products may blow the bones off the rock and they would be lost, so the use of manual pump-based sprays is necessary.

Paraloid is used for the larger, more robust bones like bowfin, the bones of which are very common in Alberta. We use 10-20% paraloid to consolidate bones and skeletons of larger specimens, as well as cracks in the matrix surrounding all fossils to aid in removal and transport back to the lab.

Paleobond™ should never be used in the field with fragile bones of this nature, as it is next to impossible to remove back in the lab without causing permanent damage to the skeletons.

Jacketing

I use the term 'jacketing' loosely here as most of the fossils are not jacketed using the usual technique of plaster and burlap. Due to the extremely fragile nature of the majority of specimens, after consolidation, the fossils are wrapped in several layers of paper towel and masking tape, with the tape labelled with all pertinent information. Sometimes fossils come out in pieces and the orientation of the pieces, as well as part and counterpart, are labelled before wrapping them using corresponding arrows or hatch marks to aid in re-attaching them in the lab. This process is often necessary due to natural cracks in the ground between different pieces of the fossil, the warping of the matrix, or crumbling of the edges of the blocks as it dries, which prevents a perfect fit during reconstruction. Larger specimens that are in danger of breaking that are still too small to properly jacket are sometimes taped to a base made of popsicle sticks taped together before wrapping to give the block some strength for transport.

Blocks containing fish skeletons less than approximately one foot square are jacketed in Gypsona bandages and all larger ones are encased in burlap and plaster. All jackets are left open on top with paper towel taped over exposed bone to prevent further damage to the delicate fossil or loss of bones which might occur when taking a lid off the jacket.

Lab techniques

Construction of support structures for specimens

After specimens are unwrapped it is often necessary to create some kind of support for the specimens before preparation, research, and long-term storage. Half jackets of either Gypsona® bandages or burlap and Plaster of Paris are constructed for smaller blocks and larger ones, respectively. To avoid further warping of the specimen, it is often necessary to coat the sides and bottom of the block if possible with thick paraloid before jacketing as this process will introduce more water to the block and potentially cause more distortion of the matrix and breakage of the fossil you are trying to conserve. If the block you are jacketing is not going to be re-jacketed after preparation, a form of fiberglass, either mat or chopped strand, is used with the plaster instead of burlap to create a more permanent support jacket.

For really small, fragile specimens a different technique is used. Small specimens that are too tiny to jacket in one of the aforementioned ways are embedded in an epoxy to ease handling during preparation and research. Epo-Tek 301 (Met-Tech Material Testing Equipment & Supplies) is used as it has been shown to be more stable than other types of epoxies. Devcon® Two-ton epoxy was initially used, but while less time consuming to work with, it has been shown to age badly. See poster for details on the use of Epo-Tek 301.

Preparation tools

There are many tools used to prepare delicate fish skeletons including: scalpels (blades numbered '11' and '15') for matrix or paraloid removal around skeletons; pin vices with insect pins (Ento Sphinx® stainless steel) numbered '000' and '3' for removing matrix touching bone; various sizes of paint brush, a small one with bristles cut very short and used with acetone or water to help clean small sections of bone or matrix coated with paraloid, and a small one with very soft bristles to brush dirt off fragile bones when blowing on specimen isn't feasible (i.e., not completely consolidated); sharp knife to trim matrix around specimen for aesthetics or for easier jacketing/embedding; fine forceps; good microscope with good depth of field and vertical travel as specimens are constantly being moved during preparation, and at times, it is necessary to stand specimen on end to prepare specific areas; sandbags to help cradle and prop up specimen at different angles to avoid straining wrists and fingers trying to hold specimen steady; various strengths of paraloid; 40 strength Paleobond™.

Preparation Techniques

1. Consolidation in lab

Paraloid is used very sparingly in the lab as it is very difficult to clean off small bones completely under high magnification. When specimens are being photographed, they are coated in ammonium chloride, and if any paraloid is covering details, the photographer will only see the relief of the consolidant, not the actual bone. Paleobond™ is used most, as it is easier to remove when thinly applied, and dries harder, faster, so preparation of the specimen can continue without too much down time.

Techniques for gluing specimens

I have developed several techniques to aid in gluing fragile specimens. All of these techniques are best applied under a microscope, as it is easy for bones to be dislodged or lost.

The first is called 'the insect pin technique.' The manufacturer-given applicators and standard eye droppers often dispense too large a drop to be useful. The end of a size 3 insect pin (with the ball and tip cut off) is dipped in a drop of Paleobond™ and carefully applied in the required spot. Sometimes it is necessary to apply it to the matrix directly beside the broken bone and 'guide' the glue to the bone using the pin as sometimes the bone itself will get wicked up into the glue on the pin, and can be difficult to reposition. Sometimes paper towel is used to remove some of the glue on the pin because, even though the drop seems small, it is often still too large and will inundate the specimen (see 'paper towel technique'). This technique usually works, but be prepared with a pin vice in the other hand to help guide the bone to its proper spot if it gets dislodged.

The second technique is called 'the paper towel technique.' Often when using the insect pin technique, the drop of Paleobond™ applied to the specimen is too large and it spreads to other places that weren't intended. Before applying the glue to the end of the pin, prepare a small piece of paper towel by folding and creasing it to get a nice point. Make sure the paper towel is as flat as it can get, as any added thickness will be a hindrance under high magnification. As soon as the glue is applied, quickly put the tip of the paper towel at the edge of the flow of glue and it will soak up the majority of the excess. Also, this technique can be used to help 'guide' the glue to the correct spot if the glue was not applied near there.

The third technique is called 'the acetone technique.' Sometimes in the field, a relatively thick layer of paraloid is applied to the bones, which can be difficult to remove in the lab. Drops of acetone are applied directly to the paraloid and either allowed to run off the specimen, or into cracks for further matrix consolidation. This technique can also be used to 'guide' paraloid to places where bones need more consolidation; apply drops of acetone to the edge of the paraloid and on the matrix itself in the direction you want the glue to go. Sometimes you need a thinner concentration of paraloid than one you have on hand, and this technique works for this as well; apply the glue to the spot you want consolidated and apply drops of acetone to it until it flows into the correct spot.

2. Bend insect pin

Sometimes it is useful to bend the tip of an insect pin into a loop to clean off flat bone surfaces that are too small for other tools, so the point of the pin doesn't scratch the bone.

3. Thin out Paraloid

Due to the high power of a microscope, you can see every little piece of paraloid on a specimen. Since it is next to impossible to get the bone surface completely clean, and due to the fragile nature of the skeletons, it is very easy to damage the bones with a lot of scratching with tools. So, if there appears to be a lot of glue, on or around the bone, clean off what you can with minimal tool use then apply a small drop of acetone to thin out the glue; this may be enough or do this procedure several times as long as the bone and matrix is consolidated well enough to handle all the acetone.

Techniques for specific projects

See poster for details.

Different matrices

There are two types of matrix at Pisces Point, both of which yield fish skeletons. There is alternating sandstone and organic layers in the quarry and both types of matrix require different techniques.

Sandstone

Sandstone is difficult to remove with pins as they are relatively soft and will bend and dull quickly, rendering them useless. The use of scalpels or carbide pins is necessary when dealing with this matrix. Also, sand grains can get lodged in important parts of the skeleton. It is always a gamble between trying to dislodge them, or making do with the information lost due to an obstruction, since a lot of damage might occur trying to remove them. If it looks like the sand grain might be easy to remove, try softening up the matrix with a little bit of acetone, wait a few moments for the matrix/skeleton to slightly harden again, then gently use a pin to dislodge the sand grain. Also, if possible, try to clean the softer matrix from around the sand grain using a pin before trying to dislodge it.

Organic

This matrix is the ideal one to work with as it is hard enough to contain the skeleton but soft enough to completely prepare with insect pins. It tends to preserve skeletons much better than sandstone as well, unveiling a beautiful fish when completely removed from the specimen.

Health warnings

There are several health and safety points to touch on that may pose a problem when using the microscope on a daily basis. Eye strain, including headaches and blurry vision, is common with the use of microscopes; make sure you take lots of small breaks and focus on distant objects so your eyes don't become accustomed to seeing near objects. Repetitive strain issues can occur in wrists and fingers. Symptoms of repetitive strain can include loss of strength in fingers and wrist, poor circulation in hand, and pain. The use of a wrist brace at the first sign of these symptoms and resting prevents the issue from getting worse. Also, the use of sandbags to prop up the specimen at any angle is needed to give the other hand a break from holding the block in potentially uncomfortable positions.

Acknowledgements

I am grateful to Mike Newbrey (Royal Tyrrell Museum) for introducing me to the novel field techniques mentioned here (hairspray and putty knives). Thanks also go to Jim McCabe (Royal Tyrrell Museum) for helping me to find the best material (Epo-Tek 301) for embedding my fish.

MOVING PALEONTOLOGICAL COLLECTIONS INTO OUR NEW HOME AT THE NATURAL HISTORY MUSEUM OF UTAH

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The New Natural History Museum of Utah

In November 2011, the brand new Natural History Museum of Utah (NHMU) opened its doors to the public. For the paleontology collections division, the job of moving in had just begun. In October of 2011, we began a six-month project stabilizing, re-housing and moving our paleontological collections from our old location at the George Thomas Building (GTB) (built in the 1930s as the University Library) into our new state-of-the-art facility. This operation was undertaken by a full time staff of three, with the help of three part-time student interns, and a number of museum volunteers. By late March 2013, we had succeeded in moving our collection of more than 25,000 vertebrate, 5000 invertebrate and 2500 paleobotanical specimens into the new building. While most of the specimens have been re-housed and re-organized into the new collections spaces, some parts of the collection are still in the process of being unpacked or re-organized.

Packing and re-housing

We were able to accomplish this major moving feat in such little time and with very minimal damage due in part to a very well organized system of packing and re-housing specimens. Specimens were divided into two major categories; smaller-sized specimens that would fit into cabinet drawers, and oversized specimens, which were moved on pallets into pallet rack shelving in the new facility.

Oversized specimens

Oversized materials were repaired, stabilized, and re-housed into clam-shell style support structures prior to moving onto pallets. Clamshell supports were modeled after those presented by the Smithsonian Institute staff at the 4th Fossil Preparation and Collections Symposium in Wyoming, in 2011. More than 100 clamshell supports were constructed by the NHMU staff from October to March, housing all of the heaviest and most delicate oversized vertebrate paleontological specimens in our collections. As other departments abandoned space in the GTB, we were able to repurpose a large room into a temporary lab dedicated to this purpose. Oversized specimens were ultimately moved on pallets that were padded with sheets of ethafoam, loaded into moving vans, transported to the new museum, and then lifted onto a new system of pallet racking on carriages in the new facility.

Fig. 1. Temporary lab for construction of clamshell support structures.

Specimens in cabinets

All specimens that fit into drawers were re-housed into new drawers in the old facility and then transported in half sized cabinets on pallets into the new facility where they were put into new cabinets on mobile carriages. In our old facility, specimens had been housed in a disparate collection of cabinets, ranging from open wooden drawers to lane-type steel cabinets. In the new facility, specimens were housed into three types of cabinet drawers, all in fully enclosed steel cabinets. Prior to re-housing, specimens were sorted for which drawer type they would reside in the new facility; full width drawer, half width drawer and holotype drawer. Specimens were re-housed into their respective drawers using two ¼ inch layers of ethafoam and were stabilized by cutting into the upper layer, or adding additional foam supports as necessary. Drawers were then covered temporarily with a third layer of foam and then wrapped with clear wrapping to keep them immobilized for the move. Packed drawers were transported on designated moving cabinets on pallets, and then unpacked directly into the new cabinets permanently mounted in the new facility.

Fig. 2. Wrapping drawers to immobilize specimens prior to moving them.

Reorganizing collections

Throughout the move, collections were reorganized into a hierarchical system according to stratigraphic age of formation, biological systematics, and skeletal elements. This proved to be the most time consuming aspect of the move, and is still underway in several parts of the collection. While most of the regular vertebrate and paleobotanical fossils are now re-housed and organized into the new collection areas; invertebrate and oversized fossils still require considerable reorganization. Some special areas of the collections were organized separately, including the holotype and figured specimens and certain oversized collections housed near public viewing areas where our collection area is visible from the public gallery. Holotype and figured specimens are now housed in a specially designed area of collections, which features additional security and stability measures. These include cabinets permanently mounted to the floor and wall (not on mobile carriages), drawers mounted with ball bearing rollers to minimize frictional movement when opening and closing, and roll-top covers over cabinets so that these specimens require an additional level of security to access. Specimens were specially chosen for housing in the visible storage area so that visitors experience is enhanced by seeing some of our most spectacular and impressive vertebrate and large mineral specimens, and as a result, we were unable to organize these specimens into our regular hierarchical order.

THE CONSERVATION AND MOUNTING OF A LARGE SKULL OF THE ICHTHYOSAUR *TEMNODONTOSAURUS PLATYODON* FROM THE JURASSIC COAST OF ENGLAND, UK

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Background

The Lyme Regis coastal area of Dorset in the United Kingdom has, since the time of Mary Anning (the area's famous fossil hunter of the early 1800s), yielded beautifully preserved examples of early Jurassic marine reptiles. Following a landslide in 2008, amateur fossil collector Mike Harrison uncovered a piece of ichthyosaur skull and, following some 6 months of effort, he recovered seven blocks containing the entire 1.5 metre long skull (Figs.1, 7). The find was registered in accordance with the area's Fossil Collecting Code of Conduct and work was undertaken by a local preparator.

Fig. 1

As part of the process to secure funding to acquire, conserve, and mount the specimen for Lyme Regis Museum, the Dorset County Museums Advisory Service asked the NHM (Natural History Museum) London to appraise the skull's condition and subsequently undertake its conservation and mounting. The skull will form the centerpiece of a new permanent exhibition and is an imposing example of this species, the first of which was discovered by Mary and Joseph Anning in 1811 at Lyme Regis.

Condition

The skull came from the pyrite-bearing 'Birchi Beds' within the Lias located between Lyme Regis and Charmouth and exhibited shrinkage cracking across all surfaces. Whilst the mechanical preparation had been of a generally good standard, the tooth rows appeared to have suffered during acid preparation, were etched and friable and exhibited possible signs of pyrite oxidation in the form of discolouration and sulphur powder (Fig.2).

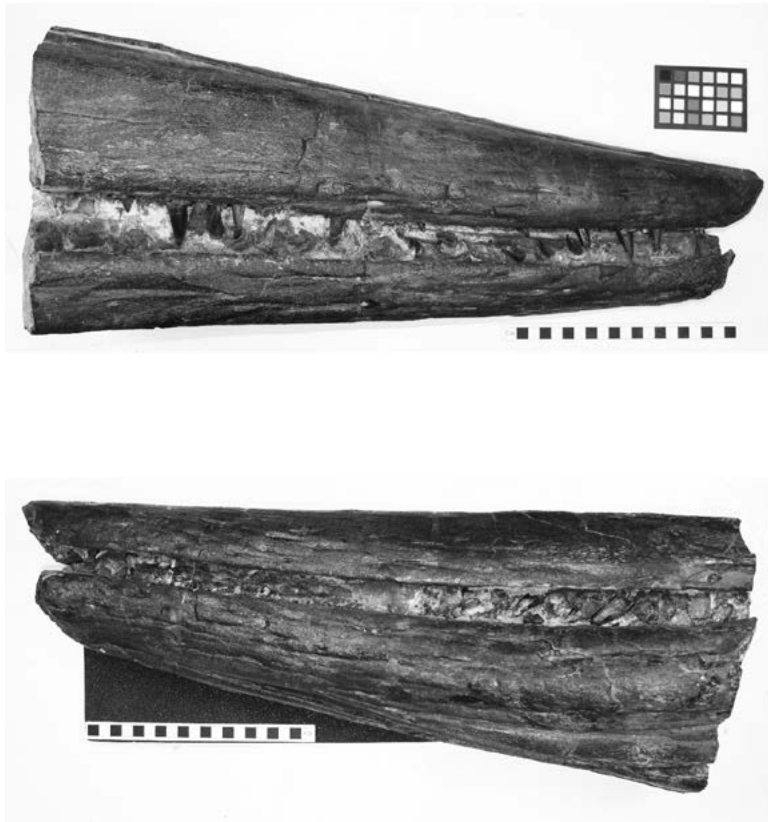

Fig. 2

Breaks in some of the blocks had been adhered using a thick white resin (possibly domestic glue), which failed across a join on one of the blocks. The resin was removed with a sharpened wood chisel and the blocks re-adhered using viscous Paraloid P72 in acetone.

The taphonomy was interesting, with the left side of the skull, including the occipital orbit and sclerotic rings, having been compressed so that this side was flattened and lifted, making it difficult to align the block containing the left mandible with the rest of the specimen.

Conservation techniques employed

Cracks were diagnosed as having been caused by shrinkage, with splitting due to movement rather than pyrite oxidation, as the edges were clean rather than 'exploded' which generally leaves behind fragmented material and broken edges. These were gap-filled for stabilization with a mixture of Paraloid P72 and glass micro-balloon powder. In some of the very narrow cracks, Japanese paper or woven polyester sheeting infused with P72 was used as filler. A wider crack and void below the left occipital orbit was filled with Jesmonite and AC100 hardener to provide strength in a vulnerable and previously broken area of the fossil.

Approximately half the teeth (those at the distal end of the jaws) had been acetic acid prepared, as evident from both the lighter colour of surrounding matrix and in its crumbly appearance by comparison to the proximal end of the jaw. The teeth in the distal half were largely matrix-free, exposed, and fragile. A sulphurous smell from this area suggested localized oxidation due to the treatment of this part of the specimen. The tooth rows and surrounding matrix were lightly air abraded with sodium bicarbonate to remove loose decayed material and treated with a paste comprising of 5% ethanolomine thioglycollate and 95% Industrial Methylated Spirit added to Sepiolite and covered in polythene film for 2 hours (Fig.3). The spent paste was removed with IMS and soft brushes (Cornish and Doyle 1984).

Fig. 3

Manufacturing of the mount

Because of the size, weight, and distortion of the individual blocks, it was decided that these should remain as separate pieces, held in orientation within the mount. A sturdy wooden pallet was constructed as a base for the specimen and the work was undertaken on a hydraulic lift table to facilitate access. In order to achieve as close a fit between the 7 blocks (which were of differing depths with some missing/reconstructed edges), each was supported ventrally on blocks of plastezote foam and sand bags.

The dorsal surfaces of the skull and rostrum were carefully checked for undercuts and these were filled with oil-free plastecine to avoid the jacket from locking when it hardened. Wider gaps were filled with plastezote strips.

The tooth rows were packed with acid-free tissue and masking-taped over for protection. The skull was then covered with polyethelene film which was marked to indicate the edges of the support jacket to be made. An inner layer for the support jacket was first formed comprising of four layer glass fibre/polyethelene resin. This choice of material was made because a thin resin jacket would be sufficiently flexible to allow for removal from the awkward contours of the distorted specimen. Once this layer of jacketing was successfully removed, an outer layer of Epopast (2 part epoxy resin and fibre paste) was added and allowed to set hard over 24 hours. The jacket was then removed and a wooden frame constructed and screwed to the outer side to form a stable base. The process described is shown in series in Fig.4.

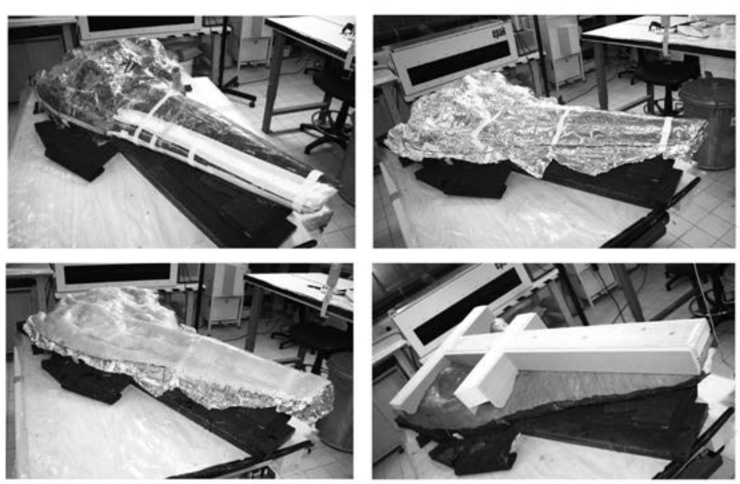

Fig. 4

The skull blocks were individually turned and seated into the jacket to facilitate manufacture of the final mount around the ventral (palate and underside) of the specimen (Fig.5).

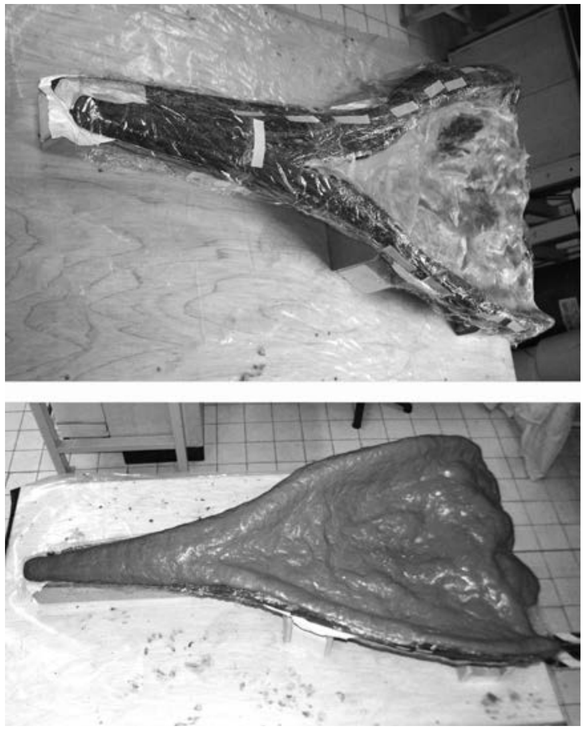

Fig. 5

The process described above was repeated (i.e. an initial flexible inner jacket was strengthened with a layer of Epopast), and a bespoke steel frame was then positioned onto the support (Fig.6) and secured with a second layer of Epopast, leaving arms protruding around the specimen onto which removable steel holds would be welded. To display the specimen dynamically, the steel frame will lift the flattened side of the skull by some 40 degrees, lowering the rostrum while leaving the better-preserved, right side tooth rows visible (Fig.7).

Fig. 6

Display and educational significance

The specimen demonstrates vividly the forces involved during the process of fossilization as the left side of the skull has been flattened, creating an exaggerated ‘V’ shape and moving the upper and lower jaws and rostrum out of alignment. Some of the bones from the palate area have dropped between the upper and lower tooth rows. Although the skull weighs some 160 kg, the forces of compression and eventual landslip broke it into seven blocks. The specimen can be compared to the Lyme Regis Museum’s cast of the 1811 Anning skull, which, by contrast is uncrushed. Thus, the specimen offers an important educational opportunity for visitors to the museum.

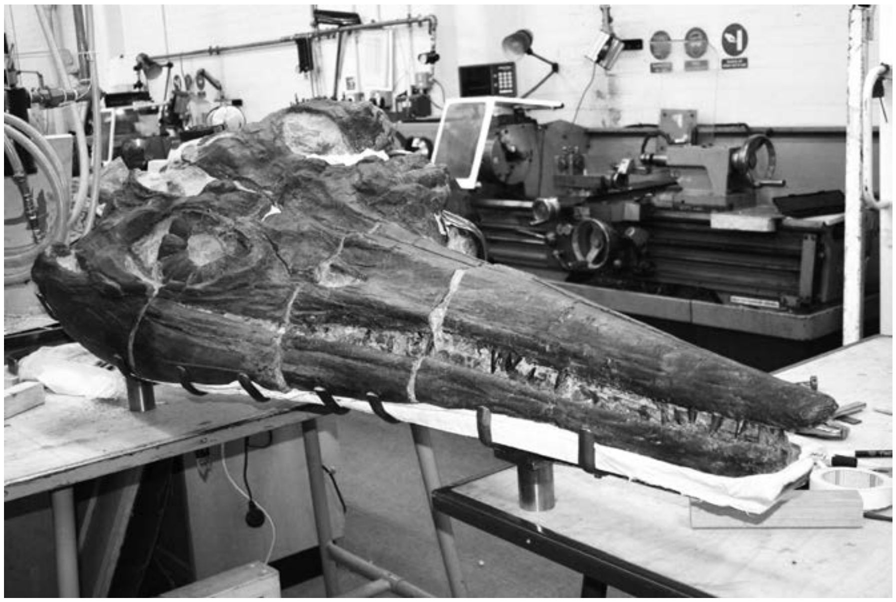

Fig. 7

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ESTIMATING THE VOLUMES AND MASSES OF BIG PLASTER JACKETS

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Recovering the fossil remains of dinosaurs and other large Mesozoic reptiles frequently involves creating and moving very large blocks of rock that can sometimes weigh up to several tonnes. Accurately knowing the mass of a fossil block greatly assists in planning how to move it, what equipment will be needed, and what sort of powered lifting in the forms of trackhoes, cranes, and even helicopters will be required. The storage of large blocks also requires knowing the masses of blocks as the loading capacities of shelves; tables and floors need to be taken into consideration.

It has been our experience at the Tyrrell Museum that people tend to underestimate the masses of large fossil jackets. This is especially worrying as bringing in cranes and helicopters to remote areas is expensive. The last thing you want is to have ordered a machine at a rate of hundreds to thousands of dollars per hour, only to find that it cannot lift the load. Alternatively, grossly overestimating the mass of a block will mean having to needlessly pay for an expensive machine, when a cheaper, smaller one would have sufficed.

Using some recently collected large jackets as examples (a plesiosaur removed as 6 small to medium jackets and a very large partial *Triceratops*) several different techniques for making estimates of their masses were tried. These jackets were then weighed with a digital scale, and the percent error of the mass estimates was calculated. Approximating the shape and dimensions of plaster jackets with tri-axial ellipsoids produced the best estimates, but these tended to underestimate the true weight by 6-7%. In contrast, approximating a jacket with a rectangular box that fully enclosed it, tended to severely overestimate the mass by up 90% is some cases. Estimates of the volume and mass of the plaster applied to large jackets shows that these are on the order of 15% of the total volume and mass. Contrary to most expectations, the relative volume of plaster, even when more layers are applied to larger blocks, does not increase, but actually decreases.

SCIENTIFIC COMMUNICATION OF FOSSIL PREPARATION IN THE DIGITAL REALM

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The rapidity of the expansion of the World Wide Web has meant that communicators of science are still coming to terms with the digital landscape and how it can best be used to reach their target audience. However, there are inherent advantages in embracing social media sites and the like to reach out to the public and fellow fossil preparators. Compared to giving public talks or writing for popular magazines; a much larger audience can be reached; the material can be accessible to all; there are no editorial barriers or limits to the size and scope of the material, and importantly, it is also possible to have a real dialogue with the audience. The material is also archived and available long after the authors have left it behind and can still be found, read, absorbed, and used many years later and, critically, it can be searched for and it is free to produce.

All of these benefits come particularly to the fore when the subject is a relatively marginal or niche issue. Few books, magazines, or even major media outlets (including digital ones) would be willing to publish a piece that might interest only a few hundred individuals (especially if they are spread around the world), but this is of no consequence to a communicator with access to the Net. Thanks to its popularity there are an unending set of articles on *Tyrannosaurus* for example, but issues such as fossil protection and preparation are often overlooked.

Between October 2010 and February 2011, we ran an extended series of blog posts on David W.E. Hone's blog, the Archosaur Musings (the final summary post indexing all others can be seen here: (http://archosaurmusings.wordpress.com/2011/02/22/darren-tanke%E2%80%99s-gorgosaurus-preparation-final-roundup/) detailing the preparation of a specimen of the tyrannosaurine dinosaur *Gorgosaurus* by Darren H. Tanke. Some additional follow-ups occurred in June 2011, with additional commentary on future work appearing in March 2012. The specimen, TMP 2009.012.0014 (Royal Tyrrell Museum, Drumheller, AB, Canada) is a substantial portion of a sub-adult individual discovered in the field by Darren H. Tanke. The entire preparation process, from opening the field jacket to a final clean of a display and research-quality specimen was covered in the blog.

The preparation was covered in close to real-time with updates from Darren H. Tanke every few days showing the progress made on the skeleton, and detailing what work had been done. In addition, there were discussions of the methods used (e.g., types of tools, repairing breaks) and issues such as health and safety and preparing material for molding or display. In addition to answering questions and discussing methods in the comment threads for each blog post, midway through the series we also deliberately ran a Q&A session to discuss the work and its implications.

The responses to the series have overall been very positive. Feedback showed that the material was considered interesting and covered an area rarely given lengthy treatments, and there were questions and comments from the public, academics, and other preparators, leading to important and valuable exchanges. While the numbers of visitors per post was not large (a few hundred per piece) the series enjoyed a major boost thanks to coverage in the online section of UK newspaper *The Guardian* by David W.E. Hone's in October 2012 which led to several thousand extra readers.

The success of this series has likely been boosted by the novelty value and the fact that tyrannosaurs are inherently 'sexy' fossils to the general public. Even so, it is clear that a good number of people, previously unfamiliar with the preparation work that goes into extracting fossils from the matrix, have gained new understanding and information from the series. Moreover, as noted above, that this is archived online makes it immediately accessible to people globally and for years to come in a way print media cannot. Anyone with enough interest in the subject (perhaps following a museum visit) to search online will likely come across the series. Collectively, therefore, we feel that this has had a very positive, if relatively minor, impact in the public's perception and understanding of preparation work and future coverage by ourselves and other colleagues will only likely increase and enhance this. To our knowledge this is the first major start-to-finish preparation of a dinosaur specimen on the Internet and we hope others will follow.

Acknowledgements

We wish to thank Donald M. Henderson (RTMP) and RTMP management for permission to cover the preparation of the *Gorgosaurus* specimen on the blog.

EVOLVING RESEARCH METHODS, EVOLVING COLLECTIONS MANAGEMENT

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Introduction

As technical and analytical methods in vertebrate palaeontology evolve, there are concomitant changes in the curation and management of research collections and the data associated with those collections. Analysis of ancient DNA (aDNA) and the analysis of stable isotopes preserved in bone are now commonplace in palaeontological research, particularly with respect to research focused on Quaternary vertebrates. Ever-improving techniques for radiometric age determination also raise interesting concerns for collections management practices. All three research areas—aDNA, isotope analyses, and age determination—generate datasets on the basis of destructive analysis, meaning that some portion of a fossil is sacrificed for the gain of scientific data. Without question, such datasets can significantly advance our understanding of the fossil record. However, destructive analyses raise several challenges for collections management. Here we highlight several collections management-related issues that destructive analyses have raised with respect to curation and management of the Quaternary Palaeontology Collection at the Royal Alberta Museum (RAM).

Impact of sampling

Destructive sampling removes physical pieces of individual specimens, thereby altering the appearance of those specimens. Any removal of a portion of a specimen, or in some cases an entire specimen, has implications for the future use of the specimen for display, other research, or outreach activities, even though those implications may not be fully realized when sampling takes place. Quite simply, there is a cost-benefit trade-off inherent in destructive sampling. In the case of museums where research is not the sole mandate, the non-research impacts must be considered. At the RAM, sampling for destructive analysis is typically conducted either on-site by the borrower or by curatorial staff after consultation with the borrower. Because fossil specimens are a limited and finite resource, "experimental" techniques can be problematic. Generally, analytical techniques for which destructive sampling is undertaken should have an already established track-record and proven scientific credibility. In cases where analytical techniques *are* being tested, a hierarchy of specimens available for testing those new techniques can be established (e.g., use of voucher specimens would not be desirable). Initial attempts to collect data through destructive analysis are generally permitted for small samples to prove the effectiveness of the method. The intent of these practices is to ensure the efficacy of the analysis and to ensure other, non-research considerations are made as part of the sampling process. In some cases, specific collections may turn out to be unsuitable for a proposed technique, perhaps because of depositional or preservational factors such as leaching or mineralization. Certainly, improvements in analytical techniques (e.g., for radiocarbon dating) have vastly reduced the sample sizes necessary for most destructive sampling. However, from a collections management perspective, the mandate of each individual institution should play a part in determining what an appropriate level of impact is in terms of destructive sampling.

Data ownership and submission

Data derived from destructive analyses raise institutional challenges, not the least of which is answering the question, "Whose data is it?" As a public institution we take the perspective that data derived from destructive analysis of fossil specimens in our care are ultimately "public" in nature. Therefore we interpret data from destructive analysis as being an inherent part of the specimen. In essence, such data are the replacement for the tangible portion of the fossil specimen that was destroyed. As such, we view timely submission of data as an essential aspect of destructive analysis loans. To facilitate this in the

Quaternary Palaeontology Program at the RAM, we have initiated a procedure by which loans of material for destructive analysis remain open until data submission is complete. This serves the dual purpose of reminding borrowers of their obligation to submit data and reminding collections management and curatorial staff of the necessity to follow up on data submissions.

A related, secondary issue arises when public institutions receive requests for data that are not yet published (e.g., radiocarbon dates). Clearly there is a balance to be struck between borrowers utilizing collections and those requesting information generated from specimens in the collection. Data embargoes for set time periods may be a reasonable approach, although such an approach is not without pitfalls.

Similar data, different questions

Increasing numbers of requests to perform similar types of analyses on individual specimens are becoming commonplace. These include concurrent requests (e.g., destructive sampling for aDNA in the same taxon from the same locality) and requests based on variation in methodologies (e.g., new techniques for collagen extraction for radiometric dating). Concurrent requests are typically treated in the same manner as non-destructive requests, that is, the initial request generally has priority. Ensuring that data from previous analyses become part of the specimen record can go some way towards answering some requests. Requests to re-sample the same specimen or taxon for the same analytical technique may be obviated if the data are already available. Given the increasing number research projects and the rapid advancement of analytical techniques, we predict that these areas will continue to be a concern for the management of palaeontological collections.

Data preservation

Long-term preservation of data is an issue that continues to evolve in response to advancing technology. In particular, those datasets which are largely electronic in format (e.g., aDNA sequences) present institutional challenges for long-term maintenance, accessibility, and readability. In the past, we have viewed large public databases (e.g., GenBank) as a primary source for long-term preservation of certain types of datasets. However, we are reluctant to assume that those public databases will remain available in perpetuity. Currently, we are requesting raw data files for our records in addition to deposition of such datasets in publicly accessible data archives. That approach raises secondary issues concerning the care and maintenance of electronically formatted data in a rapidly changing digital environment. Besides the formidable challenges of simply archiving large numbers of data files, there is also the problem of ensuring that data sets remain readable despite changing software. From this perspective, data files in a more generic form are preferable to files in a proprietary format that may rapidly become obsolete. Furthermore, raw data files are only useful if they are accompanied by informative metadata, so that it is clear what the data represent. Because the data from destructive sampling are the “replacement” for the specimen portion destroyed, similar collections management and curatorial effort needs to be deployed for their preservation as for the curation of the specimen itself.

Evolving and adapting

Museum collections are a valuable resource for research, education, and exhibition. At first sight, destructive sampling may seem incompatible with those activities. Yet a thoughtful and proactive approach to destructive sampling can enhance the scientific, heritage, and interpretive value of collections and ensure that museums are even better positioned to fulfill their core mandates and overall vision to inspire people of all ages and backgrounds to discover, appreciate, and value their natural and human heritage.

POLAR FIELDWORK

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Field work in Polar Regions is not new. Fossils in the Antarctic and Arctic Circles are sought in their respective summer months, where the conditions can be as harsh in terms of remoteness and climate as winter in temperate regions. In recent years, the Royal Tyrrell Museum of Palaeontology has been obligated to collect dinosaur and marine reptile remains in winter from northern and southern Alberta. The most recent excavation took place under unique circumstances near Ft. McMurray, Alberta, 800 km north of Drumheller. Despite the -20°C to -30°C daily temperatures, in a shed surrounded by heavy road construction machinery, one of the most complete plesiosaurs (Reptile: Sauropterygia) from the Wabiskaw member of the Clearwater Formation (Albian, 110 MYA) was recovered in 5.5 days.

COLOUR COPY TRANSFER TECHNIQUE FOR REPRODUCTION OF LOW TO NO-RELIEF FOSSIL SPECIMENS

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A variety of fossil specimens; leaves, fish, insects, have very little, if any, surface relief. Many are often preserved as little more than mineral staining with no relief, and important specimens are difficult to reproduce for study or exhibition. The absence of contour or relief provides few if any reference points for existing methods such as hand painting, and resulting copies are inexact with significant loss of detail.

By combining standard techniques of casting and decoupage (image transfer) with colour photocopying or printing; museum quality duplicates of these difficult to reproduce specimens can be made. Initially introduced by Lindoe in the late 1970s, this technique has subsequently been refined and adapted to include digital technology.

The full procedure and materials required will be presented. A printed handout of instructions will be available, as well as a downloadable pdf made available after the symposium.

THE COLLECTION, PREPARATION AND MOUNTING OF THE HOLOTYPE OF THE LATE CRETACEOUS ELASMOSAUR *ALBERTONECTES VANDERVELDEI*

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The holotype (TMP2007.011.0001) of the elasmosaur, *Albertonectes vanderveldei* (Kubo et al., 2012), was found on May 16, 2007 by Korite International Ltd. while mining for ammolite in the Upper Cretaceous Bearpaw Formation along the St. Mary's River, Alberta. The lower body pieces, numerous phalanges and tarsals that were hit with the bucket of a track hoe (hydraulic excavator) were set aside by the Korite mine workers and were brought to the Royal Tyrrell Museum of Palaeontology (RTMP) by the investigating staff on May 18, 2007. Several *in situ* articulated dorsal vertebrae were exposed. The excavation began on May 29, 2007 with an initial crew of six people (seven people in the later days) from the RTMP. The track hoe quickly cleared the remaining overburden, rock and crack hammers and awls were used to expose the skeleton and start the trenching. The bones were covered with grey clay, making them difficult to distinguish from the surrounding shale, so white acrylic paint was used to mark exposed bones. Paraloid B72 was used as the consolidant. The specimen is mostly articulated and was lying on its right side with the anterior section of the neck crossing under the posterior section of neck while extending posteriorly towards the body (Kubo *et al*., 2012). The tail (Block "C") was isolated from the body by the gap created by the track hoe when it hit the specimen. The rest of the skeleton had to be divided into two equal-sized blocks, which required the removal of some elements to provide the space needed for trenching. Keeping the number of bones to be taken out to a minimum, cervical vertebrae 68 and 35 were chosen to be removed to separate the anterior body, posterior-most, and anterior-most cervicals (Block "B") from the remaining sections of neck (Block "A"). The outlying disarticulated elements such as phalanges, carpals and a gastralia were collected separately after being mapped. The large scale trenching around the blocks was done with the excavator. Strips of burlap were soaked prior to being dipped in Plaster of Paris. There were 8-9 layers of burlap and plaster bandages with several pieces of 4x4 and 2x4 lumber placed in a triangular pattern within the jacket for reinforcement. The track hoe was used to flip each of the blocks and with slings they were lifted out of the quarry on June 18, 2007. The three blocks were transported back to the RTMP on a flatbed trailer. Once the blocks were back at the museum they were weighed. Block "A" weighed 3580 lbs, Block "B" weighed 3680 lbs, and Block "C" weighed 2550 lbs.

Preparation was started on October 19, 2007. A cast cutter was used to open the field jacket, starting with the down side or bottom to prepare the right side of the skeleton. A small hammer and awl were used to take down the bulk matrix and then a scalpel (#15 blade) was used to expose the bone. There was some air scribing needed on patches of concretionary matrix. Consolidating was done primarily with Paraloid B72 and Paleobond 100 was also used in some areas. A few areas required epoxy putty for structural support. Sodium bicarbonate (baking soda) was used to air abrade the residual clay from the bone surface. Matrix was left *in situ* in certain areas for support. The skeleton is kept in its original taphonomic position and there is no reconstruction of missing bone pieces or elements. Of the characters Sato (2003) used in her phylogenetic analysis of plesiosaurs, one hundred and four were from the postcranial skeleton. Therefore both sides of the blocks needed to be prepared to provide maximum information on the anatomy in particular the cervical count and the morphology of the girdles. So the left side that was partially exposed in the field would need to be prepared as well. Plastic wrap was placed over the specimen as a separator. Temporary plugs of latex mixed with vermiculite were placed in various spots such as the transverse processes to prevent the new jacket from locking on to the bone. Sheets of felt were then placed over the specimen. Several 20x10cm sheets of fibreglass mat dipped FGR hydrocal 95 were applied directly on to the felt. This new support jacket was then bolted to the original field jacket and the overhead crane in the preparation lab at the RTMP was used to flip the blocks. The Plaster of Paris field jackets were then peeled apart layer by layer. The left side of the skeleton was drawn and photographed. There were several cervicals under the right front paddle giving the total cervical count as 76 (Kubo et al., 2012). The adhesive, 2-ton epoxy, was used to glue some, but not all, of the larger fragments of the lower body that were hit by the track hoe. Wiffen *et al.*(1995) reported that plesiosaurs shift from a pachyosteosclerotic to an osteoporotic-like internal bone structure during ontogeny. Some bones (right femur and some vertebrae) were not glued together to retain access to the internal surfaces for study. Fragments of the lower body were not glued together to retain access to several gastroliths that would otherwise be obscured. These pieces are held in place by the support jacket. It took approximately a year and half for four technicians to complete the preparation of the specimen.

The right side with the overall better articulation, particularly the right front paddle, was the obvious choice for the display side.The specimen was to be displayed in a support jacket with a matrix-like background, essentially a horizontal panel mount. The prepared sections of the skeleton were reassembled and the vertebrae removed in the field were returned to their positions in the cervical series. Cardboard was placed around the entire specimen to form a border.The white felt would be highly visible in the recesses between the bone and the support jacket and would be difficult to colour once the specimen was in the jacket. So the felt had to be coloured before the specimen was to be placed in the support jacket. Pieces of the original shale matrix were dissolved in water to create a mud to dye the felt.The felt was then left to dry. Plastic wrap was placed over the specimen as a separator. Again latex/vermiculite plugs were placed in key spots to prevent the support jacket from locking on the specimen. The felt was applied over the specimen and the surrounding border. FGR mixed with black pigment was applied first followed by four layers of FGR and fibreglass mat. The support jacket was then lifted off the specimen and the plugs and separator was removed. The new support jacket was then placed back on the specimen and bolted to the underlying jacket. The specimen was then flipped with the overhead crane. This was repeated for each section of the body. Since the felt comes in 1m square sheets, there were the inevitable seams and texture of the felt that also need to be covered. Black pigment was premixed with dry dental plaster in a 4 litre container to provide a large enough reserve for a consistent grey colour. Out of this supply, small batches were mixed in a rubber cup. A thin coating of the coloured dental plaster was applied over the felt with a small brush. Dental plaster was chosen because it would be easy to trim excess and sand. Once the plaster was dry, the surface was painted with the same mud to match the dyed felt. Once the mud was dry, the surface was buffed to give it a mottled appearance. The specimen currently sits in four support jackets that can be lined up together for display. Since the left pubis is more complete than the right pubis, the lower body pieces can be lifted out and reassembled to view the left side. Several of the distal caudals can also be lifted out of the support jacket for research.

Acknowledgements

Korite International and the many members of the RTMP field crew for collecting the specimen. R. Cooke, D. Macleod, and J. Graham for their assistance in the preparation of TMP 2007.011.0001.

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Fig. 1: The quarry of the holotype (TMP 2007.011.0001) of *Albertonectes vanderveldei*.

Fig. 2: Korite International's track hoe flipping the tail (Block "C").

Fig. 3: Block “B” in the early stages of preparation.

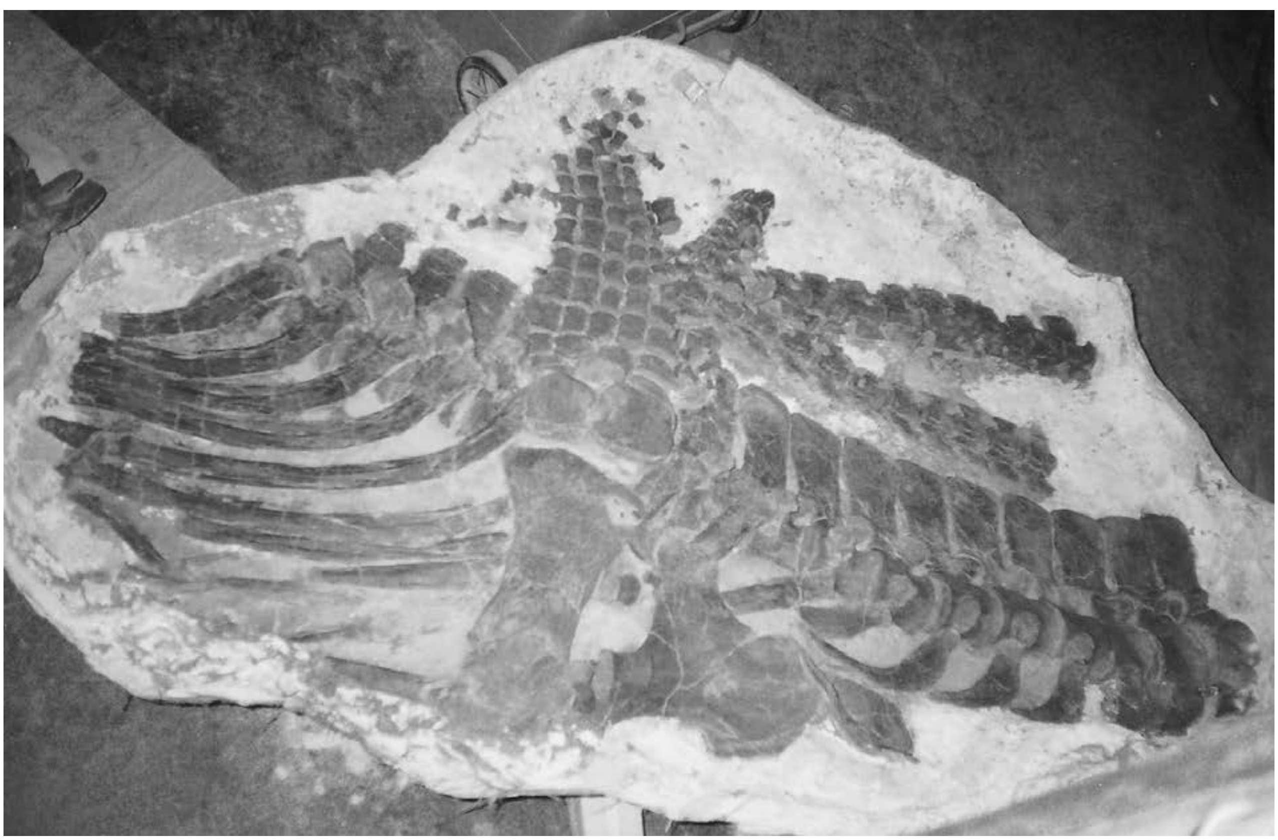

Fig. 4: The right side of the upper body and anterior cervicals of Block “B” after air abrading.

Fig. 5: The right side upper body and anterior cervicals resting on its mud dyed felt/FGR support jacket.

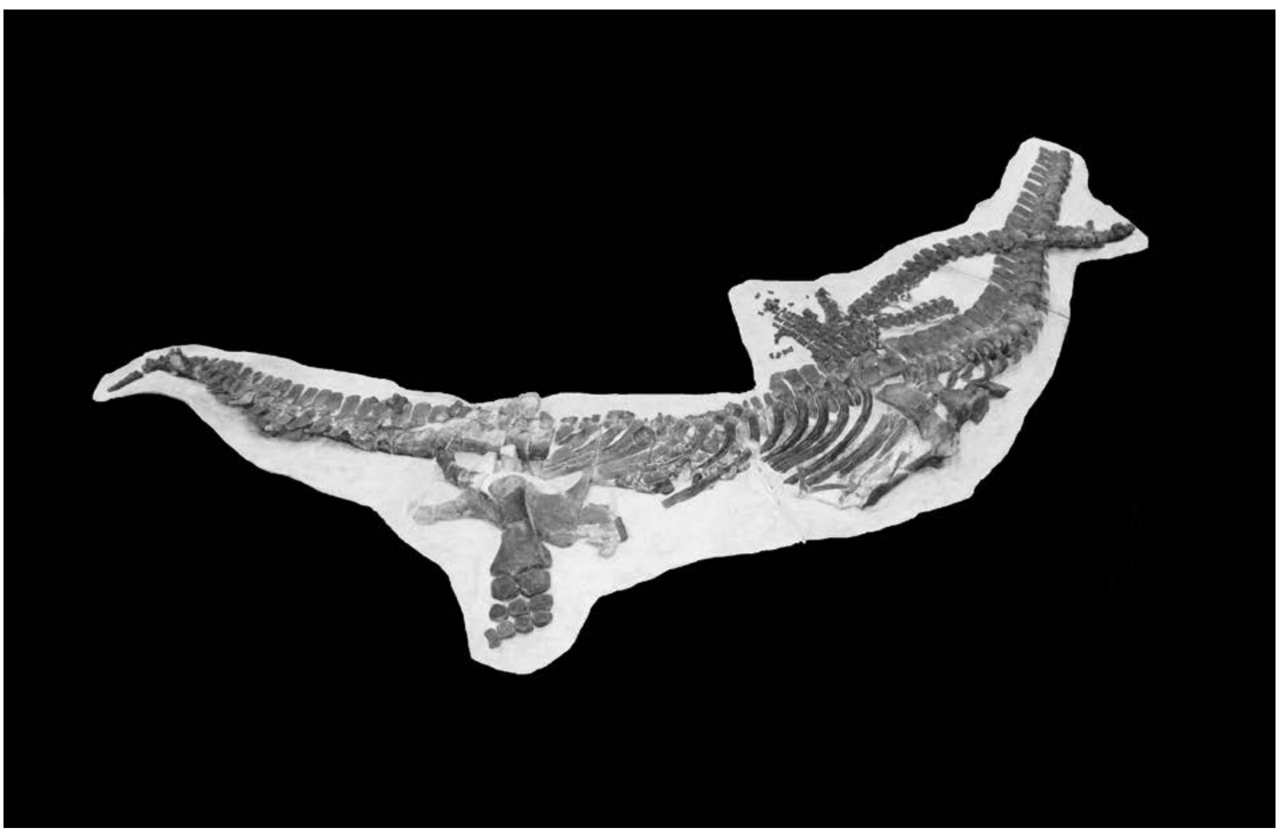

Fig. 6: The assembled skeleton of *Albertonectes vanderveldei*.

DEVELOPMENT AND PRODUCTION OF A SUPPORT FOR DINOSAUR TRACK-BEARING SLABS RECOVERED FROM HIGHWAY A16 EXCAVATIONS (NW SWITZERLAND)

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Introduction

As a result of the construction of federal Highway A16 ("Transjurane"), a new paleontological survey project, the Paleontology A16, was established in February 2000. This project, financed by the Swiss Federal Roads Authority (FEDRO, 95%) and the Canton of Jura (5%), is in charge of safeguarding and documenting the paleontological heritage prior to highway construction and to make it accessible for scientific research (Marty *et al.* 2004; Ayer et al. 2006).

Near Porrentruy (Canton of Jura, NW Switzerland), the Paleontology A16 has – between 2002 and 2011 – excavated six large Late Jurassic dinosaur track sites (Marty 2008; Marty *et al.* 2003, 2010). This project has led to the documentation of nearly 14,000 dinosaur tracks including more than 660 sauropod and tridactyl trackways. Documentation was done following ichnological standards and mainly with state-of-the-art 3D imaging technologies (laser scanning & photogrammetry). The most important tracks and trackways were cast and/or recovered as slabs.

Apart from one dinosaur track site (protected by an additional bridge), all other sites are today either destroyed and/or covered up by the Highway. During the next couple of years, the major effort of the Paleontology A16 will be to evaluate and organize the data and the collection. The track collection includes approximately 335 m^2 of casts and 245 m^2 of recovered original dinosaur-track bearing (marly) limestone slabs, whereas some of the latter can be re-assembled into over 100 m^2 large, coherent surfaces.

The consolidation of these track-bearing slabs in the laboratory is currently one of the major tasks of the Paleontology A16, both for incorporation and accessibility in the collection, and for potential re-assembly for future research and museum display. The applied methodology is the major focus of the present contribution and will be outlined in greater detail.

Recovery of slabs in the field

The majority of the recovered track-bearing surfaces was not very thick (up to several cm), rather fragile and frequently intersected by normal faults and/or desiccation cracks. In order to stabilize the surfaces and to prevent disintegration during removal, they were consolidated by gluing a fiberglass cloth with the polyvinyl acetate resin Mowilith 60® on top. This resin is characterized by a high chemical stability and efficient removability with acetone or ethanol. The surface was then split (see fig. 1A) with a chisel and a hammer or occasionally with a stone saw along normal faults and cracks into slabs of a maximum European pallet size (i.e. 1.2 x 0.8 m). Prior to removal, a detailed map of the slabs was drawn.

The resulting shape of the slabs is highly variable and mostly quite irregular as it is determined by the course of normal faults or (desiccation) cracks, but also by the position of the tracks themselves (as less cuts as possible). Most of the slabs are fragile and some are heavy with a maximum weight of up to 300 kg.

Consolidation of slabs in the laboratory

The fibreglass cloth holds the recovered fragile slabs together but also covers the dinosaur tracks. In order to study, display, and store the slabs, the fibreglass cloth had to be removed and replaced by a support on the lower face so that the slabs remained manageable for the handling staff. General research and ideas for a suitable support were carried out in a Bachelor Thesis in conservation (Miserez 2012), with the active collaboration of the Paleontology A16. This has led to the design of a support that is manufactured by the technical staff of the Paleontology A16 since August 2012.

Description of the support

The chosen support consists of the following parts (see fig. 1F):

- A layer of mineral mortar "KEIM Restauro Giess" (produced in France by *Peintures minérales Keim*; www.keim.fr) is put directly on the lower face of the slabs in order to maintain the fragments in place. Although its exact composition is unknown, this mortar is mostly mineral as it contains only 1% of organic synthetic additives. It is thus supposed to be chemically stable and compatible with the (marly) limestone. This mortar was chosen for its solidity, mineral composition, removability, and because it comes in various tints.
- A fiberglass lattice (mesh size of 4 mm) is introduced within the mortar, in order to minimize the spreading of possible cracks and avoid the separation of the fragments if the mortar should break.
- A mineral-bonding layer of "KEIM Contact Plus" (produced by *Peintures minérales Keim*), containing less than 5% of organic additives sticks the mortar to a supporting plate.
- The supporting plate consists of a 2-4 mm thin aluminum plate with a textured surface on one side to improve the bonding of the mortar, and a 19 mm thick 3-ply fir wood panel glued to the aluminum plate with the polyurethane glue Coltogum® (produced in Switzerland by *SFS Unimarket AG*; www.sfsunimarket.biz). A full aluminum plate was preferred to a honeycomb composite panel because it can easily be cut and is comparatively cheap. The fir wood panel was added in order to reinforce the entire compound, and to avoid torsion of the aluminum plate.

Manufacturing the support

The production of the support is made in several steps and controlled with a checklist. First of all, the slabs are photographed in order to record the information (collection number, position and labels of tracks) written in the field on the fibreglass cloth.

1. Overturning of slabs

As the slabs are stored on a wood panel with their upper face up, it is necessary to turn them over. This can be done by hand if the samples are neither too cumbersome nor too fragile. If not, a second wood panel is put on the sample and both panels are tightly held together with clamping sets. The slab is then lifted into a vertical position using a hoist with two straps hooked to both ends of an iron bar previously put between the wood panels. After turning the slab over, it is carefully put on a wooden pallet (see fig. 1B).

2. Cleaning

The lower face of the slabs is cleaned with a pressure washer to remove clay and marls that could diminish the adhesion of the mortar to the limestone. The lower face of the samples is then photographed for documentation, as it will no longer be visible after coating it with the mortar.

3. Preparation of the fibreglass lattice and wood-aluminum supporting plate

First of all, the textured surface of the aluminum is coated with a bonding layer of "KEIM Contact Plus", which dries in about 2 days. The 3-ply fir wood panel and the aluminum plate are then glued together by applying a thin layer of polyurethane glue Coltogum®, which dries within a few days.

In order to adapt the support to the slab, the shape of the lower face of the slab is drawn on a transparent plastic sheet (see fig. 1C). However, the support must be slightly smaller than the slabs so that these can be joined together side by side later on. Thus, a margin of about 2 cm is kept between the edge of the slab and the edge of the shape drawn on the plastic sheet. This shape is then transferred on the wood side of the wood-aluminum plate and cut out using a jig saw. The same shape is also cut into the fiberglass lattice that will be introduced within the mortar.

4. Coating with mortar

First, the lower face of the slab is moistened in order to improve the adherence of the mortar to the limestone. Then, a first layer of "KEIM Restauro Giess" mortar is applied with a trowel on the lower face of the slabs. The mortar of this first layer must be rather liquid, so that it slightly penetrates the cracks

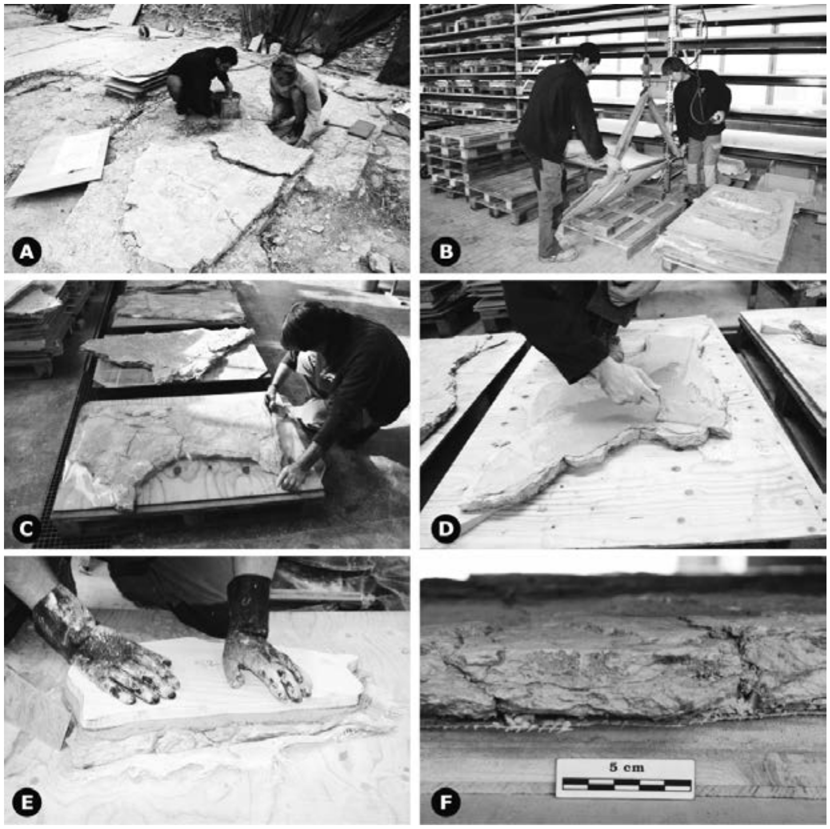

Fig. 1. A. Recovery of three connecting slabs in the field, Courtedoux—Tchâfouè tracksite, level 1055. Note the fiberglass cloth on top of the slabs, on which are drawn the tracks and labels. **B.** Overturning a slab. **C.** The shape of the lower face of the slab is drawn on a transparent plastic sheet. **D.** A fiberglass lattice is introduced within the first mortar layer. **E.** The aluminum-wood plate is put on top of the second mortar layer. **F.** Finished support in a cross-section view. From top to bottom: track-bearing (marly) limestone slab, mortar with fiberglass lattice, aluminum-wood plate. Scale bar 5 cm.

and binds together the stone fragments. This first layer has a minimal thickness of about 0.5 cm and fills the irregularities of the limestone to achieve a flat surface. The fibreglass lattice is then immediatelyput on the mortar and slightly pressed into it with a trowel until uniformly covered with mortar (see fig. 1D). The mortar then dries up in approximately one day (depending on the climatic conditions) until it strengthens.

The surface of this first mortar layer is moistened again before applying a second, about 2 cm thick mortar layer of "ice-cream" consistency. The wood-aluminum plate is put on the mortar (see fig. 1E), and overflowing mortar is removed. Weights are then put on the support while drying. Even though the mortar dries completely in only about 10 days, after about 48 hours it is hard enough to mechanically remove the mortar drops and turn the slab over again.

5. Removing the fibreglass cloth and resin

Once the support is finished, the fiberglass cloth and the Mowilith® resin can be removed. The resin is softened with organic solvents (acetone or ethanol). In order to remove the shine of the resin, Mowilith® residues are brushed off or removed with spatulas and scalpels. During the softening and dissolution of the Mowilith®, some of the resin migrates into the limestone and cracks, consolidating the stone surface and gluing together small fragments. Larger, unstable fragments may be kept in place with Mowilith® diluted in ethanol or with "KEIM Restauro Giess" mortar.

6. Labeling and documentation

The collection number is marked with brown acrylic paint diluted in water (chosen for its stability and relative removability) on the upper face of the slabs, directly on the limestone. The collection number is also stapled on the edge of the 3-ply wood panel so that the slab can be identified when stored in a shelf. The upper face of the slabs is then photographed.

7. Handling and storage

The samples are stored on 27 mm thick, 3-ply fir wood panels or on pallets, which allow them to be handled without grasping them by their edges. In order to re-assemble entire surfaces or dinosaur trackways, they can be slid on the wood panels or pallets to be put side by side. It was decided not to add any handles or wedges to save space in the storage shelves in which they are stored. Heavy samples must be moved and lifted with a forklift.

Conclusion

The removing of the fibreglass cloth and Mowilith® and cleaning of the slabs requires up to one day depending on the surface to clean. However, the production of the support is easy and fast as each step only requires a few minutes. During the first months of production, no major inconveniences were noticed, except that very large and/or heavy slabs are somewhat difficult to handle. This could eventually be improved by attaching some sort of handles. The only part of the support that is in direct contact with the slabs is the mortar "KEIM Restauro Giess". It is mainly mineral and therefore stable enough to prevent any alteration of the slabs. The 3-ply fir wood panel and the polyurethane glue of an unknown composition could eventually prove to be unsuitable in term of preventive conservation. Even if no alteration has been noticed for the moment, we do not have as yet sufficient experience to attest that all of the chosen materials of the support are riskless for the limestone slabs. Nonetheless, if ever the support must be removed from any of the slabs, it can first be cut horizontally and the mortar can be removed mechanically, (e.g. with an air driven pen, without any damage as the mortar is less hard than the limestone of the slabs).

Many of the slabs can be joined side by side with others to form larger surfaces including up to 9 m long dinosaur trackways. For scientific research or museum display, the slabs can be leveled out using wedge or a bed of sand to recreate the original *in situ* state. Thanks to the support, such manipulations can be done without much risk for the slabs or for the handling staff.

In summary, this method involves simple materials and is similar to techniques commonly applied in the restoration of mosaics and wall paintings. This support fulfills the needs of the Paleontology A16 regarding conservation, storage, and handling.

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PLASTIC MILK CRATES AND LIVESTOCK WATERING TROUGHS: A QUICK AND INEXPENSIVE MICROVERTEBRATE SCREENING COMPLEX

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Abstract

Plastic milk crates converted into screen boxes and livestock (such as cattle, horses, etc.; hereafter simply called 'stock') troughs were utilized in an outdoor microvertebrate washing complex. The necessary materials were inexpensive and readily available and assembly of the screen boxes was quick and easy. Over a 6 month period with the help of 72 Encana Badlands Science Camp participants (who washed material for the first two months of this project), we processed approximately 2400 kg (5300 lbs) of material collected from the Maastrichtian Pisces Point locality with excellent results. After Science Camp had ended for the summer, an additional 259 volunteer hours (from August through January) was spent washing, sorting, and identifying fossil material with a net result of approximately 8200 identified fossil specimens. The complex was found to be quick and efficient.

Introduction

While certainly not a new idea, the use of plastic milk crates and stock tanks to soak and wash matrix in the search for microvertebrate fossils (McKenna *et al*. 1994; Cifelli *et al*. 1996) has become increasingly convenient over the years. McKenna *et al.* (1994) mentions the use of plastic milk crates as screen boxes in Montana, but sarcastically states "we wish readers success when they ask grocery store managers for 300 of them." Perhaps before 1994 they were hard to come by, but plastic milk crates are now readily available and can be ordered either singly or in bulk through plastics manufacturing companies. They are easily converted into screen boxes and, when used with UV-resistant plastic stock tanks, are an inexpensive alternative to large-scale river-side microvertebrate screening systems.

During the spring of 2012, the Research Section of the Royal Tyrrell Museum was looking for ways in which to actively involve participants in the Encana Badlands Science Camp (through the Education Program) with a more 'hands-on' approach to the actual research process. It was determined that if an outdoor microvertebrate screen washing area was assembled, a large number of participants could take part in collecting and washing matrix from a specific locality and eventually sort and identify microvertebrates from the concentrate. This would give them start-to-finish experience in how the process of microvertebrate collection occurs.

That summer, a test screen washing complex was assembled and the participants were taken to the Pisces Point locality to collect material for washing. For the duration of the Science Camps Program, the participants attended the screen washing complex several times per day, adding more material, setting material out to dry or cleaning the troughs as necessary. Since this was the first summer of this trial, the material they sorted and identified ended up being from a different locality. Nevertheless, they still came away with a more complete understanding of how the process occurs.

The Research Section continued to collect material from that locality for the remainder of the summer, which was washed, sorted, and identified. With the onset of fall and cooler (and eventually much colder) weather, the sediment was brought inside and the processing of the material continued with great success.

Materials and methods

For this project, materials that were readily available, easily assembled and stored, and that could be used both indoors and out where needed.

The 378.5 litre (100 gallon) plastic stock tanks were purchased from a local agricultural store for approximately $130.00 (all prices are in Canadian dollars) each. The plastic milk crates are 31.75 cm (12.5") square and were purchased for approximately $12.00 each. The silicone, aluminum strips, wire mesh, and wooden supports were purchased for approximately~$4.00 per milk crate.

Individual large concrete slabs were placed in an open area. The slabs were used to keep the troughs flat and stable and the workspace around the troughs from becoming too muddy.

Eight, 378.5 litre (100 gallon) stock troughs were placed onto the concrete pads and filled with water from the tap at the back of the museum. The troughs needed little preparation for use. About a dozen dime-sized holes were drilled along the long edge of the upper rims to allow the water and sediment to drain completely when the troughs were cleaned. Each trough was then numbered using a large permanent marker to ensure that there was no inadvertent cross contamination occurred if different localities were being washed concurrently.

The milk crates are made of molded plastic and come in a variety of colors, which could come in handy for identifying multiple localities when bulk washing. The top 15.2 cm (6") of the sides are perforated with large holes and handles, but the bottom 12.7 cm (5") are solid plastic, which stops any sediment from escaping during the washing process. The bottom is a latticework of strong plastic struts with 2.5 cm (1") gaps.

The stainless steel #032 gauge mesh (32 opening per inch or 0.0065" wire diameter) was cut to fit snugly and placed in the bottom of the milk crate. It was screwed into place from the inside at 8 locations around the periphery of the crate to keep the screen taut. Along the inside vertical sides of the crate and on top of the screen were screwed four pieces of bracket aluminum that had a right angle bend. These strips secured the screen in place. Each piece of aluminum is 2.7 cm (1") vertically (located along the side of the crate) and 1.27 cm (0.5") horizontally (located along the bottom of the crate). These pieces of aluminum were secured with two screws each. The screws were made of stainless steel to prevent rusting. Also, the tips of each screw should then be ground off or flattened to alleviate any possibility of injury.

Silicone was used to seal both the top and bottom edges of the aluminum strips, as well as along the seams in the corner where the pieces met, to ensure that no fossils were retained within the gaps. The silicone was allowed to cure for at least 24 hours, as per the instructions on the tube, and then the screen boxes were ready for use.

Milled 2x4 lumber, each approximately 1.2 m (4') in length, were slid into the two opposing handles of the milk crate screen boxes and set onto the top rims of the water-filled troughs. Three milk crates fit into each water trough. Matrix was then scooped into the screen boxes and soaking/washing commenced.

Once the water had become sufficiently dirty as to hinder the washing process (due to a high level of particles in suspension), the screen boxes were removed and the troughs were simply tipped over to allow the water and fine clean sediment to run out onto the ground behind the concrete slabs. Most of this fine matter eroded away during the next rain and left little evidence of the process behind.

Discussion and conclusions

As with all test projects there are pros and cons that affect the final outcome. Below is a list of pros and cons experienced with the use of this complex:

The positive aspects of this type of microvertebrate screening process are:

- The materials are readily available and inexpensive
- The materials necessary and assembly time for the screen boxes is minimal
- The stock tanks have a high UV rating and can withstand extended periods in the sun
- The small size of the stock tanks make them easily moved for storage
- The stock tanks nest within one another and therefore take up less storage space when not in use
- The stock tanks are small enough to tip over when cleaning without spending time to remove the water first
- The 2x4 supports keep the boxes high in the water column so the clean matrix that has filtered through does not interfere with the concentrate remaining in the screen boxes
- The troughs are deep enough to allow considerable accumulation of disconsolidated sediment before cleaning becomes necessary
- The milk crates are ready-made and only need the installation of the screen lining
- The milk crates are sturdily constructed and will last a considerable length of time
- The plastic struts across the bottom of the milk crates supports the screen so more material may be added than in unsupported screen boxes

- The supported bottom stops the screen from being pulled out from under the aluminum strip or stretching out of shape, minimizing potential fossil loss
- The milk crates have multiple holes and handles high up on the sides which allows the water to flow through aiding in the disconsolidation process
- The milk crates are fairly light weight and easily manipulated even with a layer of wet matrix along the bottom
- Lifting one end of the 2x4 supports several inches into the air allows the technician to test flow rates and determine whether the material is ready to be set out to dry or if more material should be added
- The multiple handles and machine-cut holes in the top of the milk crates allowed easy access for wiring identification cards to decrease the possibility of cross-contamination between localities
- Outdoor use lessens the worry of a mess indoors and leaves room for other projects
- The water is warmed by the sun which increased the slight convection within the trough helping with the disconsolidation process
- Setting the washed concentrate outside decreases the drying time during the summer
- The complex may be brought into the museum during the winter and washing continued or stored as necessary

Some negative aspects of this type of process are:

- There is an increased possibility of vandalism or theft after hours or disruption by animals (although we did not experience any during the summer of 2012)
- The 2x4 supports kept the boxes high in the water column so the troughs had to be filled quite full to submerge the matrix
- Constant submergence promotes the deterioration of the silicone and its eventual failure as well as promoting the rusting of non-stainless steel screws
- Being outside in the summer increases the water's evaporation rate so the troughs had to be topped up regularly (every few days during continued hot sunny weather)
- Being outdoors means that the technician has to go out in all types of weather to maintain the washing process
- Washing at the museum instead of in a field camp means that the technician is tied to the washing location
- The wetting and drying process cracks the wooden supports quickly which may lead to the technician getting splinters or other mild injuries
- The troughs basically create a pond environment which attracts multitudes of insects that need to be rescued daily, including stinging insects like bees and wasps
- Once the weather begins to cool, the convection within the trough ceases completely and the disconsolidation process stops below 4°C (39° F)

Conclusions

Overall, the trial use of these materials during the summer of 2012 was considered a success. The use of plastic milk crates to wash matrix in the hunt for microvertebrate material is a quick, easy, and an inexpensive alternative to building boxes from scratch. Plastic stock tanks are convenient because they need little preparation before use, and can be easily stored when the project is completed. An outdoor system increases the washing potential of the matrix because of the natural convective turnover within the troughs due to daily heating and cooling of the water. The recovery of over 8200 identified fossils indicated that this quick, easy, and inexpensive screen washing complex works so well that the project is going to continue next summer.

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CREATING A HIGH-RESOLUTION MOLD AND CAST OF *VANCLEAVEA CAMPI*

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Introduction

Vancleavea campi, the Late Triassic archosauriform from Ghost Ranch, NM, is known from a few fragmentary specimens- including the holotype and almost complete articulated skeleton, GR-138 (Nesbitt *et al.* 2009). A three dimensional reproduction, useful for research, as well as exhibit, was desired and the lead author was given the task of producing such a cast (Fig. 1).

The skeleton is intertwined with those of other animals in a crowded bonebed and the goal was to highlight this animal's skeletal elements without the visual confusion of elements from other animals appearing in the cast. Modifying standard practices (Reser 1981, Cavin 2011), the skeleton of *Vancleavea* was isolated from the conglomerate of bones, and molded using directly evacuated rubber, pressure, and additional procedures to produce a high resolution cast with zero damage to the fossil material. This cast would be exhibited a few feet away from the actual bonebed block in medium to low ambient light provided by florescent fixtures. Historically, visitors had difficulty understanding what they were seeing on the block. A degree of poetic license was exercised in highlighting features of the cast.

Methods and materials

While the skull and left femur have been removed and three dimensionally prepared, the remainder remains in bas-relief on the surface of a sub-block removed from the much larger *Coelophysis* Quarry block in the center of the exhibit hall at the Ruth Hall Museum of Paleontology, Ghost Ranch, New Mexico, U.S.A. Prepared by museum curator Alex Downs, the bone was well stabilized and consolidated. The mudstone matrix is stabilized in places, but not consistently, and is full of cracks and fissures.

Pre-molding provisions

The block was sealed by carefully tamping tissue paper into the larger cracks over which a veneer of modeling clay was spread. Smaller cracks were sealed with clay alone. Irregularities in the surface of the matrix and bones from other animals were also covered with tissue and clay in this manner. The skull was treated similarly to the minimum extent needed to prevent trapped rubber. (See figure 4 to see the apparent need.) The surface of the clay was stippled with a ball-end mimeograph stylus to produce a visual artifact similar to the surface of a golf ball.Thus, these surfaces were instantly identifiable as artificial, but unobtrusive.

The mold would only cover a portion of the surface of the block, so sturdy clay walls were placed along the perimeter of the skeleton to contain the rubber and plaster of the mother-mold. The rest of the block was covered with aluminum foil as a splash-guard (Fig. 2).

Molding

Next, rubber was poured in a series of evacuated batches with the first layer massaged with compressed air at low psi since the mold was larger than vacuum chamber.The average depth was 1.5 cm and 7 mm on the walls. The rubber on the walls formed a skirt covering the mother mold which was poured in plaster to an average depth of 4.5 cm. After the plaster was fully cured, all mother molds received a coat of varnish followed by paste wax. This facilitates easier cleaning of resin.

Now, with the bottom rubber of what will be a one-piece mold removed from the block and placed on top of its mother mold, rubber sides to contain the resin were added. Rubber was poured in a flat-bottomed pan to a depth 6 mm and cut into strips 10 cm wide. These were glued around the bottom edge with silicone caulk and held in place with sand bags until the caulk set. Gaps in the seams were filled with rubber applied with great care to avoid drips on the registration surface.

The skull and femur were molded in standard two-piece molds with multiple sprues and gates using the lay-up method (Fig. 3). Although the contact area is small, the sprues are large to allow any resin misbehavior to occur there, rather than in the cast. Each batch of rubber was evacuated twice, once in the container, and again after application to the specimen. This is most important on the first coat, everything goes into the vacuum, the expanding meniscus ensures 100% coverage and the vacuum ensures bubble free contact of the rubber with the substrate. Our equipment facilitates rapid movement in and out of the vacuum chamber.

These specimens are delicate and complex so the rubber over them must be thin (2 mm), to optimize its full elasticity. The rubber was re-enforced with nylon stocking material to enhance durability and dimensional stability. It was also allowed to cure under pressure so remaining bubbles would compress to the same dimensions they would as when the resin filled mold is pressurized.

Casting

The one piece body-fossil mold is the largest by far and takes 7 liters (1.5 gal.) of resin to fill. With the other two molds, this project used two gallons of resin. A kit of resin produces two gallons costing $400.00. The amount needed to fill a mold is typically determined by filling the mold with water and measuring the quantity. However, this mold is made of multiple rubber parts glued together. Completely removing water from a complex of seams is problematic and curing urethane behaves badly in the presence of water. In this case, the volume was determined by filling the mold with epoxy coated aquarium gravel. The large mold also must be leveled before pouring by inserting shims under the bottom of the mother mold and finding an average level over the undulating registration surface in two axes.

The desired color must be determined and added to one of the components. Pigment is added to part “B” with this resin. It was mixed to be a little darker than the base color of the fossil bone (a light gray with faint blue overtones). Thirty milliliters was added to a gallon of part “B” which is already pigmented white. This provided a high level of color saturation helpful in making the resin as opaque as the natural material and the white correctly lightened the shade.

For a multi-batch pour, and especially a multi-mold project, the pigmented resin is kept in an airtight container such as paint can. Warm dry air from a hair dryer is blown into it every time it is closed, displacing humid air. The wide top also facilitates remixing to avoid color separation. Urethane resins can be unpredictable, but if cured under pressure they exhibit model behavior.

The largest mold was too big to fit in the vacuum or pressure chamber and the large volume of reacting resin increases exothermy so precautions were taken in pouring it. Resin was poured in three successive batches sequentially catalyzed, the last added before the first reached gel-stage. Each batch was evacuated before pouring with the first receiving the compressed air massage mentioned above.

After the resin (4 cm thick) cured, there were two “islands” of registration surface not covered. Dams were chosen as the economical method to contain resin covering the islands. Rubber left over from making the mold walls was cut into strips placed around the “islands,” with the ends butting up against the mold walls and clamped in place with clothespins. A thin flash coat of resin was poured over this construction to seal it. When that set, the enclosure was filled to a depth of 1.5 cm covering the high points.

The rubber halves of the skull and femur molds were joined with a very thin layer of vegetable shortening applied to the mating surfaces. Care must be exercised to keep it off the registration surface. It allows the mating surfaces to easily slide over each other and correctly lock into the alignments features designed into them. The mother molds are placed on each side and the “sandwich” held together with more than several large rubber bands. The resin batches are evacuated before use, poured in the molds to 25% of capacity, evacuated, filled completely and set in the pressure chamber to cure overnight. The 25% volume of the initial filling is a flexible number as long as, under vacuum, the meniscus rises into the sprue channel.

Chasing the casts

The casts will need a certain amount of machining, and since resins do not really reach full cure for a month or longer, if possible, it is advantageous to wait several weeks before working the resin because it will be easier to carve, saw, and otherwise mill. The large slab-like cast was designed to have a sacrificial 5 mm rind around the edge so mold marks could be removed. This was done with a large flame-shaped carbide burr in a ¼" pneumatic die grinder followed by a pencil grinder with a smaller egg shaped burr to provide a pleasing pattern of tool-marks all around the edge.

The smaller casts had flashing thin enough to be blown off with compressed air while the sprues were cut off with a coping saw, the stumps milled close to contour with a pencil grinder and finished flush by carving to the surface under the microscope. Sewing needles (button needles) in pin-vises and ground to various bevels were used for this final chasing. After painting, the skull and femur were fastened to the main cast with steel-filled epoxy, which bonded very strongly to the urethane resin.

Painting

Initially, resin casts have a thin oily scrim from the components of the resin itself and the vehicle delivering the pigment. This must be removed with detergents before painting can begin. Even mild solvents like alcohol attack the surface of the resin. A powdered laboratory detergent, long used to clean medical instruments, worked very well in this case.

Fossil bone contains infiltrated matrix as well as mineralized organic material. Since the resin was the color of the bone by itself, all the shades of paint applied to it would be the colors of the variegated matrix wiped back to reveal the essential bone color to varying degrees. A series of thin washes of differing dilutions of these colors was also used to help provide depth. All the areas covered with stippled clay were painted the same mono-color so the artificial areas in the cast could be easily distinguished.

India ink was the base applied color to provide contrast that could be softened to various degrees by subsequent applications of other materials. It was wiped back vigorously on the bone where it stayed in the pores and foramina (Fig. 5). Multiple washes were used over the India ink on other parts of the cast. All the paints and washes consisted of artist's oil colors thinned with genuine distilled turpentine; this combination has demonstrated longevity and effectiveness over urethane resin in the past.

Results and conclusions

A splendid property of silicone rubber became quite apparent during the wiping back process, that is, it faithfully reproduces the substrate. In this case the skeleton on the slab was covered with the thickest obscuring consolidant, followed by the skull with the femur producing the most accurate bone surface on the cast. Consolidants have to be in the bone, not on it, to produce the most accurate casts. Time was not available to pursue reduction of the consolidant layers, but the issue should be borne in mind. With the exception of part of an anterior *Coelophysis* skull overlaying our target, this criterion was met.

These procedures produced an effective exhibit element and an accurate research cast. More importantly, the post procedure condition of the specimen is excellent. There was no rubber infiltration of the skull or femur. The molds came off cleanly and easily, as did the tissue/clay infillings. No repair of any kind was needed (Fig. 4). This was also true of the block, which was easy to de-mold and divest of the myriad of infillings. This circumstance is due to the masterful preparation of the specimen by Alex Downs. His expertise ensured both the present condition of the specimen and the quality – our position on consolidant build-up notwithstanding – of the cast (Fig. 6).

Materials List

• modeling clay	Van Aken Plastina
• RTV rubber	Silicones Incorporated GI-1000
• tissue paper	Georgia Pacific Angel Soft Toilet Tissue
• urethane resin	Hapco™ Ultralloy 108 white
• de-airing agent	Hapco™ antiair
• resin pigments	Hapco™ Color Dispersions
• oil paint pigments	Grumbacher, Van Gogh, Graham, Winton
• turpentine	Windsor Newton Distilled Oil Color Turpentine
• India ink	Martin's Bombay
• laboratory detergent	Organex™
• steel filled epoxy	J-B Weld
• pastewax	Johnson
• varnish	Minwax Polyurethane Semi-Gloss
• aluminum foil	Reynolds
• silicone caulk	G.E.
• aquarium gravel	Estes Spectra Stone
• vegetable shortening	Crisco
• plaster	Hydrocal White

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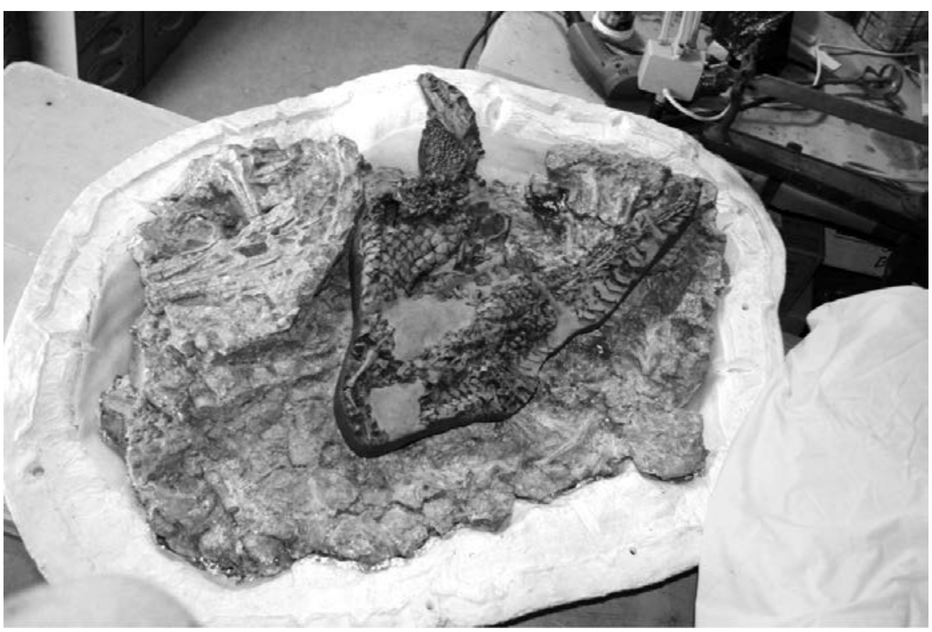

Fig. 1. Vancleavea cast superimposed on the actual specimen in the Ghost Ranch sub-block.

Fig. 2. Block with clay walls, rubber poured, and aluminum-foil splash guard in place before mother mold was poured.

Fig. 3. Exploded view of skull mold showing sprue and air channel placement.

Fig. 4. De-molded skull showing zero damage.

Fig. 5. Painted skull cast before the application of the last wash.

Fig. 6. Completed cast viewed outdoors in the harsh morning light.

CULTIVATING PEDAGOGY: A HOLISTIC APPROACH TO PROFESSIONAL DEVELOPMENT

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The nature of our profession

Many of us have stumbled into the profession of preparing fossils and caring for fossil collections. This discovery may have occurred through a university course, volunteer service, an acquaintance with a working professional, or even an early childhood interest. Regardless of how we may have entered into the profession, we all share a common interest in the acquisition, conservation, and care of specimens with scientific and historical significance. These common interests serve to advance the study of science and broaden the general public's understanding of life's biodiversity.

The task of acquiring fossil specimens that we prepare and conserve for the purpose of research and education is familiar to us all. Yet over the years, differing methods and techniques have been employed to care for and manage these collections. Given that our experience is cumulative, how do we go about imparting this knowledge tradition to the next generation of fossil preparators and collections personnel? Cultivating pedagogy, whereby people are equipped with the tools of how to critically think about their discipline, may help to foster a continuum of knowledge and professional development within our community.

The status of current professional training

While there are various educational paths and training available for those pursuing an academic interest in our profession, few options remain for those seeking further education related to technical or supportive roles within our profession. The cumulative experience and expertise of seasoned professionals largely shapes the direction of future fossil preparators and collections personnel. The common sense wisdom of this professional working community over time has defined our current meaning of best practices. While many working professionals desire to impart their knowledge to inquiring minds, our prevailing responsibilities do not always allow us to fully invest our knowledge in others. In light of this predicament, how might we as a community, better equip those seeking an education in our field where no formal degrees, curriculums, or certificates are available?

The need for holistic education

Many of us have particular areas of interest or a focused skill set that we are intent on cultivating. The broader we develop our understanding of museum curation beyond our particular areas of interest, the better equipped we will be to impart a holistic knowledge to those seeking training. Understanding why we do what we do, and for what end or purpose, affects the result of our work and the way in which we go about doing it. Teaching people how to think instead of what to think and giving them a knowledge base of methods and techniques to draw from will allow them to make informative decisions on their own, as issues arise. Recognizing and fostering an individual's innate talents and skills are important when mentoring students, staff, and volunteers. Soliciting funding for educational opportunities such as workshops, training sessions, curriculum, and peer reviewed publications will be useful. Participating in discussion forums, list serves, and web tutorials will also add to our current understanding of developing best practices. As a result of broadening our own knowledge base, we will be better able to equip those seeking an education in fossil preparation and collections management.

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THE COOPER CENTER: DEVELOPMENT OF A NEW CURATIONAL FACILITY AND VOLUNTEER TRAINING PROGRAM

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A partnership to preserve the past in Orange County

Paleontological mitigation in Orange County, California, over the past 35 years has resulted in a backlog of fossil and artifact specimens spanning from Jurassic to historic time. The Dr. John D. Cooper Archaeological and Paleontological Center (The Cooper Center) was established as a partnership between California State University, Fullerton (CSUF), and the County of Orange (OC Parks) to manage and promote outreach and research on the County's vast archaeological and paleontological collections. Improvements included the construction of laboratory, office, and new climate-controlled collections space, which opened in July, 2011, and the Center became fully staffed in April of 2012. CSUF has begun development of a vertebrate paleontology program within their geological sciences department, to compliment existing invertebrate paleontology, paleoecology, paleoclimatology, and sedimentology programs. In about a year and a half of operation, almost 20,000 fossil specimens and archaeological artifacts have been cataloged and curated of an estimated 2 million+, representing a history of Orange County going back 180 million years. The collections represent almost unlimited research potential with global significance. Outreach efforts include temporary exhibits throughout the County, and a strong social networking presence, including a series of educational shows on a dedicated channel on YouTube, The Cooper Channel, developed entirely by volunteers.

Volunteer program

As a small facility with a minimal staff and budget, volunteers are crucial to the daily operations of the Cooper Center. In a short amount of time, The Cooper Center has established an extremely successful and popular volunteer program, with over 40 volunteers, students, and interns who collectively donate over 200 hours a week. A training program funded by the Society of Vertebrate Paleontology's Marvin and Beth Hix Preparators' Grant has been initiated to improve the quality of the volunteers working at the Cooper Center paleontology laboratory, to maximize the efficiency of training for the staff, and to increase the sense of value and accomplishment for volunteers, students, and interns. Productivity from volunteers enrolled in the curation training program has increased by 300%, with vast improvements in the quality of work and reduction of error. Additionally, volunteers report feeling a greater sense of accomplishment and interest in seemingly mundane tasks such as repackaging materials to archival standards. Additional training programs to be introduced in the near future include fossil preparation, docents, lead volunteers, and research and analysis. The Cooper Center represents a novel approach to managing the growing volume and decreased funding of paleontological collections worldwide, with responsibility for the management of the collection split by the partnership between CSUF and OC Parks and a strong well-organized volunteer program.

BLUE-GREEN DISCOLOURATION OF FOSSILS AT THE RTMP: POTENTIAL CAUSES AND TREATMENTS

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Between 1987 and 1993, a number of fossils in the Royal Tyrrell Museum of Palaeontology (RTMP) collections developed a blue-green staining, or 'discolouration', on their surfaces and surrounding matrix. Many of the affected fossils had been stored together in proximity to various molds made from latex, silicone rubber, polyester resin, and fibreglass. RTMP staff inferred that somehow these molding materials were reacting with the fossils to cause the discolouration.

Samples were sent for analysis to the Canadian Conservation Institute (CCI) in 1987 and again in 2010, with the aim of identifying the blue-green substance and the mechanism by which it formed. Both resulting reports were inconclusive, but they ruled out potential causes such as mould, lichen, copper carbonate, vivianite and other blue/green minerals, adhesives and consolidants, cyanoacrylate accelerator, and specific vapours emitted by the molds (methyl ethyl ketone, acetone, styrene, silanes, hydrochloric acid, and hydrogen peroxide).

CCI's 2012 analysis detected trace levels of a triphenylmethane dye known as Basic Green 4 in some of the affected fossils. CCI noted that Tapparo et al. (2011) had found similar triphenylmethane compounds forming on the surfaces of prehistoric flints at the Natural History Museum in Verona, Italy. Tapparo *et al.* (2011) concluded that the discolouration was caused when volatiles emitted by a rubber stabilizer in the plastic pads under their storage cabinets reacted with the flints. CCI suggested that a similar reaction could have occurred at the RTMP, although they could not replicate the process. Exposure experiments between various molding and casting materials and previously unaffected fossils are ongoing at the RTMP.

The blue-green discolouration can be removed mechanically when only the matrix around a fossil is affected. Air abrasion using bicarbonate of soda has been most effective but is not suitable for all fossils and must be evaluated on a case by case basis. When the surface of the fossil itself is stained, it is difficult if not impossible to remove. The surface of a severely stained pachycephalosaur skull dome (TMP 1987.036.0363) was swabbed with various chemicals used in the removal of stains from masonry (Grimmer, 1988). They were applied in order of least to most harsh: water, mild detergent, acetone, ethyl alcohol, hydrogen peroxide, acetic acid, trisodium phosphate, and mineral spirits. All except the latter three were also applied in the form of a poultice with powdered dolomite, a method used in stone conservation in which the chemical loosens the stain and the powder absorbs it, drawing it away from the object's surface (Grimmer, 1988). Regardless of the success of the treatments, the decision to use harsh chemicals to remove the staining must be carefully considered, as the chemicals applied may interact with the fossils in unforeseen ways and cause further problems in the future. Attempts to remove the stain will continue.

While the blue-green discolouration is primarily a cosmetic concern as the structural integrity of the fossil is unaffected, the compounds found on the discoloured fossils could prohibit future analyses of these specimens (Tapparo *et al.*, 2011). Discolouration of an object is classified as deterioration (Tetrault, 2011) and the principles of preventive conservation dictate that any deterioration should be minimized (National Park Service Museum Handbook, 2012). To prevent any further discolouration of fossils in the future, all molds, casts and any other potentially unstable plastic or rubber materials will be separated from fossil specimens.

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TESTING THE TENSILE STRENGTH OF PARALOID B-72 TO DETERMINE ITS POTENTIAL APPLICATIONS AS A PALAEONTOLOGICAL ADHESIVE

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Although Paraloid (Acryloid) B-72 is known to be an effective consolidant, its potential as a structural adhesive is disputed in the field of palaeontological conservation. The tensile strength of a 50% w/w solution of Paraloid B-72 was tested in comparison with Paleobond PB100 (cyanoacrylate) and Devcon 2-Ton epoxy using a universal testing machine at the University of Alberta. Thirty limestone test samples were prepared for each adhesive. Limestone was chosen as a proxy for fossil bone for the purpose of standardization. The samples were pulled at a load rate of 0.085 MPa per second.

The average tensile strengths in MPa were 2.215, 3.402 and 5.425 respectively, and 5.098 MPa for the limestone. These results indicate that the epoxy is an undesirable adhesive choice in this scenario because its bond is stronger than the limestone. Furthermore, while the Paleobond PB100 had favourable results it should only be considered a potential option for tensile strength when vital criteria such as reversibility and long term stability are taken into consideration. Thus, although Paraloid B-72 had the lowest tensile strength of the three adhesives these tests illustrate that there are applications where it would be an acceptable choice as an adhesive in palaeontological conservation.

PREPARATION IN THE GALLERY: METHODS USED TO ENRICH VISITOR EXPERIENCE ABOUT PREPARATION AND COLLECTION

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The Royal Tyrrell Museum employs an interactive approach to the education of its visitors; from the use of gallery experience officers to educational productions such as *Science Break*. One of the most successful teaching exhibits employed today is the gallery preparation table, which is located outside the large window that overlooks the preparation lab. The gallery preparation table provides visitors with a close up view of the many aspects of preparation, while supplying a platform for questions and discussion. This table was first introduced in the summer of 1999, as a transitional interactive display, during the temporary exhibit of *China's Feathered Dinosaurs*. The preparation table was such a success with staff and visitors that the project is still ongoing today. Additional educational methods are employed in this area of the gallery, including a look into the process of collecting fossils in the field, which utilizes listening devices for supplementary information. In addition, the large window overlooking the preparation lab incorporates video displays that provide information on fossils being prepared at five different stations. Three monitors exhibit live views of actual fossil preparation ongoing in the lab. These additional exhibits and displays are helpful in promoting questions and discussion from visitors with the staff at the gallery preparation table. Through the progression and evolution of the gallery preparation table, staffing has changed many times over the past 14 years, but the exhibit has remained successful in its main purpose; to display a specimen during preparation while promoting a dialogue on the techniques and procedures of collection and preservation at the museum.

TECHNIQUES UTILIZED TO ISOLATE AND PREPARE CHONDRICHTHYAN VERTEBRAE AND SUBMILILETER-SIZED DENTICLES FOR PHOTOGRAPHY AND DESCRIPTION

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In 2011, an extremely rare, partial ray called a guitarfish, *Myledaphus bipartitus* (TMP 2006.038.0013) was jacketed and collected near the top of the Dinosaur Park Formation (Campanian), Dinosaur Provincial Park, Alberta. This unique find included a string of vertebrae surrounded with cartilage and denticles in a fine siltstone. Additionally, isolated teeth, precaudal and caudal vertebrae, cartilage, and denticles were collected from the site via surface collecting and bulk matrix sampling as the specimen was mostly eroded away.

The section of sixteen vertebrae was identified as a caudal segment, causing immediate interest as there have been no caudal vertebrae described from *M. bipartitus.* The specimen was prepared from the top (erosional surface) down, as opposed to the more conventional method of bottom up, owing to the fragile and partially eroded nature of the specimen. The specimen was photographed and subsequently mapped using a small wire grid (10x10 cm). The section of vertebrae, including approximately 5-8 cm of surrounding matrix and 5 cm of matrix underneath, was removed from the block for further preparation and study. Of the remaining matrix, approximately 3 cm was removed from the surface for screen washing as there appeared to be no further articulated material. Screen washing boxes comprised of a screen size of 32 holes per inch, which permits sediment to fall through thereby retaining small fossils. However, most denticles are too small to be retained in the screen for analysis. It was necessary to sample denticles directly from the specimen itself. Cartilage was systematically removed from each individual vertebra in the column and placed in position-labeled vials.

Cartilage containing embedded denticles was broken down using a sonic bath for approximately 10 min. in water at 20°C to remove and isolate denticles (0.1-0.3 mm diameter) for identification and description. Preparation consisted of additional sonic bath treatments for 5 min intervals and some mechanical preparation using small insect pins. Due to the small size and delicate nature of the denticles, specimens were mechanically prepared in a work area isolated by draped plastic sheets to catch, retain, and allow for easy detection of the small denticles, which are prone to springing from the work area during preparation. Further cleaning was necessary in acetone to remove small particles and fibers clinging to the surface. Four types of unique denticles were identified. The best specimens of each type were carefully transferred to stubs for photography in an environmental scanning electron microscope. After each imaging, the denticles were shifted to display alternate profiles, and the adhesive stub material needed to be mechanically prepared off the denticles. These images were cropped, rotated and placed alongside images of isolated vertebrae that were photographed with ammonium chloride dust. The images will be used to describe and elucidate the caudal morphology of this rare specimen of *M. bipartitus*.

RECOGNIZING AND SOLVING THE IDENTITY OF DINOSAUR MYSTERY QUARRIES IN ALBERTA

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The history of excavation of dinosaurs in Alberta spans nearly 130 years. Early collectors kept poor locality data, making relocation of these sites for subsequent work difficult. In the badlands, old quarries are found, but who was there, when, and what was collected are unknown and beg for resolution. Once resolved, the scientific value of the specimen increases and questions regarding aspects of early collecting are better understood and addressed (e.g. Maganuco, 2004; Tanke *et al*., 2004, 2010a,b; Brinkman, 2013). Some quarries, especially in Dinosaur Provincial Park (DPP) are marked with a metal *in situ* quarry stake, but several hundred more quarries across the province were never marked and remain unlocated (lost quarries) or are found and unidentified (mystery quarries). The latter can be identified by the following features:

A. Notch cut into the side of outcrop creating a hole large enough to contain a skull and/or portion of a skeleton. Notch may be badly eroded depending on vintage and rock type. Quarries in harder sandstone are still visible nearly 100 years later, whereas sites in soft shale or small in size may erode away in <10 years.
B. Eroded waste rock below the site often showing disruptive bedding plane structures (from that of the original *in situ* rock). The scree slope of *ex situ* rock can erode to resemble *in situ* rock. Digging into it however reveals loose sediment and jumbled up pieces of rock- sometimes bearing pickaxe marks.
C. The presence of garbage in the site or scattered nearby. Garbage from quarrying activity consists of: plaster, wads of plaster/burlap, milled lumber (often encrusted in lichens), tree trunks or branches (both unused jacket splints), newspaper, cans, glassware, glazed earthenware (jugs), wire and nails. Garbage in these sites is readily differentiated from that generated by farmers/ranchers and heavy industry (i.e. oil field). Absence of plastic trash indicates the site is likely pre-WWII.
D. Bone deliberately left behind, or newly exposed by subsequent erosion.
E. Presence of vegetation. Quarries often disrupt natural rainfall drainage patterns. Flat quarry floors capture rainwater and loose eroded sediments, creating ideal growing conditions for plants.

With experience, solving a mystery quarry is not that difficult and done by various means:

1. Size of excavation. A small quarry 2 metres x 1.5 metres into the hillside didn't contain a full adult hadrosaur, but could hold a ceratopsian skull. However, this is only a general guide. Sometimes quarries are made oversize because the specimen was disarticulated or while vainly pursuing skeletal parts lost to erosion or never preserved.
2. Bone on site. Early collectors in Alberta often ignored bone that was already eroded out. In some cases, looking below the site and finding bone pieces identifies the animal in question. Pieces of the type specimen of *Styracosaurus parksi* (AMNH 5372), collected in 1915 were found 91 years later and catalogued as TMP 2006.019.0005. Historical photographs in Brown and Schlaikjer (1937) also matched the terrain (see 1915 vs. 2006 photopairs in Tanke, 2010b; figs. 51A-B and 52A-B). Sometimes *in situ* bone is found, especially in quarries where the animal was disarticulated. Subsequent erosion reveals bones unknown to the original collectors. A mystery quarry containing ankylosaur scutes and a left humerus is a good lead—somewhere a museum has an ankylosaur missing that humerus. Museums with ankylosaur skeletons collected from your field area with a left humerus preserved are readily eliminated.
3. Quarry trash. Early collectors were pretty casual when it came to garbage disposal in quarries. Some collectors, such as Levi Sternberg, left rather messy sites. Trash in quarries was left laying around or became buried in the scree slope during quarrying activities. Decades later, these items still sit on the surface or are re-exposed by erosion.
    a. Tin cans, nails, and wire usually survive if they are just laying on the surface and can dry

out. Any metal buried shallowly and in a damp soil horizon will eventually rust away. Nails and wire indicate that crates are being built on site and therefore a major specimen was collected.

b. Lumber or tree branches can survive a long time—wood dating back nearly 100 years has been seen. Short flat milled plank pieces are remnants from crate construction. Unused tree trunks or branches are good indicators something large was removed- these would have served as splints within larger jackets. Proximally, branches may still preserve axe or saw cuts revealing human modification. The older the wood, the darker, more rotted, and lichen-encrusted it is.

c. Glassware is usually found broken, but may be reassembled. Old glass has unequal wall thickness, more crude construction than modern glassware, air bubbles, and formerly clear has turned a purple color (c. 1920 and older glass) due to chemical additions to the old glass reacting with UV light. Bottles and jars can sometimes be identified and dated using antique glass collector catalogues.

d. Earthenware "moonshine" jugs (for shellac glue) or pieces thereof are useful for dating. In Alberta, historical photographs show they were used from 1917-1921 only.

e. Newspaper is the most valuable item left behind. Logic would dictate that is would not survive long on the surface, but 1916 newspaper was found this way in 2001 and 1918 paper in 2006. In all DPP cases but one, the year of the newspaper equals the year of excavation. The year of the paper can be learned from the top of the page, but if that is not preserved, then it can be deduced from datelines and other clues. A c. WWI quarry with a newspaper ad for a store sale happening on Saturday, July 18 can be narrowed down to 1914 via internet old calendar searches because July 18 does not always occur on a Saturday. Newspaper source is also critical. Collectors often receive mail and newspapers from home. Pieces of a 1925 Ottawa Citizen newspaper found in a mystery quarry are not from an AMNH dig because the AMNH worked in Alberta 1910-1915. However, the Geological Survey of Canada, based in Ottawa, was in Alberta that year so one can ascertain that they excavated that quarry.

4. Archival photographs or film. Old photographs are ideal for use in finding a lost site or identifying a mystery quarry. Usually multiple photographs are taken at any given site. Over time, they can become mixed up. Sorting these out can be done by looking for commonality of subject matter like landmarks/strata, fossils, people (and their clothing and hats), horses, tools, etc. One caveat of their use however, can be the image was printed backwards—a not uncommon occurrence. Shadow casts in photographs can provide useful orientation information as to which way the camera was facing.
5. Most expeditions should have produced a crate listing of all major specimens collected that summer. This will be useful for process of elimination work.
6. Historical accounts. General histories of who was working where and when exist and provide a good general background. Landowners, local history books, microfilmed or digitized online newspaper accounts also provide information.

Examples of resolved mystery quarries in Alberta are related in Tanke (2001, 2005a,b, 2006, 2010a), Tanke and Ralrick (2010), Tanke and Evans (2011, accepted manuscript); and Tanke and Russell (2012). Similar sites have been relocated in the United States (Hunt and Lucas, 2003) with identification success (e.g. Anonymous, 1998; Keimig, 2000; Sullivan, 2006; Tabrum, 2006; Wahl *et al*., 2007; Switek, 2012; Sullivan and Lucas 2011, 2013). Hunt-Foster *et al*. (2010) record a failed quarry relocation attempt. Overseas, a lost *Spinosaurus* site in northern Africa was possibly identified via quarry trash interpretation (Highfield, 2001).

Mystery quarry identification: a hypothetical case

Here is a hypothetical case study of a mystery quarry found, the thought processes and reasoning involved, and its successful identity resolution. Most of points 1-6 immediately above are utilized and highlighted.

While prospecting for fossils in the badlands, a mystery quarry is located. A well-eroded notch 3.5 metres (11.5') wide, 3 metres (9.8'), and a back wall up to 2.5 metres (8.2') is present. The size of the hole (**1**) indicates a major specimen was collected. Some bone (**2**) remains in the quarry. Also there is some wire (**3a**), milled lumber (**3b**), purple glass pieces (**3c**), and eroded plaster chunks (**3f**). The presence of purple glass indicates the site is c. 1920 or older.

So we know the site yielded a large and major specimen and was collected circa 1920 or older.

A disarticulated adult hadrosaur left coracoid in perfect condition and the distal half of a badly eroded hadrosaur tail remain in the quarry (**2**). The coracoid is found emerging in the quarries far corner, was fully *in situ* when the quarry was worked, and the original collector did not see it. However, the tail must have been known to him, being exposed on the edge of the quarry.

The site is c. 1920 or older, yielded a hadrosaur which was partially disarticulated, is missing the left coracoid (more perhaps?) and missing the distal tail.

Historical accounts (**6**) show Barnum Brown worked the area 1916-1917, and George F. Sternberg was there 1919-1923. No other crews worked there until 1963. The purple glass means any 1963 - present work is discounted.

Site is c. 1920 or older, yielded a hadrosaur which was partially disarticulated, missing the left coracoid and distal half of the tail; and likely collected by Brown or Sternberg.

A scrap of newspaper (**3e**) is found in the scree slope. A partial story describes baseball legend Babe Ruth having a successful beginning to his first season with the New York Yankees.

Internet research reveals Babe Ruth began with the New York Yankees in 1920. Knowing this, Brown is eliminated from consideration. The hadrosaur quarry was likely Sternberg's in 1920.

Historical accounts (**6**) reveal that Sternberg collected independently in 1920 and he sold his entire collection to the University of Alberta (UALVP).

The hadrosaur with its missing left coracoid and distal end of the tail must be stored at UALVP, or elsewhere if it was traded or sold subsequently.

UALVP collection records and specimen lists penned by Sternberg in 1920 (**5**) reveal he collected four hadrosaur specimens. Three are at the UALVP. One was collected near the town of Steveville, 15 kilometres distant from your mystery quarry and is discounted. The second was traded to an American museum but was sub adult—too small to fit the adult coracoid and tail. It's discounted, leaving two adult hadrosaurs.

Your mystery quarry must have yielded one of the two remaining hadrosaur specimens.

The two adult hadrosaurs are examined. One has a distal tail preserved and discounted. By process of elimination *Gryposaurus* UALVP 1234 is revealed. Is it the dinosaur from your mystery quarry? The left coracoid to it is in fact missing, and the proximal half of an articulated tail is present of which the distal segment is badly eroded.

Gryposaurus UALVP 1234 is the dinosaur which came from the mystery quarry.

Can this conclusion be further tested? Yes. UALVP 1234 preserves the right coracoid. You compare the one you have by now collected and prepared to that collected in 1920. Morphologically and size-wise they match. In UALVP archives are Sternberg photographs (**4**) labeled "Alberta badlands, 1920." Examining these, you find two field photographs; one showing your mystery quarry before excavation and one showing the exposed skeleton, somewhat disarticulated anteriorly and with its badly eroded tail, which Sternberg deemed unsalvageable so he left it behind.

Gryposaurus UALVP 1234 came from the mystery quarry and also the identity of some "Alberta badlands, 1920" pictures can be upgraded. The coracoid you collected can be donated to UALVP, and you share the spatial and stratigraphic information you've recorded on site.

Not all mystery quarries are solved this way, but the scenario, logic, and process of elimination methodology is typical. Some mystery quarries are known, but contain only plaster so their identity remains unknown for now- perhaps forever. Quarry trash, depending on its age, may come under protective legislation and considered as archeological artifacts. Use of metal detectors and/or removal of trash from older palaeontological sites or in protected areas may violate local, provincial, state, or federal laws.

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PROFESSIONAL PALAEONTOLOGY AND INDUSTRY IN ALBERTA, CANADA: A SUCCESSFUL WORKING RELATIONSHIP

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Introduction

In Alberta, the Royal Tyrrell Museum (RTM) and the Royal Alberta Museum (RAM) benefit from working with industry, which includes the activities of oil companies, various types of mining operations (coal, ammonite, etc.), gravel pits and road, rail, residential and commercial construction. In Alberta, by law, it is mandatory to report the discovery of any fossils uncovered during any of these activities to the Minister of Culture via the RTM (Alberta 2000). The RTM either works directly with the companies themselves (oil, mining, construction) or filters projects to the RAM (gravel pits) to recover any fossils that are encountered during excavation activities.

Legislation

The *Historical Resources Act,* to which palaeontological resources (fossils) were added on July 5, 1978, is the main piece of legislation governing the collection and protection of fossils in Alberta (Alberta 2000). Section 31 of the *Act* states that a company must report any fossils discovered during development to the Minister of Culture (in this case via the RTM). Section 37(2) of the *Act* states that if the Minister feels that the operation of activities will damage a historic resource, he or she can order that an assessment be performed to mitigate this damage before operation of the activities begin (Alberta 2000). Thus, in Alberta, at the very least, companies are required to report any palaeontological finds as outlined in section 31. In cases where it is determined that industry operations will negatively impact palaeontological resources, they may be required to submit impact assessments and/or have ongoing monitoring for their project. Once a fossil has been discovered, companies work with the Resource Management Program at the RTM that acts as a conduit between professional palaeontological consultants and both the RTM and the RAM, to help mitigate damage to palaeontological resources in the province.

History

Palaeontologists in Alberta have been working with industry to recover fossils at least since the mid-1930s. In 1936, "folded calcareous argillite", originally thought to be dinosaur eggs, was found during highway construction near Waterton National Park and investigated by C.M. Sternberg (Anonymous 1937 a, b). In the late 1970s, Philip J. Currie took part in the collection of a hadrosaur discovered during surveying of the Dome Petroleum pipeline (Anonymous 1977 a, b).

Since then, the RTM and RAM have worked with a variety of industries and companies. This has resulted in a number of significant specimens being recovered and deposited in both museum collections, including significant mammal material being discovered in Drumheller and a marine reptile skeleton in Fort McMurray due to road and building construction projects. Projects such as sewer construction in Edmonton have turned up a dinosaur bonebed. In September 2010, the RTM had its 25th anniversary. To celebrate this milestone, the exhibit *Alberta Unearthed* was installed, highlighting the top 25 specimens collected in Alberta over the last 25 years. Of these 25 specimens, five (25%) of them are a direct result of industry. This illustrates how the cooperation between industry and palaeontologists can produce some of the most important scientific and display specimens.

Since 1989, the Quaternary Palaeontology Program at the RAM has been working closely with members of the sand and gravel industry. Current Quaternary palaeontology collection holdings at the RAM is nearly 32,000 specimens. Of those, approximately 6000 were collected through cooperative relationships with members of the sand and gravel industry. The large number of Quaternary fossils recovered from gravel pits has been essential to understanding the record of megafauna in the province and for examination of late Pleistocene geological and faunal patterns (e.g., Burns and Young 1994; Jass *et al.* 2011).

Working Together

Despite the fact that companies are legally obligated to report fossil finds, it is important to encourage them to actually do so. One myth commonly encountered within industry is that a project will be shut down, either temporarily or permanently, if a fossil is found during excavation. In practice, RTM and RAM researchers and palaeontological consultants work with companies to quickly get fossil excavation work done so there will be minimal impact to the companies. In some instances, companies are asked to rope off the area where the fossil is located so they can continue working without putting the safety of the fossil at risk. When microfossil sites are discovered companies are often asked to dig out a large sample, place it to the side and continue working.

Workers at the companies often take an interest in the palaeontological excavations and palaeontologists will take the time to discuss finds with them. Often, industry staff and management are encouraged to visit museum collections to better understand how fossils are used for both research and outreach purposes. This seems to be particularly effective in encouraging industry participation in the recovery of fossils. Another effective tool for encouraging industry buy-in is naming new sites or specimens after the workers who discover the site or specimen. For example the Zagas site (a Paleocene fossil mammal locality found during the construction of the Stoney Trail interchange in Calgary, Alberta) was named after the person who first reported fossil clams at the site. People who discover sites or fossils may even be included in scientific publications. There is also the potential that companies and individuals will be named in exhibits where specimens they found are being used. Casts of fossils are sometimes provided to companies to display in their corporate offices or at local museums. At times, the media will be called about a site. The possibility of positive media attention, highlighting the good corporate citizenship of the company may also be an incentive to report a fossil. However, this is typically just a bonus for the museums and the company and not the primary reason for reporting the fossil.

Industry can also help in fossil extraction and research in Alberta in a variety of ways. When doing their work, companies move an abundance of overburden to reveal potentially fossiliferous bedrock, sands, and gravels. This can result in the discovery of fossils that would not have been exposed naturally within the foreseeable future. This is particularly true for Quaternary fossils from gravel pits, where isolated remains are abundant, but very thinly distributed within large volumes of sand and gravel. At times, companies will supply museum teams with heavy equipment and skilled operators. This includes equipment to remove overburden more quickly or lift jacketed fossils on to trucks or trailers. RTM staff have been offered places to stay when working at distances from the museum, reducing costs and travel time. Companies have paid for portions of grade surveys and have provided volunteers for various activities. These are not things that the companies are in any way required to do, yet measurably aid in the expedited collection of specimens.

There are some challenges associated with the cooperation of palaeontologists and industry. There can be considerable staff turnover in industry, which presents obvious challenges to maintaining long-term relationships. Continual effort to maintain open communication with industry is helpful, but in an ever-evolving staff environment, such efforts require significant inputs of time. Unsuspecting damage can be done to fossils by heavy machinery if they are not seen or recognized for what they are right away. In this case, educating workers ahead of time on what to look for and how to proceed when they find something is key to preventing damage to fossils.

When museum staff are working in mining or construction areas, extra safety equipment and procedures are required. Education for museum staff on the importance of proper safety within work areas and enforcing the safety regulations is essential and is often provided free of charge by the host company. Museum staff may need to take special training before working in these industries.

Proper communication and understanding of each other's work approaches can also be a challenge. The mind set of industry and palaeontologists, while neither is wrong, can be very different. It is sometimes the thoughts of industry that they will be shut down or held up when they find a fossil, costing the company time and money. It is important that palaeontologists working with companies do not perpetuate this notion. This may require palaeontologists to work more quickly than they would normally. On the other hand it is important that companies understand the importance of collecting the specimens properly. Educating the groups on the reality in both situations is important to provide a healthy working relationship. Companies should be made aware that palaeontologists do not want to interfere with their work and palaeontologists should acknowledge that this is a business for these companies, interfering as little as possible. It is also important that industry be made aware of the importance of these finds. Allowing palaeontologists to collect specimens contributes to the heritage of all people living in Alberta and increases our understanding of prehistoric life.

Several Success Stories

RTM has had a long standing working relationship with Korite International, Smoky River Coal and several companies from the oil sands. These relationships have provided specimens that are rare and exemplary. The relationship with Korite began in 1977 when they were finding ammonites with purported mosasaur bite marks. These ammonites benefitted the RTM greatly when they were later used for research purposes (e.g. Kase *et al.* 1998). In 2002, they found their first marine reptile, a mosasaur. Since then they have found six more marine reptiles (two plesiosaurs and four mosasaurs), making them one of the world's most important localities for these Late Cretaceous vertebrates. Their method of digging, including a spotter close by, allows them to spot marine reptiles before they are destroyed by machinery. Since 2007, Korite has provided heavy machinery to trench and then remove jacketed specimens, saving palaeontologists weeks of work. Due to their significant contributions, in 2012 a new genus of plesiosaur (*Albertonectes vanderveldei*) was named after Korite's late founder, René Vandervelde (Kubo *et al*. 2012).

Companies that the RTM has been working with in the oil sands include Suncor, Syncrude (e.g. Anonymous 2000 a,b; Shufelt 2011) and Canadian Natural Resources Ltd. (CNRL). Syncrude found the first marine reptile (an ichthyosaur) in the oil sands mines in 1992 (Nichol 1994). As with Korite, this is now a significant region for older marine reptiles of Early Cretaceous age, producing both plesiosaur and ichthyosaur fossils. In 2010, a surprising find, possibly a new type of ankylosaur, was found at Suncor. CNRL has contributed invertebrate fossils to the museum collections. Collectively, working with oil sands industry over the past two and half decades has resulted in the discovery and collection of thirteen major marine reptile finds, representing three new taxa (Tanke and Mitchell, in progress) and one dinosaur. All of these finds were made possible through the cooperation of the companies and their diligent reporting of fossils. These companies have also been helpful by providing transportation within their mines, machinery for overburden removal, food, volunteers and materials for excavation. Oil sands companies have also supported research by providing funding to university students studying marine reptiles found in their quarries (e.g. Druckenmiller and Maxwell 2010; Druckenmiller and Russell 2006, 2008, 2009).

The RTM began its relationship with Smoky River Coal (now Grande Cache Coal) in the fall of 1989. A slab of dinosaur tracks was reported by the mine. Later work by RTM staff disclosed half a dozen spectacular new sites preserving thousands of Lower Cretaceous dinosaur ichnites and trackways. Numerous plant remains were also seen. Plant fossils and ichnites were collected or moulded in latex rubber. The mine assisted by granting permission to use restricted access roads, storage of RTM materials and equipment, alerting the RTM to newly exposed sites, provided heating materials allowing latex to cure properly in freezing temperatures, allowed a tour of an underground mine to investigate the possibly of ichnites in the ceiling, allowed use of low-flying helicopters to explore inaccessible outcrops and photograph trackways, and the use of a large crane to extract a heavy slab of dinosaur ichnites. The mine also supported several post-secondary students, one with strong ties to the RTM (e.g. McCrea 2000; McCrea and Sargeant 2001). In exchange, the RTM gave formal talks to mine staff and/or Grande Cache citizens, talked with mine workers who visited museum work sites, and provided some casts of dinosaur tracks to both the mine and the town of Grande Cache (Anonymous 1992). Our work generated local newspaper coverage where the mine was acknowledged for their assistance.

Conclusion

Through dedicated cooperative ventures and education over the past four decades, we have witnessed a strong growth and mutual respect leading to the discovery of fossils that otherwise would never have been found. Our work with industry has resulted in a better understanding of each other's work procedures. Such professional relationships bode well for future discoveries, scientific research, and the preservation of often hitherto little known aspects of Alberta's fossil heritage.

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EYE SURGERY AND THE FOSSIL PREPARATOR: SOME PERSONAL PERSPECTIVES

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Introduction

An estimated 75% of North American adults use, or will require, some type of visual augmentation or correction in their lifetime via prescription glasses, contact lenses, lens replacement (due to cataracts), laser surgery, or other procedures. Lens replacement surgery for cataracts first occurred in 1949 and correcting vision defects by laser began in 1989. Since these technological advances, millions of people have been successfully treated by both methods.

Both authors are fossil preparators who have recently undergone major eye surgeries; Tanke had laser (LASIK©) in 2010 and Reser had bilateral lens replacements in 2012. With a combined 68 years of fossil preparation experience (Tanke, 33; Reser, 35), the authors are now acquainted with fossil preparation before and post-surgery. With the latest eye surgery technologies, it is possible for recipients to continue much of their life without prescription eyeglasses, be it for cosmetic or medical reasons, though for fossil preparators, reading glasses or other means of vision correction may be required for detailed work. Here we present our experiences prior to, post-operation, and after recovery. We share our observations with others in the field of palaeontology, especially technicians, to serve as background information for those thinking of getting laser eye surgery or needing lens replacement. Having the work done can be a life-changing experience that one should be prepared for. It is different than simply getting a new set of prescription glasses; it can be like getting an entirely new set of eyes. We also thought these observations could be useful for those training or supervising fossil preparation lab volunteers. [Usage of the brand names LASIK© or OptiVISOR© herein are not to be considered product endorsements by us or the Alberta Government and are provided here for general reference only.]

Tanke's perspectives: laser eye surgery

My previous vision was "very poor"; I'd worn glasses with a very strong prescription since about age seven. Very near- sighted, anything more than 15 cm (6") away was badly out of focus; for example, a newspaper held 25 cm (10") away was unreadable regardless of font size. Everything would become in equal focus when I brought the newspaper close (about 11 cm or 4.5") to my face. Contact lenses were tried in 1984-1985 but dust and especially wind constantly drying them out resulted in their disuse. My decision to get LASIK© was a personal one, having long desired to be rid of glasses. By 2010 the technology had improved more and at $3000 (CAD), it was still expensive, but affordable.

More immediate post-operation effects were light sensitivity, dryness, itchiness, uneven focusing (i.e. one eye focused more than the other or, using both eyes, something that is slightly out of focus today, is in focus tomorrow). Some of these symptoms rarely and briefly reappear now and on such a minute scale that their effects are negligible. Some occurred while I wore glasses; their occurrences post-operation may not be LASIK©-related. Some people see flares or halos around lights in full darkness so therefore someone else should drive at dusk and night until your eyes have recovered. Probably the one permanent change post-LASIK© is my vision at mid-dusk which is not as good as before, but could perhaps be age-related. Sudden changes in light levels can be an issue; leaving a lit room and going outside at night can be a bit of an adventure as I slowly gain my night vision. Sometimes there are differences viewing objects via reflected light or transmitted light.

During fossil preparation I have to wear reading glasses for any work that is 40 cm (16") or closer. Post-LASIK©, I tried preparation without optical assistance on just matrix but did not entirely trust my vision and therefore the quality of my work would be compromised. For close up work I now wear a head-mounted flip-up visor (OptiVISOR©) mostly with 5X lenses, often used in conjunction with my

1.5X reading glasses. I can do microscope work without any corrective lenses. In the field I can do general uncovering work without glasses, but close up I use 1.5X reading glasses, often augmented with the 5X OptiVISOR©. After my initial LASIK© examination, I was told that due to age and eye condition that LASIK© would mostly work, but after recovery objects 40 cm (16") away or closer I would still need reading glasses; they were fully correct in that determination. Having a little bit more close up vision, even just 10 cm (4") for fossil preparation without reading glasses would be great, but that's life.

If you get LASIK©, you'll undergo an adjustment period, while your brain "re-hardwires" to what you are seeing and you experiment with different strength reading glasses until you find what works best. Remember though, your eyes are healing over a long period and can be readjusting for up to a year, so the reading glasses you use now may need to be replaced tomorrow, then back again the day after. Do keep reading glasses of different strengths handy as your vision may fluctuate slightly. I now have 20/20 vision.

Reser's perspectives: lens replacement for cataracts

I've worn glasses since the age of nine and progressed to trifocals. I was very near sighted (20/400) with unilateral astigmatism. However within 10 cm (4") my vision was very good with great depth perception. This allowed certain proficiency for close up work without glasses. Tempered glass goggles allowed me to almost touch the work with my nose without fear of flying debris. If I needed magnification I went straight to the microscope which I always, and still, use without glasses. Visor magnifiers don't work well for me and I only use them in extreme circumstances. This was a satisfactory arrangement for decades.

Since I've always spent time outdoors, lived fifty years in New Mexico, and have done substantial fieldwork, it's not surprising I developed incipient cataracts. For three years, I was unable to get a glasses prescription that actually worked decently. My health care provider offered cataract surgery as a solution. Consulting with the surgeon, I explained that I would like to retain, as far as possible, good near vision without glasses. He replied that I would still have to wear glasses, but he would adjust the trade-offs to provide something close to what I wanted. My worst eye was done on October 24, 2012 and the next one on November 7, 2012. The prescription for my trifocals was done a month later. My distant vision is just shy of 20/20. I can read street signs, and resolution of horizon details might be better than ever. In the field, ground details are sharper and clearer than before. Worth mentioning is that I had a set of glasses made up with only the distance prescription for the entire lens allowing me to see my feet clearly without having to bend my neck down to bring the long range lens to bear. Wearers of bi and trifocals will know what I'm talking about. This is a great improvement for prospecting and injury prevention in broken country.

My natural good close vision is gone. Without glasses, I focus well at 30 cm (12") but the depth of that focus is only about 25 mm (1"). With the glasses, my middle vision focuses from 43- 53 cm (17-21") and the close lens focuses at 15 cm (6"). Using the same microscope without glasses as I've always done, I find my depth of vision is about half of that prior, meaning I have to adjust the focus twice as often. When I do this I think I see as sharply as before but I can't be certain. This uncertainty over whether I could resume working to the tolerances I expect of myself has largely vanished. I say "largely" because my old vision is not available for comparison. My memory of it though persuades me that I haven't lost my touch.

Discussion

Tanke's perspective

Cataract surgery may be required to address a medical issue; most get LASIK© for cosmetic reasons. The latter should not be taken lightly. It took about one year before my eyes fully healed and all post-surgery symptoms went away. During this time I had to be extra careful about getting dust and rock chips in my eyes. Many fossil preparators also do fieldwork in hot, dusty, windy areas, and with intense sunlight. All of these can or will negatively affect your healing eyes. Forest fire or cigarette smoke, pollen, or airborne chemical vapors (i.e. acetone solvent in glue) would also likely cause some aggravation. Sweat, laden with grit or insect repellant and UV protection (creams or sprays), can also get into your eyes. These will likely have negative consequences too, so wear a bandana and goggles, and avoid applying such products to your forehead and eye regions. Women might want to think twice about using makeup until healing is advanced.

I was able to do fieldwork within a week of surgery, but under relatively dust-free and cool to cold weather. Three months later, there were some days where my shorter range focusing was not 100% and looking for smaller fossils on the ground somewhat compromised. They simply “blended in” and were overlooked. This was not a dryness issue— I simply could not see them clearly because my eyes were still adjusting and healing. Someone considering LASIK© should schedule it soon after your field season has ended to maximize your healing time prior to next summer’s work. A regimen of specialized eye drops will be used post-operation, but you should also keep a bottle of regular lubricating eye drops on your person for about a year; eye dryness was the number one issue for me. Do other work and/or schedule preparation jobs that are larger and easier to see to avoid eye strain and fatigue during healing.

Reser’s perspective

The minor discomfort I felt after each procedure lasted about a week, and after two months, everything was normal except I occasionally feel the edges of the artificial lenses in my eyes without pain or irritation—a reminder of sorts. A caveat is that the urge to rub my eyes is now an outright prohibition. I found this easy to comply with probably because of the “reminder” just mentioned. I also am hyper-aware of the need to don eye protection at just the hint of producing dust, blowback, etc. where I used to just half close my eyes. I can still deal with the swirling desert dust. Prior, I was developing the typical old person’s diminished night vision, and now at full dark, my night vision is about the same. But dusk is a real problem and I studiously avoid driving then. This is odd because everything is brighter now and colors more vibrant. I had dry eye problems before the procedures and a month after them the condition was just as before with no increase in my twice daily use of artificial tears.

General discussion

A survey asked respondents who both did fieldwork and/or fossil preparation and had undergone LASIK© or lens replacement about the pre and post-operation conditions and its subsequent longer term effects on them; results are shown in Table 1. While the respondent size is small, negative post-operation symptoms of dryness, reduced close up focus and altered dusk vision were noted by nearly all.

The authors feel that a comment on eye surgery and older field or lab volunteers is required here. These volunteers may have failing eyesight, new eye prescriptions, or have undergone lens replacement, LASIK©, or other invasive eye procedures. New volunteers or those so affected should be specifically identified. If they have undergone any type of eye procedure a sufficient healing time should be allowed. Bright or dusty conditions, work resulting in flying rock chips, or projects needing close up work (with resultant eyestrain) should be avoided or mitigated. Consider putting them on larger, more generalized projects where they can work at or near arm’s length. New volunteers of any age having recently undergone LASIK© or lens replacement may not only have difficulties due to their inexperience; supervisors need to be aware that post-operation they may simply not yet be able to see at the level of detail expected and should be managed accordingly.

Perhaps mentioning the use of personal protective equipment (i.e. safety glasses) would be appropriate.

Conclusions

The authors hope this paper has given readers considering LASIK© surgery or needing lens replacement some background on what they might expect if they follow through and get the work done.

Sex/ age	Years as preparator with glasses vs. those with eye surgery	Surgery cosmetic (C) or medical (M)?/ Laser (LASIK) or cataract replacement?	Surgery date(s)	Time until you could prepare fossils after surgery?	Any post-operation issues/regrets having the procedure done?	Duration of these symptoms?	Pre-operation were you near or far-sighted?	Focusing issues post-surgery?	Any negative changes?	Was your new vision as predicted by surgeons?	Any long term changes? Did you need follow up surgery?
F/45	15/4	C; LASIK	July 2008	3 days	No, No	---	Near	worse than pre-surgery; can't focus within 25cm (10") of eyes	No, able to deal with dusty conditions which was issue with contacts	Yes	No, No
M/ 69	35/0.3	M; cataract	Oct and Nov 2012	1.5 months	Impaired dusk vision; No	Permanent, respondent believed	Near; astigmatism (one eye)	See text; "Reser perspectives"	Reduced dusk vision; see text	Surgeons uncertain about positive outcome; vision is better than expected	No indication of need for follow up and vision currently stabilized
M/ 59	31/10	C; LASIK	June 2002	Immediately	Dryness, drooping eyelids, bad night vision; No	Dryness still an issue; night vision took a year to get back to normal	Near and astigmatism	Close up work requires reading glasses; distance vision OK	No, and night vision now as good as before	Yes	Had surgery for droopy eyelids
M/ 52	33/2	C; LASIK	March 2011	In field 3-4 days later/no issues; able to prepare fossils on return (1 month)	Dryness, dusk vision impaired; No	Dryness 6 months; still a bit dusk impaired	Near	Close up work requires reading glasses and/or head-mounted magnifying visor	Reduced dusk vision; see text	Yes	No, No

Table 1. Results of a questionnaire sent to people who had LASIK© eye surgery or lens replacement due to cataracts and post-operative effects on them as a fossil preparator.

TESTING A NEW PROCEDURE FOR REMOVING AGED CONSOLIDANTS FROM HISTORIC COLLECTIONS

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Introduction

A recurring issue for fossil collections is how to handle the variable, and sometimes destructive, techniques historically used for preserving fossils. One common historic technique was to 'shellac' specimens with natural resins to increase stability and make them more aesthetically pleasing (Bather 1908; Howie 1984). As a coating aged, it often shrank and peeled, becoming viscous and darkening to the point of obscuring the specimen. Materials used at the time were also prone to cross linking as they aged (Davidson and Alderson 2009). At the Non Vertebrate Paleontology lab of the Texas Natural Science Center at University of Texas at Austin, these complications are exacerbated in the sections of repository which have inadequate climate control, and exposure to high levels of dust. We want to remove the aged consolidant and re-consolidate where needed, using archival methods and materials. Current techniques for consolidant removal include applying liquid solvents repeatedly, or as a poultice, to 'soften' the aged consolidants, then manual removal with a pin vice. These techniques are less than ideal with fossil marine invertebrates, due to the moisture absorption and marring that can occur from the pin vice. Any method we use should not swell the matrix with absorbed liquid, should be gentle enough not to mar the surface of the soft fossil material, and should remove cleanly leaving no residue.

The gel debonding formulations used for consolidant removal in fossil teeth was chosen as a candidate for testing. The gel suspension clings to the surface, softening the consolidant. As the consolidant softens and swells, it is absorbed into the gel, leaving the surface of the specimen clean of its aged coating. For our purposes, we adjusted the basic method described for one pH-basic formulation and one pH-acidic formulation, then tested these across various specimens (Dorge 2000; Williams and Doyle 2010). We were hoping that although the original uses of the formulation were for more robust test subjects, that the gel would be effective in removing aged, cross-linked consolidants from highly porous, soft material.

Materials and methods

Nine specimens were selected from our historic collections; three from the Dumble Survey collection, three from the Plummer Collection and three from the Rio Bravo collection. Only non-type specimens of common taxa were considered. Criteria for selection were collection during or before 1940 and visible darkening of consolidant. Fragments of aged consolidant were removed from these samples with a scalpel, or, for harder matrix, a rock saw lubricated with water. These samples were tested for resin composition with FT-IR spectrometry by Julian Carter, conservator for the National Museum of Wales. The results suggest the Dumble Survey specimens were treated with shellac or cellulose acetate. From the Plummer collection, results were less than clear, with a range of possible resins. Consolidants from the Rio Bravo collection were shown to be same material in all three cases, a mixture of copal and sandrac.

Because of the consistency of resins used in consolidating the Rio Bravo material, we chose this collection as a starting point for testing. Six specimens from lot Rio Bravo NPL 53306 were selected for consolidant removal using gel formulations; two smooth *Spisula praetenius* shells, one rough surfaced *Spisula* sp. internal mold, an intact *Modiolus texanus* shell cluster and two unidentified bivalves whose shells appear to have been to delaminating at the time of initial consolidation.

The formulation for the gel consists of 6g Carbopol® EZ-2 and 20 ml Ethomeen® C/25 for the gel component, and 200 ml ethanol, 200 ml acetone and 50 ml xylene for the solvent component. The single step method combines the Carbopol® EZ-2 and Ethomeen® C/25, then the solvents, then catalyses this mixture with 50 ml of deionized water. The 2 stage method combines the Carbopol® EZ-2 and 50 ml of deionized water, and requires a resting period of +/-8 hours before adding the Ethomeen® C/25, and finally the solvent component directly after (Williams and Doyle 2010). We received a sample of Ethomeen® C/25 and Carbopol® EZ-2 which we tested with pH strips. The starting pH was 8.0 and the Carbopol® EZ-2 solution, also tested with pH strips, was pH 5.0. Our Ethomeen was listed as 'Ethomeen C/25A', which the representative of Azko-Noble Chemicals assured us was not significant. No further information was provided.

The acidic-pH formulation was made following the single step method, to which we added 20 ml of Ethomeen® C/25 in increments of 5 ml to help raise the pH to 6.0 (Williams and Doyle 2010). For the base-pH formulation, we followed their two-step method, and added 45 ml of Ethomeen® C/25, in 10 and 5 ml increments, to achieve a pH of 8.5. For this formulation, it was necessary to increase the concentration of solvents to keep the same ratio of gel to solvent. Gel was applied with a wooden tongue depressor, and covered with gauze. Plastic was then loosely placed over the specimen. After 15-20 minutes, the plastic was peeled back and discarded. The gel was then removed by peeling back the gauze and checking for shell fragments suspended in the gel. With a stiff bristle paintbrush, the last of the gel was scooped off the surface. Specimens were checked for residue using a dissecting microscope at 8X magnification. Under this magnification, specimens were cleaned of any residue using a brush dampened with water. A rubber cement eraser was also used, but was not effective over rough surfaces.

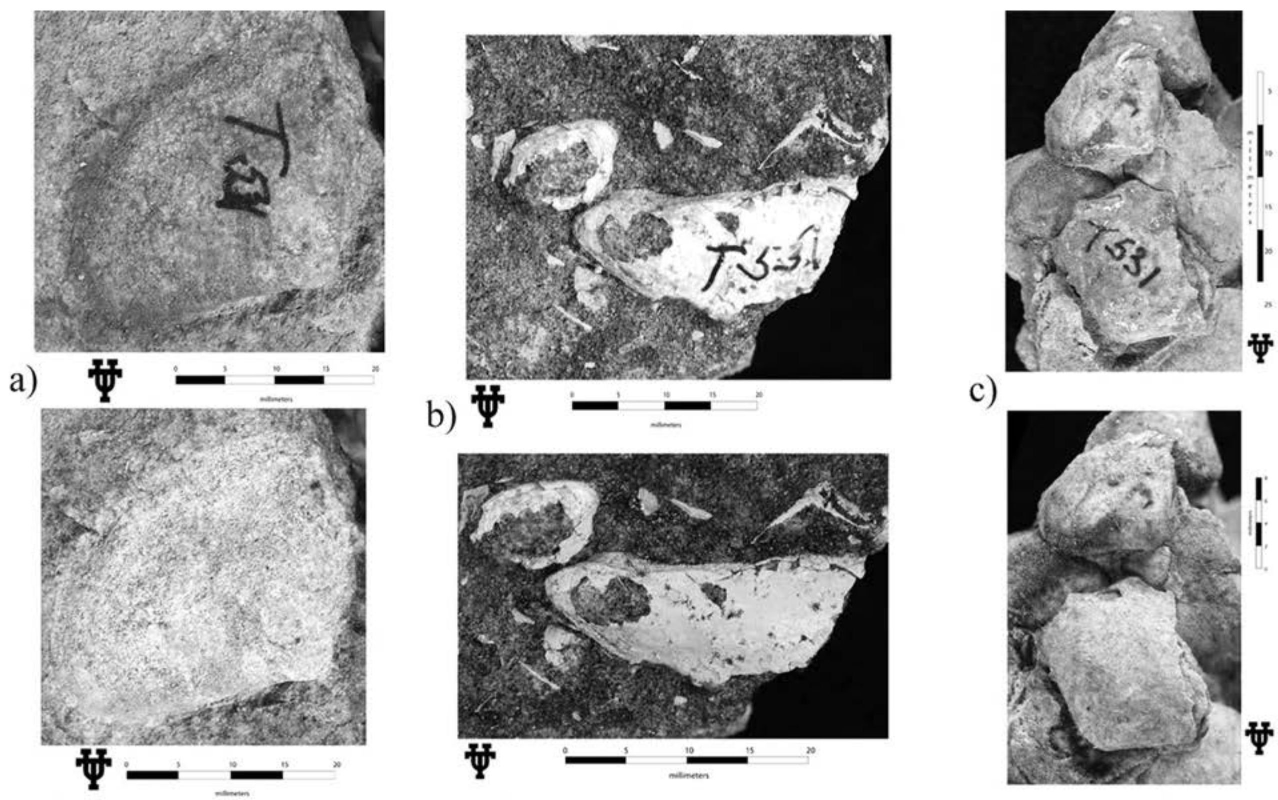

Fig. 1. Three specimens from lot Rio Bravo NPL53301.1. Top row shows untreated specimens, bottom row shows post treatment. a) Rough surface *Spisula* sp. b) unidentified bivalve. c) *Modiolus texanus* shell cluster.

Conclusion and discussion

Previous studies of this gel solvent method on oil paintings showed very little gel is left on the surface, residue was equivalent to touching the surface 10 times with ungloved hands (Dorge 2000). Testing in 2004 of solvent gel residue on aged oil paint showed Ethomeen® C/25 residue degrades fairly rapidly and disappears from the substrate (Stulic and Dorge 2004). Our project has not attempted to quantifiably measure residue on fossil surfaces, or degradation rates thereof. Oil paintings do not have the porosity and textural complications of fossils, which makes preparation records detailing the materials and methods all the more vital for long term custodianship of treated specimens.

We observed the aged consolidant soften and get drawn into the layer of gel. The acidic gel formulation removed all the consolidant it contacted, without damaging the shells beneath. Removing the residue from of the textured surfaces was a challenge even with a second treatment. The more pH-basic formulation left residue consisting of unabsorbed soft shellac and gel. After repeating the treatment, specimens were still were covered in gel and soft consolidant. Adjusting the formula to provide a slightly acidic gel, with a thicker consistency, is the formulation we have found that leaves behind the least residue and does not mar the delicate shell material. These thicker formulations do not penetrate cavities or deep curved planes. None of the gel variants caused visible degradation of matrix or shell material. None of the specimens treated needed re-consolidation, and we are monitoring them for any changes that may occur over the next few months.

This technique has been effective at removing aged consolidants, and the requirements for safety of the specimen. Residue is still a question, we have not yet studied how long it persists, or the effects it has on these fossils. Additionally, as shown in Fig. 1a, locality numbers written on top of the dried resin were stripped off during the cleaning process. All marks on specimens must be carefully recorded prior to treatment.

Selection of specimens to have aged shellac removed will be on a case by case basis. Smooth specimens take the treatment very well. Some internal molds and other heavily textured surfaces present a challenge, and are only recommended for treatment when consolidant removal is required for research, or to prevent a cracking aged consolidant from further damaging the specimen.

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